A partial list of peer reviewed journal articles that used Low Resolution Electromagnetic Tomorgraphy (LORETA) as of October 2009

1. Zavada, A., A.M. Strijkstra, A.S. Boerema, S. Daan, and D.G.M. Beersma, *Evidence for differential human slow-wave activity regulation across the brain*. Journal of Sleep Research, 2009. **18**(1): p. 3-10.

Summary: The regulation of the timing of sleep is thought to be linked to the temporal dynamics of slow-wave activity [SWA, electroencephalogram (EEG) spectral power in the ~0.75-4.5 Hz range] in the cortical non-rapid eye movement (NREM) sleep EEG. In the two-process model of sleep regulation, SWA was used as a direct indication of sleep debt, or Process S. Originally, estimation of the latter was performed in a gross way, by measuring average SWA across NREM-REM sleep cycles, fitting an exponential curve to the values thus obtained and estimating its time constant. In later studies, SWA was assumed to be proportional to the instantaneous decay rate of Process S, rather than taken as a direct reflection of S. Following up on this, we extended the existing model of SWA dynamics in which the effects of intrusions of REM sleep and wakefulness were incorporated. For each subject, a 'gain constant' can be estimated that quantifies the efficiency of SWA in dissipating S. As the course of SWA is variable across cortical locations, local differences are likely to exist in the rate of discharge of S, eventually leading to different levels of S in different cortical regions. In this study, we estimate the extent of local differences of SWA regulation on the basis of the extended model of SWA dynamics, for 26 locations on the scalp. We observed higher efficiency of SWA in dissipation of S in frontal EEG derivations, suggesting that SWA regulation has a clear local aspect. This result further suggests that the process involved in (local) SWA regulation cannot be identical to the Process S involved (with Process C) in effectual determination of sleep timing - a single behaviour that cannot vary between locations on the scalp. We therefore propose to distinguish these two representations and characterize the former, purely SWA-related, as 'Process Z', which then is different for different locations on the scalp. To demonstrate those differences, we compare the gain constants derived for the medial EEG derivations (Fz, Cz, Pz, Oz) with each other and with the decay rate derived from SWA values per NREM-REM sleep cycle. © 2008 European Sleep Research Society.

2. Zariffa, J. and M.R. Popovic, *Localization of active pathways in peripheral nerves: A simulation study*. IEEE Transactions on Neural Systems and Rehabilitation Engineering, 2009. **17**(1): p. 53-62.

Summary: A methodology is investigated for determining the location of active pathways in a peripheral nerve using measurements from a multicontact cuff electrode. The problem is treated as an inverse problem of source localization and solved using the sLORETA algorithm, developed for the electroencephalogram/ magnetoencephalogram source localization problem. Simulated measurements are generated corresponding to action potentials traveling along either one or three pathways in a rat sciatic nerve. The performance of the proposed methodology using these measurements is evaluated in terms of localization error, missed pathways, and spurious pathways. The source localization performance when assuming an idealized nerve anatomy is compared to that when the correct anatomy is known. The effect of a spatio-temporal constraint based on the nerve anatomy and electrophysiology is also investigated. The approach in its present form was not found to be sufficiently reliable for subfascicular localization in practice, due to mean localization errors in the 140-180 μm range, high numbers of spurious pathways, and low resolution. Nonetheless, the constraints were shown to produce a marked reduction in the number of spurious pathways. Conditions under which the source localization approach may be useful for peripheral nerves are discussed. © 2006 IEEE.

3. Zaehle, T., L. Jancke, C.S. Herrmann, and M. Meyer, *Pre-attentive spectro-temporal feature processing in the human auditory system*. Brain Topography, 2009. **22**(2): p. 97-108.

Summary: In the present study, we investigated the pre-attentive processing of low-level acoustic properties and the impact of this mechanism on functional lateralization in the human auditory system. Mismatch negativity (MMN) of the event-related potentials (ERP) were recorded in 19 adult humans who passively listened to a standard stimulus and spectrally and temporally deviant sounds. We predicted modulations of the MMN amplitude in response to spectrally and temporally graded deviants. Based on recent models of functional hemispheric lateralisation, we further hypothesized a left-lateralized source of the MMN in response to temporal deviants and, in contrast, a right-lateralized source of the MMN in response to spectral deviants. In agreement with our hypothesis, we showed that spectrally and temporally deviant sounds lead to robust MMNs recorded from frontocentral scalp electrodes. The amplitudes of the MMNs were modulated by the grade of spectral and temporal deviation from the standard sound. Furthermore, by using an assumption-free source localization approach (LORETA) we demonstrated functionally lateralized activations with dominance of the right hemisphere for the processing of spectral characteristics and of the left hemisphere for the processing of temporal acoustic properties. Results of our study further contribute to the ongoing debate on the role of low-level acoustic feature perception in functional hemispheric lateralization in the context of auditory and speech processing. Our data indicate that the pre-attentive feature-specific deviant processing is mediated by partly distinct neural subsystems for temporal and spectral information. © 2009 Springer Science+Business Media, LLC.

4. Yao, J., A. Chen, C. Carmona, and J.P.A. Dewald, *Cortical overlap of joint representations contributes to the loss of independent joint control following stroke*. NeuroImage, 2009. **45**(2): p. 490-499.

Summary: The loss of independent joint control in the paretic upper limb is a cardinal sign of movement disorders following stroke. However, the underlying neural mechanisms for such a loss following stroke are still largely unknown. In order to investigate the possible contribution of altered sensorimotor cortical activity to the loss of independent joint control, we measured electroencephalographic (EEG) and torque signals during the generation of static shoulder/elbow torques. We found significant increases in the overlap of shoulder and elbow joint representations at the cortical level in stroke subjects as compared to control subjects. Linear regression results demonstrated significant associations between the cortical overlap of joint representations and the degree of the loss of independent joint control. Therefore, we conclude that an increased overlap of cortical representations for shoulder and elbow contributes to the expression of the loss of independent shoulder/elbow control of the paretic upper limb in chronic hemiparetic stroke survivors. © 2008 Elsevier Inc. All rights reserved.

5. Weis, M., F. Römer, M. Haardt, D. Jannek, and P. Husar, *Multi-dimensional space-time-frequency component analysis of event related EEG data using closed-form PARAFAC*. ICASSP, IEEE International Conference on Acoustics, Speech and Signal Processing - Proceedings, 2009: p. 349-352.

Summary: The efficient analysis of electroencephalographic (EEG) data is a long standing problem in neuroscience, which has regained new interest due to the possibilities of multidimensional signal processing. We analyze event related multi-channel EEG recordings on the basis of the time-varying spectrum for each channel. It is a common approach to use wavelet transformations for the time-frequency analysis (TFA) of the data. To identify the signal components we decompose the data into time-frequency-space atoms using Parallel Factor (PARAFAC) analysis. In this paper we show that a TFA based on the Wigner-Ville distribution together with the recently developed closedform PARAFAC algorithm enhance the separability of the signal components. This renders it an attractive approach for processing EEG data. Additionally, we introduce the new concept of component amplitudes, which resolve the scaling ambiguity in the PARAFAC model and can be used to judge the relevance of the individual components. ©2009 IEEE.

6. Van Overwalle, F., S. Van den Eede, K. Baetens, and M. Vandekerckhove, *Trait inferences in goal-directed behavior: ERP timing and localization under spontaneous and intentional processing*. Social Cognitive and Affective Neuroscience, 2009. **4**(2): p. 177-190.

Summary: This study measured event-related potentials (ERPs) during multiple goal and trait inferences, under spontaneous or intentional instructions.

Participants read sentences describing several goal-implying behaviors of a target person from which also a strong trait could be inferred or not. The last word of each sentence determined the consistency with the inference induced during preceding sentences. In comparison with behaviors that implied only a goal, stronger waveforms beginning at ~150 ms were obtained when the behaviors additionally implied a trait. These ERPs showed considerable parallels between spontaneous and intentional inferences. This suggests that traits embedded in a stream of goal-directed behaviors were detected more rapidly and automatically than mere goals, irrespective of the participants' spontaneous or intentional instructions. In line with this, source localization (LORETA) of the ERPs show predominantly activation in the temporo-parietal junction (TPJ) during 150-200 ms, suggesting that goals were detected at that time interval. During 200-300 ms, activation was stronger at the medial prefrontal cortex (mPFC) for multiple goals and traits as opposed to goals only, suggesting that traits were inferred during this time window. A cued recall measure taken after the presentation of the stimulus material support the occurrence of goal and trait inferences and shows significant correlations with the neural components, indicating that these components are valid neural indices of spontaneous and intentional social inferences. The early detection of multiple goal and trait inferences is explained in terms of their greater social relevance, leading to privileged attention allocation and processing in the brain. © The Author (2009). Published by Oxford University Press.

7. Van der Cruyssen, L., M. Van Duynslaeger, A. Cortoos, and F. Van Overwalle, *ERP time course and brain areas of spontaneous and intentional goal inferences*. Social Neuroscience, 2009. **4**(2): p. 165-184.

Summary: This study measured event-related potentials during spontaneous and intentional goal inferences. Participants read sentences describing the behavior of a target person from which a strong goal or intention could be inferred. The last word of each sentence determined the consistency with the goal induced during preceding sentences. In comparison with behaviors that were consistent with the implied goal, a stronger P200 waveform was obtained when the behaviors were irrelevant with that goal or did not contain goal-directed behavior at all, and this P200 showed considerable parallels between spontaneous and intentional inferences. This indicates that goals were inferred rapidly and automatically while reading the behaviors, irrespective of the participants' spontaneous or intentional instructions. In line with this, source localization (LORETA) of the event-related potentials shows predominantly activation in the temporoparietal junction (TPJ) during and immediately after goal detection (225-300 ms). Before and after this time interval, however, activation is stronger at the TPJ during spontaneous processing, and stronger at the medial prefrontal cortex (mPFC) during intentional processing. Memory measures taken after the presentation of the stimulus materials support the occurrence of goal inferences and show significant correlations with the neural components, indicating that these components are valid neural indices of spontaneous and intentional goal inferences. The results are highly similar to previous ERP research on trait inferences that revealed a similar division of brain activation for spontaneous (TPJ) and intentional (mPFC) processes, but appearing later at about 600 ms, pointing to similar brain areas recruited for social inferences, but at different timings for different inference types.

8. Valdés-Sosa, P.A., M. Vega-Hernández, J.M. Sánchez-Bornot, E. Martínez-Montes, and M.A. Bobes, *EEG source imaging with spatio-temporal tomographic nonnegative independent component analysis*. Human Brain Mapping, 2009. **30**(6): p. 1898-1910.

Summary: This article describes a spatio-temporal EEG/MEG source imaging (ESI) that extracts a parsimonious set of "atoms" or components, each the outer product of both a spatial and a temporal signature. The sources estimated are localized as smooth, minimally overlapping patches of cortical activation that are obtained by constraining spatial signatures to be nonnegative (NN), orthogonal, sparse, and smooth-in effect integrating ESI with NN-ICA. This constitutes a generalization of work by this group on the use of multiple penalties for ESI. A multiplicative update algorithm is derived being stable, fast and converging within seconds near the optimal solution. This procedure, spatio-temporal tomographic NN ICA (STTONNICA), is equally able to recover superficial or deep sources without additional weighting constraints as tested with simulations. STTONNICA analysis of ERPs to familiar and unfamiliar faces yields an occipital-fusiform atom activated by all faces and a more frontal atom that only is active with familiar faces. The temporal signatures are at present unconstrained but can be required to be smooth, complex, or following a multivariate autoregressive model. © 2009 Wiley-Liss, Inc.

9. Toth, M., B. Faludi, J. Wackermann, J. Czopf, and I. Kondakor, *Characteristic changes in brain electrical activity due to chronic hypoxia in patients with obstructive sleep apnea syndrome (OSAS): A combined EEG study using LORETA and omega complexity*. Brain Topography, 2009. **22**(3): p. 185-190.

Summary: EEG background activity of patients with obstructive sleep apnea syndrome (OSAS, N = 25) was compared to that of normal controls (N = 14) to reflect alterations of brain electrical activity caused by chronic intermittent hypoxia in OSAS. Global and regional (left vs. right, anterior vs. posterior) measures of spatial complexity (Omega) were used to characterize the degree of spatial synchrony of EEG. Low resolution electromagnetic tomography (LORETA) was used to localize generators of EEG activity in separate frequency bands. Comparing patients to controls, lower Omega complexity was found globally and in the right hemisphere. Using LORETA, an increased medium frequency activity was seen bilaterally in the precuneus, paracentral and posterior cingulate cortex. These findings indicate that alterations caused by chronic hypoxia in brain electrical activity in regions associated with influencing emotional regulation, long-term memory and the default mode network. Global synchronization (lower Omega complexity) may indicate a significantly reduced number of relatively independent, parallel neural processes due to chronic global

hypoxic state in apneic patients as well as over the right hemisphere. © 2009 Springer Science+Business Media, LLC.

10. Tombini, M., F. Zappasodi, L. Zollo, G. Pellegrino, G. Cavallo, F. Tecchio, E. Guglielmelli, and P.M. Rossini, *Brain activity preceding a 2D manual catching task*. NeuroImage, 2009. **47**(4): p. 1735-1746.

Summary: We investigated the event-related desynchronization (ERD) and synchronization (ERS) properties of cortical EEG rhythms in regions of interest (ROI) during the preparation of a 2D task for manual catching of a moving object. EEG signals were recorded through a 32-channel system in eleven healthy subjects during the interception task consisting of 2D catching with the right hand of a handle moving at constant velocity (1.5 m/s) on a predefined straight trajectory. The first session of catching movements (CATCHING_PRE) was compared with a second session after 1 h with identical characteristics (CATCHING_POST) and with other two conditions, where the subjects had to reach and grasp the handle fixed in the medium of platform (REACHING) and they looked at the object moving without catching it (GAZE TRACKING). Changes of cortical rhythms were correlated with dynamic and kinematic indexes of motor performance in both catching sessions. Movements requiring different strategies (predictive versus prospective) are supported by specific changes of cortical EEG rhythms: in the CATCHING condition a more evident power decrease (ERD) in alpha 2 and beta band in the sensorimotor region contralateral to the catching hand was observed, while in the REACHING one a bilateral ERD in beta band was found. Motor learning and movement automatization were characterized by a significant reduction of theta ERS in the anterior cingulate cortex (ACC), a ROI linked to focused attention, and with a shift of neuronal activation in alpha 2 band from the bilateral superior parietal areas to the homologous area of the left hemisphere. Finally, our EEG findings are consistent with the role of supplementary motor (SMA), premotor and prefrontal areas in motor planning and preparation. In particular, theta ERS in left SMA significantly correlated with an improvement of motor performance, as evidenced by its correlation with the training-related reduction of interception time (IT). © 2009 Elsevier Inc. All rights reserved.

11. Tereshchenko, E.P., V.A. Ponomarev, Y.D. Kropotov, and A. Müller, *Comparative efficiencies of different methods for removing blink artifacts in analyzing quantitative electroencephalogram and event-related potentials*. Human Physiology, 2009. **35**(2): p. 241-247.

Summary: Different methods for blink artifact correction in multichannel electoencephalogram (EEG) have been compared with respect to their efficiency and the relative systemic error of the estimation of the parameters of EEG spectra and event-related potentials (ERPs). Three methods of blink artifact correction have been used: Distraction of the electrooculogram (EOG) signals from EEG signals, zeroing independent EEG components associated with vertical eye movement, and zeroing the principal EEG components related to blinking. The

results have shown that these correction methods can substantially improve the accuracy of the estimation of quantitative EEG parameters while only slightly distorting signals from most EEG sites. It is concluded that wide use of these methods for EEG processing in fundamental and applied studies would be advisable. © Pleiades Publishing, Ltd. 2009.

12. Tei, S., P.L. Faber, D. Lehmann, T. Tsujiuchi, H. Kumano, R.D. Pascual-Marqui, L.R.R. Gianotti, and K. Kochi, *Meditators and non-meditators: EEG source imaging during resting*. Brain Topography, 2009. **22**(3): p. 158-165.

Summary: Many meditation exercises aim at increased awareness of ongoing experiences through sustained attention and at detachment, i.e., non-engaging observation of these ongoing experiences by the intent not to analyze, judge or expect anything. Long-term meditation practice is believed to generalize the ability of increased awareness and greater detachment into everyday life. We hypothesized that neuroplasticity effects of meditation (correlates of increased awareness and detachment) would be detectable in a no-task resting state. EEG recorded during resting was compared between Qigong meditators and controls. Using LORETA (low resolution electromagnetic tomography) to compute the intracerebral source locations, differences in brain activations between groups were found in the inhibitory delta EEG frequency band. In the meditators, appraisal systems were inhibited, while brain areas involved in the detection and integration of internal and external sensory information showed increased activation. This suggests that neuroplasticity effects of long-term meditation practice, subjectively described as increased awareness and greater detachment, are carried over into non-meditating states. © 2009 Springer Science+Business Media, LLC.

13. Tamaki, M., T. Matsuoka, H. Nittono, and T. Hori, *Activation of fast sleep spindles at the premotor cortex and parietal areas contributes to motor learning: A study using sLORETA*. Clinical Neurophysiology, 2009. **120**(5): p. 878-886.

Summary: Objective: The present study examined whether slow and/or fast sleep spindles are related to visuomotor learning, by examining the densities of current sleep spindle activities. Methods: Participants completed a visuomotor task before and after sleep on the learning night. This task was not performed on the non-learning night. Standard polysomnographic recordings were made. After the amplitudes of slow and fast spindles were calculated, sLORETA was used to localize the source of slow and fast spindles and to investigate the relationship between spindle activity and motor learning. Results: Fast spindle amplitude was significantly larger on the learning than on the non-learning nights, particularly at the left frontal area. sLORETA revealed that fast spindle activities in the left frontal and left parietal areas were enhanced when a new visuomotor skill was learned. There were no significant learning-dependent changes in slow spindle activity. Conclusions: Fast spindle activity increases in cortical areas that are involved in learning a new visuomotor skill. The thalamocortical network that underlies the generation of fast spindles may contribute to the synaptic plasticity that occurs during sleep. Significance: Activity of fast sleep spindles is a possible biomarker of memory deficits. © 2009 International Federation of Clinical Neurophysiology.

14. Stern, Y., M.Y. Neufeld, S. Kipervasser, A. Zilberstein, I. Fried, M. Teicher, and E. Adi-Japha, *Source localization of temporal lobe epilepsy using PCA - LORETA analysis on ictal EEG recordings*. Journal of Clinical Neurophysiology, 2009. **26**(2): p. 109-116.

Summary: Localizing the source of an epileptic seizure using noninvasive EEG suffers from inaccuracies produced by other generators not related to the epileptic source. The authors isolated the ictal epileptic activity, and applied a source localization algorithm to identify its estimated location. Ten ictal EEG scalp recordings from five different patients were analyzed. The patients were known to have temporal lobe epilepsy with a single epileptic focus that had a concordant MRI lesion. The patients had become seizure-free following partial temporal lobectomy. A midinterval (~5 seconds) period of ictal activity was used for Principal Component Analysis starting at ictal onset. The level of epileptic activity at each electrode (i.e., the eigenvector of the component that manifest epileptic characteristic), was used as an input for low-resolution tomography analysis for EEG inverse solution (). The algorithm accurately and robustly identified the epileptic focus in these patients. Principal component analysis and source localization methods can be used in the future to monitor the progression of an epileptic seizure and its expansion to other areas. Copyright © 2009 American Clinical Neurophysiology Society.

15. Soei, E., C. Bellebaum, and I. Daum, *Relational and non-relational memory - Electrophysiological correlates of novelty detection, repetition detection and subsequent memory*. European Journal of Neuroscience, 2009. **29**(2): p. 388-398.

Summary: The dissociability of novelty detection in relational (RM) and non-relational memory (NRM) is currently under debate. To further address the time courses and underlying brain correlates of novelty detection, event-related potentials (ERPs) were analysed for encoding and retrieval on three memory tasks in healthy subjects. Spatial and non-spatial RM as well as NRM were assessed separately. The ERPs related to RM and NRM were dissociable for hits and correct rejections in an early and late time window. An early old/new effect was observed for NRM. A late old/new effect replicated the frequently reported recollection-associated old/new effect in terms of direction and amplitudes. Four different novelty types (spatial relational, non-spatial relational, horizontal non-relational and inverted non-relational) were examined. The P3a related to novelty detection differed in horizontal vs. inverted distractors in NRM, but not in spatial vs. non-spatial RM. ERPs for repetition detection (hits during retrieval) and also for subsequent hits (encoding phase) differed between RM and NRM. These findings are discussed in relation to potential brain correlates in RM and NRM during encoding and retrieval. © 2008 Federation of European Neuroscience Societies and Blackwell Publishing Ltd.

16. Shulman, A., B. Goldstein, and A.M. Strashun, *Final common pathway for tinnitus: Theoretical and clinical implications of neuroanatomical substrates.* International Tinnitus Journal, 2009. **15**(1): p. 5-50.

Summary: A final common pathway (FCP) for tinnitus has been hypothesized since 1989 for all clinical types of tinnitus, particularly subjective idiopathic tinnitus (SIT) of the severe disabling type. This was intended to explain the transformation-transition of the sensation of an aberrant auditory sensation - tinnitus (i.e., the sensory component) - to one of affect (i.e., the emotional-behavioral component) or, conversely, that an emotional-behavioral stimulus (affect) can result in the clinical manifestation of a sensation (a sensory stimulus). Understanding the pathophysiology of this transformation is fundamental for the diagnosis of tinnitus and the treatment of the patient, and it presents a dilemma to basic science, neuroscience, and clinical medicine. Clinically, tinnitus is not a unitary symptom; it constitutes many clinical types; can have its origin in the auditory or nonauditory systems and in the peripheral or central nervous system; and may be clinically manifest or subclinical. Accumulating evidence is presented to support the original hypothesis of an FCP. The resolution of this dilemma involves sensory processing (i.e., the integration, identification, and understanding of the ongoing, underlying, simultaneous, multiple associated brain function processes not only from one sensory modality but from multiple sensory modalities accompanying and associated with an FCP). In the FCP, the predominant brain function process is that of the sensory-affect transformation of a sensation and its conscious awareness by the affected patient. The neuroanatomical substrates identified in 1989 in tinnitus patients (reported originally in 1991 and published in 1995) are presented as a common framework for the hypothesis of an FCP. They further the understanding of the clinical heterogeneity of the tinnitus symptom, clinically manifest as multiple brain functions associated with the clinical course of tinnitus patients, particularly those with SIT. The FCP provides a model for tinnitus theory, diagnosis, and treatment. The FCP is not a tinnitus theory. Specifically, it is a hypothesis that attempts to explain how an aberrant auditory sensory stimulus becomes transformed into one of affect and somatomotor response. The neuroanatomical substrates of the FCP provide a basis for the identification of the involved neurocircuitries and neurochemistries. The physiology and biochemistry underlying the neuroanatomical substrates of the FCP provide a basis for translation for tinnitus diagnosis and treatment. The neuroanatomical substrates of the FCP are presented as algorithms of (1) components of a sensation (i.e., sensory, affect, and psychomotor), a translation from basic sensory physiology for tinnitus; (2) clinically manifest biophysiological brain functions and underlying processes associated with the tinnitus; (3) a model for investigation of metabolic-electrophysiological correlates for tinnitus; (4) the basis for an integrated theory of tinnitus and brain function (i.e., tinnitus dyssynchrony-synchrony theory; (5) a model for the identification of underlying neurocircuitries and neurochemistries involved in brain for the sensory-affect transformation of an aberrant auditory stimulus (tinnitus); (6) a model for the selection-introduction of innovative therapies attempting tinnitus relief; and (7) its clinical translation for objective monitoring systems for the determination of the efficacy of modalities of therapy attempting tinnitus relief. The hypothesis of the FCP for tinnitus and the identified neuroanatomical substrates, when viewed in terms of the physiology of sensory processing, is considered to be expanded and broader in its application for all sensations, normal or aberrant.

17. Schendan, H.E. and S.M. Maher, *Object knowledge during entry-level categorization is activated and modified by implicit memory after 200 ms*. NeuroImage, 2009. **44**(4): p. 1423-1438.

Summary: The timing of activating memory about visual objects is important for theories of human cognition but largely unknown, especially for tasks like entry level categorization that activate semantic memory. We tested an implicit memory-categorization "equivalence" hypothesis of multiple memory systems theory that a cortical system that stores structural knowledge to support entry level categorization also stores long-term, perceptual implicit memory, resulting in priming of this knowledge. Event-related brain potentials (ERPs) were recorded to impoverished pictures of new and repeated objects that were similar in perceptual properties but differed in categorization success. The cortical dynamics of object knowledge were defined using categorization ratings and naming. As predicted, rating, naming, and repetition effects on a frontocentral N350 show that implicit memory modifies the object knowledge network supporting categorization. This ERP is a complex of components between 200 and 500 ms indexing temporally overlapping substates from more perceptual to more conceptual knowledge. A frontopolar N350 subcomponent defines the first substate of a process of object model selection from occipitotemporal cortex based on shape similarity, and indicates that implicit memory in this system is greater with better categorization success. Afterwards, parietal positivity and a slow wave index secondary, post-model selection processes, like evaluating the success of a decision or memory match, and working memory for overt report, respectively. Altogether, ERP findings support the equivalence hypothesis and a two-state interactive account of visual object knowledge, and delineate the timing of multiple memory systems. © 2008 Elsevier Inc. All rights reserved.

18. Saletu, M., P. Anderer, G.M. Saletu-Zyhlarz, M. Mandl, B. Saletu, and J. Zeitlhofer, *Modafinil improves information processing speed and increases energetic resources for orientation of attention in narcoleptics: Double-blind, placebo-controlled ERP studies with low-resolution brain electromagnetic tomography (LORETA)*. Sleep Medicine, 2009. **10**(8): p. 850-858.

Summary: Background and purpose: Recent neuroimaging studies in narcolepsy discovered significant gray matter loss in the right prefrontal and frontomesial cortex, a critical region for executive processing. In the present study, event-related potential (ERP) low-resolution brain electromagnetic tomography

(LORETA) was used to investigate cognition before and after modafinil as compared with placebo. Patients and methods: In a double-blind, placebo-controlled cross-over design, 15 patients were treated with a 3-week fixed titration scheme of modafinil and placebo. The Epworth Sleepiness Scale (ESS), Maintenance of Wakefulness Test (MWT) and auditory ERPs (odd-ball paradigm) were obtained before and after the 3 weeks of therapy. Latencies, amplitudes and LORETA sources were determined for standard (N1 and P2) and target (N2 and P300) ERP components. Results: The ESS score improved significantly from 15.4 (± 4.0) under placebo to 10.2 (± 4.1) under 400 mg modafinil (p = 0.004). In the MWT, latency to sleep increased nonsignificantly after modafinil treatment (11.9 ± 6.9 versus 13.3 ± 7.1 min). In the ERP, N2 and P300 latencies were shortened significantly. While ERP amplitudes showed only minor changes, LORETA revealed increased source strengths: for N1 in the left auditory cortex and for P300 in the medial and right dorsolateral prefrontal cortex. Conclusion: LORETA revealed that modafinil improved information processing speed and increased energetic resources in prefrontal cortical regions, which is in agreement with other neuroimaging studies. © 2009 Elsevier B.V. All rights reserved.

19. Saletu, B., P. Anderer, M. Wolzt, D. Nosiska, A. Assandri, E. Noseda, F. Nannipieri, and G.M. Saletu-Zyhlarz, *Double-blind, placebo-controlled, multiple-ascending-dose study on the pharmacodynamics of ABIO-08/01, a new CNS drug with potential anxiolytic activity: 2. EEG-tomography findings based on LORETA (low-resolution brain electromagnetic tomography).* Neuropsychobiology, 2009. **59**(2): p. 110-122.

Summary: Effects of ABIO-08/01, a new potentially anxiolytic isoxazoline, on regional electrical brain generators were investigated by 3-dimensional EEG tomography. In a double- blind, placebo-controlled, multiple-ascending-dose study, 16 healthy males (30.2 ± 5.7 years) received 3 oral drug doses (10, 20, 40 mg) and placebo for 7 days (8-day wash-out) in a randomized non-balanced design for phase-1 studies. A 3-min vigilance-controlled (V) EEG, a 4-min resting (R) EEG with eyes closed, a 1-min eyes-open (EO) EEG and psychometric tests were performed 0, 1 and 6 h after taking the drug on days 1 and 5. Low-resolution brain electromagnetic tomography (LORETA) was computed from the spectrally analyzed EEG data, and differences between drug and placebo were displayed as statistical parametric maps. Data were registered to the Talairach-Tournoux Human Brain Atlas available as a digitized MRI. An overall omnibus significance test followed by a voxel-by-voxel t test demonstrated significant regional EEG changes after ABIO-08/01 versus placebo, dependent on recording condition, dose and time. While in the EO-EEG specifically the lowest dose of ABIO-08/01 induced pronounced sedative effects (delta/theta and beta increase) 1 h after acute and slightly less so after superimposed administration, in the 6th hour a decrease in alpha and beta activity signaled less sedative and more relaxant action. In the V-EEG these changes were less pronounced, in the R-EEG partly opposite. Hemisphere-specific changes were observed, suggesting increases in LORETA power over the left temporal, parietal, superior frontal regions and

decreases over the right prefrontal, temporal pole and occipital regions. These LORETA changes are discussed in the light of neuroimaging findings on anxiety and anxiolytics. Copyright © 2009 S. Karger AG, Basel.

20. Romero, S., M.A. Mañanas, and M.J. Barbanoj, *Influence of ocular filtering in eeg data on the assessment of drug-induced effects on the brain*, in *Human Brain Mapping*. 2009. p. 1470-1480.

21. Ricardo-Garcell, J., J.J. González-Olvera, E. Miranda, T. Harmony, E. Reyes, L. Almeida, L. Galán, D. Díaz, L. Ramírez, A. Fernández-Bouzas, and E. Aubert, *EEG sources in a group of patients with major depressive disorders*. International Journal of Psychophysiology, 2009. **71**(1): p. 70-74.

Summary: EEG sources were assessed in a group of patients with major moderate-severe depressive disorder (MDD) as classified by trained clinicians according to DSM-IV criteria. Frequency Domain Variable Resolution Electromagnetic Tomography (FD-VARETA) was used to calculate EEG sources. The Z-values indicated that EEG sources were abnormal (increase in current density) in all patients, with most demonstrating abnormal EEG sources in both hemispheres but with maximal inverse solution located primarily in the right. Twenty-nine patients had a predominant topography of the abnormal EEG maximal inverse solution in the frontal lobes. The remaining seven patients had a bilateral abnormal increase in current density in the superior parietal lobe. The EEG maximal abnormal inverse solution frequency was observed in both hemispheres such that the increases in current density were prevalent in alpha and theta bands. The results suggest that any of the two hemispheres could be affected by MDD, but abnormal EEG sources can be found more frequently in the right one, with the maximal abnormal inverse solution at the alpha and theta bands in frontal and parietal cortices. © 2008 Elsevier B.V. All rights reserved.

22. Ribolsi, M., G. Koch, V. Magni, G. Di Lorenzo, I.A. Rubino, A. Siracusano, and D. Centonze, *Abnormal brain lateralization and connectivity in schizophrenia*. Reviews in the Neurosciences, 2009. **20**(1): p. 61-70.

Summary: Schizophrenia is a complex disorder mainly characterized by thought disturbances, hallucinations, and decay of social and cognitive performances. From past attempts to identify the exclusive brain lesions responsible for specific domains of schizophrenia symptoms such as delusion and auditory hallucinations, recent data pointed towards network alterations leading to abnormal brain asymmetry and connectivity as important determinants of schizophrenia pathophysiology. Several contributions have reported reduced brain lateralization in schizophrenia, causing a failure of left hemisphere dominance. Evidence of altered connectivity among distinct cortical areas is also accumulating. The aim of the present article is to critically review such contributions.

23. Ren, G.Q., Y. Yang, and X. Li, *Early cortical processing of linguistic pitch patterns as revealed by the mismatch negativity*. Neuroscience, 2009. **162**(1): p. 87-95.

Summary: Previous brain imaging studies have shown the left hemispheric dominance for processing of lexical tone in native speakers. However, the low temporal resolution related to neuroimaging techniques might not explicitly detect the brain activities that occur at a relatively small or a determined time frame. We used the mismatch negativity (MMN) and a source estimation technique (low-resolution electromagnetic tomography [LORETA]) to probe the brain activities underlying the early pre-attentive processing of Mandarin lexical tone and intonation. A passive oddball paradigm was applied to present tone and intonation contrast in a speech and nonspeech context. The results showed that no difference of the MMN amplitudes existed between speech and nonspeech conditions, although a larger MMN was found for tone than intonation condition. Source localization of the MMNs for all of the conditions showed the right hemispheric dominance, regardless of their linguistic functions (tone vs. intonation) or speech context (speech vs. nonspeech). Interestingly, the MMN generator for normal tone and hummed tone originated from the same cortical area (right parietal lobe, BA 19). These findings suggest that the pre-attentive cortical processing can be modulated not only by speech stimuli, but also by their nonspeech hums. Our data are compatible with the acoustic hypothesis of speech processing. Crown Copyright © 2009.

24. Proverbio, A.M., M. Del Zotto, N. Crotti, and A. Zani, *A no-go related prefrontal negativity larger to irrelevant stimuli that are difficult to suppress*. Behavioral and Brain Functions, 2009. **5**.

Summary: Background: There is a wide debate in the literature about whether N2/P3 effects in no-go trials reflect the inhibition of an intended action, or the absence of a negative movement-related potential typical of go trials. The aim of this study was to provide an objective measure of the suppression of irrelevant information (in a conjoined selective visual attention task) under conditions that were perfectly comparable from the viewpoint of the motoric processes involved. Methods: Twenty-nine right-handed students took part in the study. Their EEGs were recorded from 128 scalp sites while they viewed gratings of four different spatial frequencies (from 0.75 to 6 c/deg) randomly flashed in the four upper and lower quadrants of the visual field. The tasks consisted of attending and responding to a conjunction of spatial frequency and space location. Intermediate frequencies (1.5 and 3 c/deg) acted as distracters or lures. Analysis of the ERPs elicited by the same physical stimulus, close in spatial frequency to the actual target and falling within the attended quadrant (pseudo-target) vs. a non-target location, allowed us to identify the time course and neural bases of brain activation during the suppression of irrelevant information. Results: FAs were on average 9% for pseudo-targets and 0.2% for other types of lures, indicating that the former were more difficult to suppress. Target-related ERP components (occipito/temporal selection negativity, posterior P3b and precentral motor N2)

were greater to pseudo-targets than other distracters. A large prefrontal negativity (370-430 ms) was also identified, much larger to pseudo-targets than non-targets (and absent in response to real targets), thus reflecting response inhibition and top-down cognitive control processes. Conclusion: A LORETA inverse solution identified the neural generators of this effect in the left dorsolateral prefrontal cortex (DLPF), left and right fusiform gyri and bilateral superior temporal cortices. The tentative hypothesis is advanced that these activations might reflect the modulatory effects exerted by the fronto/temporal circuit for the suppression of irrelevant information. © 2009 Proverbio et al; licensee BioMed Central Ltd.

25. Proverbio, A.M., R. Adorni, A. Zani, and L. Trestianu, *Sex differences in the brain response to affective scenes with or without humans*. Neuropsychologia, 2009. **47**(12): p. 2374-2388.

Summary: Recent findings have demonstrated that women might be more reactive than men to viewing painful stimuli (vicarious response to pain), and therefore more empathic [Han, S., Fan, Y., & Mao, L. (2008). Gender difference in empathy for pain: An electrophysiological investigation. Brain Research, 1196, 85-93]. We investigated whether the two sexes differed in their cerebral responses to affective pictures portraying humans in different positive or negative contexts compared to natural or urban scenarios. 440 IAPS slides were presented to 24 Italian students (12 women and 12 men). Half the pictures displayed humans while the remaining scenes lacked visible persons. ERPs were recorded from 128 electrodes and swLORETA (standardized weighted Low-Resolution Electromagnetic Tomography) source reconstruction was performed. Occipital P115 was greater in response to persons than to scenes and was affected by the emotional valence of the human pictures. This suggests that processing of biologically relevant stimuli is prioritized. Orbitofrontal N2 was greater in response to positive than negative human pictures in women but not in men, and not to scenes. A late positivity (LP) to suffering humans far exceeded the response to negative scenes in women but not in men. In both sexes, the contrast suffering-minus-happy humans revealed a difference in the activation of the occipito/temporal, right occipital (BA19), bilateral parahippocampal, left dorsal prefrontal cortex (DPFC) and left amygdala. However, increased right amygdala and right frontal area activities were observed only in women. The humans-minus-scenes contrast revealed a difference in the activation of the middle occipital gyrus (MOG) in men, and of the left inferior parietal (BA40), left superior temporal gyrus (STG, BA38) and right cingulate (BA31) in women (270-290 ms). These data indicate a sex-related difference in the brain response to humans, possibly supporting human empathy. © 2008.

26. Proverbio, A. and R. Adorni, *New insights into name category-related effects: Is the Age of Acquisition a possible factor?* Behavioral and Brain Functions, 2009. **5**.

Summary: Background: Electrophysiological, hemodynamic and neuropsychological studies have provided evidence of dissociation in the way words belonging to different semantic categories (e.g., animals, tools, actions) are represented in the brain. The aim of the present study was to investigate whether a word's semantic domain may affect the amplitude and latency of ERP components, independently of any other factor. Methods: EEGs were recorded from 16 volunteers engaged in a lexical decision task (word/non-word discrimination) involving 100 words (flora and fauna names). This task allowed us to evaluate differences in processing between words belonging to different categories (fauna vs. flora) independently of task demands. All stimuli were balanced in terms of length, frequency of occurrence, familiarity and imageability. Low Resolution Electromagnetic Tomography (LORETA) was performed on ERP difference waves of interest. Results: Our findings showed that the two categories were discriminated as early as 200 ms post-stimulus, with larger responses to flora names over the left occipito-temporal areas, namely BA37 and BA20. Category-related ERP differences were also observed in the amplitudes of the later centro-parietal N400, posterior P300 and anterior LP components. Behavioral responses to words denoting fauna were more accurate than to words denoting flora. Conclusion: Overall, it seems that it was easier to access the lexical properties of fauna, probably because of their biologically relevant status. The results are discussed in the light of the possible role played by different factors. © 2009 Adorni and Proverbio; licensee BioMed Central Ltd.

27. Pratt, H., A. Starr, H.J. Michalewski, A. Dimitrijevic, N. Bleich, and N. Mittelman, *Auditory-evoked potentials to frequency increase and decrease of high- and low-frequency tones*. Clinical Neurophysiology, 2009. **120**(2): p. 360-373.

Summary: Objective: To define cortical brain responses to large and small frequency changes (increase and decrease) of high- and low-frequency tones. Methods: Event-Related Potentials (ERPs) were recorded in response to a 10% or a 50% frequency increase from 250 or 4000 Hz tones that were approximately 3 s in duration and presented at 500-ms intervals. Frequency increase was followed after 1 s by a decrease back to base frequency. Frequency changes occurred at least 1 s before or after tone onset or offset, respectively. Subjects were not attending to the stimuli. Latency, amplitude and source current density estimates of ERPs were compared across frequency changes. Results: All frequency changes evoked components P50, N100, and P200. N100 and P200 had double peaks at bilateral and right temporal sites, respectively. These components were followed by a slow negativity (SN). The constituents of N100 were predominantly localized to temporo-parietal auditory areas. The potentials and their intracranial distributions were affected by both base frequency (larger potentials to low frequency) and direction of change (larger potentials to increase than decrease), as well as by change magnitude (larger potentials to larger change). The differences between frequency increase and decrease depended on base frequency (smaller difference to high frequency) and were localized to frontal areas. Conclusions: Brain activity varies according to frequency change direction and magnitude as well as base frequency. Significance: The effects of base frequency and direction of change may reflect brain networks involved in more complex processing such as speech that are differentially sensitive to frequency modulations of high (consonant discrimination) and low (vowels and prosody) frequencies. © 2008 International Federation of Clinical Neurophysiology.

28. Pratt, H., A. Starr, H.J. Michalewski, A. Dimitrijevic, N. Bleich, and N. Mittelman, *Cortical evoked potentials to an auditory illusion: Binaural beats*. Clinical Neurophysiology, 2009. **120**(8): p. 1514-1524.

Summary: Objective: To define brain activity corresponding to an auditory illusion of 3 and 6 Hz binaural beats in 250 Hz or 1000 Hz base frequencies, and compare it to the sound onset response. Methods: Event-Related Potentials (ERPs) were recorded in response to unmodulated tones of 250 or 1000 Hz to one ear and 3 or 6 Hz higher to the other, creating an illusion of amplitude modulations (beats) of 3 Hz and 6 Hz, in base frequencies of 250 Hz and 1000 Hz. Tones were 2000 ms in duration and presented with approximately 1 s intervals. Latency, amplitude and source current density estimates of ERP components to tone onset and subsequent beats-evoked oscillations were determined and compared across beat frequencies with both base frequencies. Results: All stimuli evoked tone-onset P50, N100 and P200 components followed by oscillations corresponding to the beat frequency, and a subsequent tone-offset complex. Beats-evoked oscillations were higher in amplitude with the low base frequency and to the low beat frequency. Sources of the beats-evoked oscillations across all stimulus conditions located mostly to left lateral and inferior temporal lobe areas in all stimulus conditions. Onset-evoked components were not different across stimulus conditions; P50 had significantly different sources than the beats-evoked oscillations; and N100 and P200 sources located to the same temporal lobe regions as beats-evoked oscillations, but were bilateral and also included frontal and parietal contributions. Conclusions: Neural activity with slightly different volley frequencies from left and right ear converges and interacts in the central auditory brainstem pathways to generate beats of neural activity to modulate activities in the left temporal lobe, giving rise to the illusion of binaural beats. Cortical potentials recorded to binaural beats are distinct from onset responses. Significance: Brain activity corresponding to an auditory illusion of low frequency beats can be recorded from the scalp. © 2009 International Federation of Clinical Neurophysiology.

29. Ou, W., A. Nummenmaa, M. Hämäläinen, and P. Golland, *Multimodal functional imaging using fMRI-informed regional EEG/MEG source estimation*. Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics), 2009. **5636 LNCS**: p. 88-100.

Summary: We propose a novel method, fMRI-Informed Regional Estimation (FIRE), which utilizes information from fMRI in E/MEG source reconstruction. FIRE takes advantage of the spatial alignment between the neural and the vascular activities, while allowing for substantial differences in their dynamics. Furthermore, with the regional approach, FIRE can be efficiently applied to a dense grid of sources. Inspection of our optimization procedure reveals that FIRE is related to the re-weighted minimum-norm algorithms, the difference being that the weights in the proposed approach are computed from both the current estimates and fMRI data. Analysis of both simulated and human fMRI-MEG data shows that FIRE reduces the ambiguities in source localization present in the minimum-norm estimates. Comparisons with several joint fMRI-E/MEG algorithms demonstrate robustness of FIRE in the presence of sources silent to either fMRI or E/MEG measurements. © 2009 Springer Berlin Heidelberg.

30. Ou, W., M.S. Hämäläinen, and P. Golland, *A distributed spatio-temporal EEG/MEG inverse solver*. NeuroImage, 2009. **44**(3): p. 932-946.

Summary: We propose a novel $\ell_1\ell_2$-norm inverse solver for estimating the sources of EEG/MEG signals. Based on the standard ℓ_1-norm inverse solvers, this sparse distributed inverse solver integrates the ℓ_1-norm spatial model with a temporal model of the source signals in order to avoid unstable activation patterns and "spiky" reconstructed signals often produced by the currently used sparse solvers. The joint spatio-temporal model leads to a cost function with an $\ell_1\ell_2$-norm regularizer whose minimization can be reduced to a convex second-order cone programming (SOCP) problem and efficiently solved using the interior-point method. The efficient computation of the SOCP problem allows us to implement permutation tests for estimating statistical significance of the inverse solution. Validation with simulated and human MEG data shows that the proposed solver yields source time course estimates qualitatively similar to those obtained through dipole fitting, but without the need to specify the number of dipole sources in advance. Furthermore, the $\ell_1\ell_2$-norm solver achieves fewer false positives and a better representation of the source locations than the conventional ℓ_2 minimum-norm estimates. © 2008 Elsevier Inc. All rights reserved.

31. Ortigue, S., N. Patel, and F. Bianchi-Demicheli, *New electroencephalogram (EEG) neuroimaging methods of analyzing brain activity applicable to the study of human sexual response*. Journal of Sexual Medicine, 2009. **6**(7): p. 1830-1845.

Summary: Introduction. Electroencephalogram (EEG) combined with brain source localization algorithms is becoming a powerful tool in the neuroimaging study of human cerebral functions. Aim. The present article provides a tutorial on the various EEG methods currently used to study the human brain activity, notably during sexual response. Main Outcome Measures. Review of published literature on standard EEG waveform analyses and most recent electrical neuroimaging techniques (microstate approach and two methods of brain source localization). Methods. Retrospective overview of pertinent literature. Results. Although the standard EEG waveform analyses enable millisecond time-resolution information about the human sexual responses in the brain, less is clear about their related spatial information. Nowadays, the improvement of EEG techniques and statistical approaches allows the visualization of the dynamics of the human sexual response with a higher spatiotemporal resolution. Here, we describe these enhanced techniques and summarize along with an overview of what we have learned from them in terms of chronoarchitecture of sexual response in the human brain. Finally, the speculation on how we may be able to use other enhanced approaches, such as independent component analysis, are also presented. Conclusions. EEG neuroimaging has already been proven as a strong worthwhile research tool. Combining this approach with standard EEG waveform analyses in sexual medicine may provide a better understanding of the neural activity underlying the human sexual response in both healthy and clinical populations. Ortigue S, Patel N, and Bianchi-Demicheli F. New EEG neuroimaging methods of analyzing brain activity applicable to the study of human sexual response. © 2009 International Society for Sexual Medicine.

32. Neuhaus, A.H., C. Opgen-Rhein, C. Urbanek, M. Gross, E. Hahn, T.M.T. Ta, S. Koehler, and M. Dettling, *Spatiotemporal mapping of sex differences during attentional processing*. Human Brain Mapping, 2009. **30**(9): p. 2997-3008.

Summary: Functional neuroimaging studies have increasingly aimed at approximating neural substrates of human cognitive sex differences elicited by visuospatial challenge. It has been suggested that females and males use different behaviorally relevant neurocognitive strategies. In females, greater right prefrontal cortex activation has been found in several studies. The spatiotemporal dynamics of neural events associated with these sex differences is still unclear. We studied 22 female and 22 male participants matched for age, education, and nicotine with 29-channel-electroencephalogram recorded under a visual selective attention paradigm, the Attention Network Test. Visual event-related potentials (ERP) were topographically analyzed and neuroelectric sources were estimated. In absence of behavioral differences, ERP analysis revealed a novel frontal-occipital second peak of visual N100 that was significantly increased in females relative to males. Further, in females exclusively, a corresponding central ERP component at around 220 ms was found; here, a strong correlation between stimulus salience and sex difference of the central ERP component amplitude was observed. Subsequent source analysis revealed increased cortical current densities in right rostral prefrontal (BA 10) and occipital cortex (BA 19) in female subjects. This is the first study to report on a tripartite association between sex differences in ERPs, visual stimulus salience, and right prefrontal cortex activation during attentional processing. © 2009 Wiley-Liss, Inc.

33. Murphy, M., B.A. Riedner, R. Huber, M. Massimini, F. Ferrarelli, and G. Tononi, *Source modeling sleep slow waves*. Proceedings of the National Academy of Sciences of the United States of America, 2009. **106**(5): p. 1608-1613.

Summary: Slow waves are the most prominent electroencephalographic (EEG) feature of sleep. These waves arise from the synchronization of slow oscillations in the membrane potentials of millions of neurons. Scalp-level studies have indicated that slow waves are not instantaneous events, but rather they travel across the brain. Previous studies of EEG slow waves were limited by the poor spatial resolution of EEGs and by the difficulty of relating scalp potentials to the activity of the underlying cortex. Here we use high-density EEG (hd-EEG) source modeling to show that individual spontaneous slow waves have distinct cortical origins, propagate uniquely across the cortex, and involve unique subsets of cortical structures. However, when the waves are examined en masse, we find that there are diffuse hot spots of slow wave origins centered on the lateral sulci. Furthermore, slow wave propagation along the anterior-posterior axis of the brain is largely mediated by a cingulate highway. As a group, slow waves are associated with large currents in the medial frontal gyrus, the middle frontal gyrus, the inferior frontal gyrus, the anterior cingulate, the precuneus, and the posterior cingulate. These areas overlap with the major connectional backbone of the cortex and with many parts of the default network. © 2009 by The National Academy of Sciences of the USA.

34. Mueller, E.M., S.G. Hofmann, D.L. Santesso, A.E. Meuret, S. Bitran, and D.A. Pizzagalli, *Electrophysiological evidence of attentional biases in social anxiety disorder*. Psychological Medicine, 2009. **39**(7): p. 1141-1152.

Summary: Background. Previous studies investigating attentional biases in social anxiety disorder (SAD) have yielded mixed results. Recent event-related potential (ERP) studies using the dot-probe paradigm in non-anxious participants have shown that the P1 component is sensitive to visuospatial attention towards emotional faces. We used a dot-probe task in conjunction with high-density ERPs and source localization to investigate attentional biases in SAD. Method. Twelve SAD and 15 control participants performed a modified dot-probe task using angry-neutral and happy-neutral face pairs. The P1 component elicited by face pairs was analyzed to test the hypothesis that SAD participants would display early hypervigilance to threat-related cues. The P1 component to probes replacing angry, happy or neutral faces was used to evaluate whether SAD participants show either sustained hypervigilance or decreased visual processing of threat-related cues at later processing stages. Results. Compared to controls, SAD participants showed relatively (a) potentiated P1 amplitudes and fusiform gyrus (FG) activation to angry-neutral versus happy-neutral face pairs; (b) decreased P1 amplitudes to probes replacing emotional (angry and happy) versus neutral faces; and (c) higher sensitivity (d′) to probes following angry-neutral versus happy-neutral face pairs. SAD participants also showed significantly shorter reaction times (RTs) to probes replacing angry versus happy faces, but no group differences emerged for RT. Conclusions. The results provide electrophysiological support for early hypervigilance to angry faces in SAD with involvement of the FG, and reduced visual processing of emotionally salient locations at later stages of information processing, which might be a manifestation of attentional avoidance. © 2008 Cambridge University Press.

35. Mobascher, A., J. Brinkmeyer, T. Warbrick, F. Musso, H.J. Wittsack, R. Stoermer, A. Saleh, A. Schnitzler, and G. Winterer, *Fluctuations in electrodermal activity reveal variations in single trial brain responses to painful laser stimuli - A fMRI/EEG study*. NeuroImage, 2009. **44**(3): p. 1081-1092.

Summary: Pain is a complex experience with sensory, emotional and cognitive aspects. It also includes a sympathetic response that can be captured by measuring the electrodermal activity (EDA). The present study was performed to investigate which brain areas are associated with sympathetic activation in experimental pain; an issue that has not been addressed with fMRI (functional magnetic resonance imaging) thus far. Twelve healthy subjects received painful laser stimulation to the left hand. The event-related fMRI BOLD (blood oxygen level dependent) response was measured together with simultaneous EEG (electroencephalography) and EDA recordings. Laser stimuli induced the expected EDA response, evoked EEG potentials and BOLD responses. Single trial EDA amplitudes were used to guide further analysis of fMRI and EEG data. We found significantly higher BOLD responses in trials with high EDA vs. low EDA trials, predominantly in the insula and somatosensory cortex (S1/S2). Likewise, in the EEG we found the N2 laser evoked potentials to have significantly higher amplitudes in trials with high vs. low EDA. Furthermore EDA-informed BOLD modeling explained additional signal variance in sensory areas and yielded higher group level activation. We conclude that the sympathetic response to pain is associated with activation in pain-processing brain regions, predominantly in sensory areas and that single trial (EDA)-information can add to BOLD modeling by taking some of the response variability across trials and subjects into account. Thus, EDA is a useful additional, objective index when pain is studied with fMRI/EEG which might be of particular relevance in the context of genetic- and pharmacoimaging. © 2008 Elsevier Inc. All rights reserved.

36. Mobascher, A., J. Brinkmeyer, T. Warbrick, F. Musso, H.J. Wittsack, A. Saleh, A. Schnitzler, and G. Winterer, *Laser-evoked potential P2 single-trial amplitudes covary with the fMRI BOLD response in the medial pain system and interconnected subcortical structures*. NeuroImage, 2009. **45**(3): p. 917-926.

Summary: Pain is a complex experience with sensory, emotional and cognitive aspects. The cortical representation of pain - the pain matrix - consists of a network of regions including the primary (S1) and secondary (S2) sensory cortex, insula, and anterior cingulate cortex (ACC). These structures interact with brain regions such as the prefrontal cortex and the amygdalae. Simultaneous EEG/fMRI (electroencephalography/functional magnetic resonance imaging) has recently been introduced as a method to study the spatiotemporal characteristics of cognitive processes with high spatial and high temporal resolution at the same time. The present study was conducted to clarify if single trial EEG-informed BOLD modeling supports the definition of functional compartments within the pain matrix and interconnected regions. Twenty healthy subjects received painful laser stimulation while EEG and the fMRI blood oxygen level dependent (BOLD) signal were recorded simultaneously. While the laser-evoked N2 potential

provided no additional information for BOLD modeling, the regressor obtained from the single trial laser-evoked P2 potential explained additional variance in a network of cortical and subcortical structures that largely overlapped with the pain matrix. This modeling strategy yielded pronounced activation in the ACC, right amygdala and thalamus. Our results suggest that laser-evoked potential (LEP) informed fMRI can be used to visualize BOLD activation in the pain matrix with an emphasis on functional compartments (as defined by the temporal dynamics of the LEP) such as the medial pain system. Furthermore, our findings suggest a concerted effort of the ACC and the amygdala in the cognitive-emotional evaluation of pain. © 2009 Elsevier Inc. All rights reserved.

37. Mitsonis, C.I., C. Potagas, I. Zervas, and K. Sfagos, *The effects of stressful life events on the course of multiple sclerosis: A review.* International Journal of Neuroscience, 2009. **119**(3): p. 315-335.

Summary: There is growing body of evidence that support an association between stressful life events and an increased risk for Multiple Sclerosis (MS) exacerbations. However, the nature of this relationship remains unclear, because of the lack of agreement about the definition of stress and/or because of research design problems. This article summarizes the psychological and biological mechanisms by which stress may impact MS progression. Findings indicate a number of factors, including stressor chronicity, frequency, severity and type, depression, anxiety, health locus of control, optimism, perceived social support, and coping strategies. Applied implications are discussed, concentrating on the need for multidisciplinary care interventions that target patients' disease symptoms. Copyright © 2009 Informa Healthcare USA, Inc.

38. Meltzer, J.A., G.A. Fonzo, and R.T. Constable, *Transverse patterning dissociates human EEG theta power and hippocampal BOLD activation.* Psychophysiology, 2009. **46**(1): p. 153-162.

Summary: Theta oscillations (4-8 Hz) are often modulated in human electroencephalogram (EEG) studies of memory, whereas overlapping frequencies dominate rodent hippocampal EEG. An emerging parallelism between theta reactivity and hippocampal functional magnetic resonance imaging activation has suggested a homology between theta activity in humans and rodents, representing a process of cortico-hippocampal interaction involved in memory. In the present study, we investigated EEG reactivity during performance of a relational memory task that induces a negative hippocampal blood oxygenation level dependent (BOLD) signal change, compared to a nonrelational control condition. Relational trials induced theta increases and alpha decreases. Low Resolution Electromagnetic Brain Tomography estimates localized theta and alpha modulation to frontal midline and parietal midline cortices, respectively, both of which exhibit negative BOLD responses in this task. Thus, theta and alpha dynamics are dissociable from positive BOLD activation, and may, in fact, colocalize with negative BOLD responses. Copyright © 2008 Society for Psychophysiological Research.

39. McMenamin, B.W., A.J. Shackman, J.S. Maxwell, L.L. Greischar, and R.J. Davidson, *Validation of regression-based myogenic correction techniques for scalp and source-localized EEG*. Psychophysiology, 2009. **46**(3): p. 578-592.

Summary: EEG and EEG source-estimation are susceptible to electromyographic artifacts (EMG) generated by the cranial muscles. EMG can mask genuine effects or masquerade as a legitimate effect - even in low frequencies, such as alpha (8-13 Hz). Although regression-based correction has been used previously, only cursory attempts at validation exist, and the utility for source-localized data is unknown. To address this, EEG was recorded from 17 participants while neurogenic and myogenic activity were factorially varied. We assessed the sensitivity and specificity of four regression-based techniques: between-subjects, between-subjects using difference-scores, within-subjects condition-wise, and within-subject epoch-wise on the scalp and in data modeled using the LORETA algorithm. Although within-subject epoch-wise showed superior performance on the scalp, no technique succeeded in the source-space. Aside from validating the novel epoch-wise methods on the scalp, we highlight methods requiring further development. Copyright © 2009 Society for Psychophysiological Research.

40. Maurer, U., K. Bucher, S. Brem, R. Benz, F. Kranz, E. Schulz, S. van der Mark, H.C. Steinhausen, and D. Brandeis, *Neurophysiology in Preschool Improves Behavioral Prediction of Reading Ability Throughout Primary School*. Biological Psychiatry, 2009. **66**(4): p. 341-348.

Summary: Background: More struggling readers could profit from additional help at the beginning of reading acquisition if dyslexia prediction were more successful. Currently, prediction is based only on behavioral assessment of early phonological processing deficits associated with dyslexia, but it might be improved by adding brain-based measures. Methods: In a 5-year longitudinal study of children with (n = 21) and without (n = 23) familial risk for dyslexia, we tested whether neurophysiological measures of automatic phoneme and tone deviance processing obtained in kindergarten would improve prediction of reading over behavioral measures alone. Results: Together, neurophysiological and behavioral measures obtained in kindergarten significantly predicted reading in school. Particularly the late mismatch negativity measure that indicated hemispheric lateralization of automatic phoneme processing improved prediction of reading ability over behavioral measures. It was also the only significant predictor for long-term reading success in fifth grade. Importantly, this result also held for the subgroup of children at familial risk. Conclusions: The results demonstrate that brain-based measures of processing deficits associated with dyslexia improve prediction of reading and thus may be further evaluated to complement clinical practice of dyslexia prediction, especially in targeted populations, such as children with a familial risk. © 2009 Society of Biological Psychiatry.

41. Martín-Loeches, M., A. Sel, P. Casado, L. Jiménez, and L. Castellanos, *Encouraging expressions affect the brain and alter visual attention*. PLoS ONE, 2009. **4**(6).

Summary: Background: Very often, encouraging or discouraging expressions are used in competitive contexts, such as sports practice, aiming at provoking an emotional reaction on the listener and, consequently, an effect on subsequent cognition and/or performance. However, the actual efficiency of these expressions has not been tested scientifically. Methodology/Principal Findings: To fill this gap, we studied the effects of encouraging, discouraging, and neutral expressions on event-related brain electrical activity during a visual selective attention task in which targets were determined by location, shape, and color. Although the expressions preceded the attentional task, both encouraging and discouraging messages elicited a similar long-lasting brain emotional response present during the visuospatial task. In addition, encouraging expressions were able to alter the customary working pattern of the visual attention system for shape selection in the attended location, increasing the P1 and the SP modulations while simultaneously fading away the SN. Conclusions/Significance: This was interpreted as an enhancement of the attentional processes for shape in the attended location after an encouraging expression. It can be stated, therefore, that encouraging expressions, as those used in sport practice, as well as in many other contexts and situations, do seem to be efficient in exerting emotional reactions and measurable effects on cognition. © 2009 Martin-Loeches et al.

42. Mangina, C.A., *Historical milestones of Neuroscientific Psychophysiology*. International Journal of Psychophysiology, 2009. **73**(2): p. 76-80.

Summary: The main developments emphasizing the birth and ascent of Neuroscientific Psychophysiology are highlighted. More than a century ago, monumental contributions laid the grounds for our understanding of the human brain-body-behavior-environment interrelationships with theoretical, methodological, empirical and applied underpinnings. Thousands of Psychophysiologists worldwide have contributed to enrich humanity's knowledge and will continue to enhance Neuroscientific Psychophysiology by enlarging its horizons and important ramifications. The excellence of Neuroscientific Psychophysiology is reflected in the world renowned and highly acclaimed International Journal of Psychophysiology which this year, celebrated its 25th Anniversary. The International Organization of Psychophysiology, associated with the United Nations (New York) unites professional Neuroscientists from around the world and integrates interdisciplinary Psychophysiology as a leading neuroscience. © 2009 Elsevier B.V. All rights reserved.

43. Li, L., D. Yao, and G. Yin, *Spatio-temporal dynamics of visual selective attention identified by a common spatial pattern decomposition method*. Brain Research, 2009. **1282**: p. 84-94.

Summary: Three spatio-temporal neurophysiological patterns involved in visual selective attention were identified from the human event-related potentials (ERPs) by a novel common spatial pattern (CSP) decomposition method and the standardized low resolution brain electromagnetic tomography (sLORETA). In the experiment, stimuli were rapidly presented randomly to the right or left visual fields while subjects attended to one visual field at a time (Clark, Hillyard, 1996. Spatial selective attention affects early extrastriate but not striate components of the visual evoked potential. J. Cogn. Neurosci. 8, 387-402). The spatial patterns indicated that visual cortex, prefrontal cortex (PFC), anterior cingulate cortex (ACC) and posterior parietal cortex (PPC) were involved in the control of top-down attention. The temporal waveforms indicated that contralateral PFC and PPC were activated synchronously at about 150 ms after the stimulus onset, with early attention effects only occurring in PFC, and the PPC was activated earlier than that of PFC during 200-260 ms. The results imply that humans adopt different allocation strategies for resources in visual attention and un-attention situations. For attention case, visual cortex consumes the most resources and for non-attention situation, the ACC and PPC consume the most resources. © 2009 Elsevier B.V. All rights reserved.

44. Levin, R.J., *Revisiting post-ejaculation refractory time - What we know and what we do not know in males and in females*. Journal of Sexual Medicine, 2009. **6**(9): p. 2376-2389.

Summary: Introduction. The post-ejaculation refractory time (PERT), the period after a single ejaculation when further erections and ejaculations are inhibited, has been studied and well-documented in male rats. Since its first attribution in men by Masters and Johnson and its inaccurate delineation in their graphic sexual response model in 1966 it has been infrequently studied whereas scant attention has been paid to any such possible activity in women after female ejaculation. Aim. To critically review our current knowledge about PERT in rats and humans and describe and correct shortcomings and errors in previous publications and propose corrections. Methods. Review of published literature. Main Outcome Measures. Identifying evidence-based data to support authority-based facts. Results. The review exposes the extremely limited evidence-based data that our knowledge of PERT is based on. The paucity of data for most aspects of human PERT is remarkable; even the generally accepted statement that the duration of PERT increases with age has no published support data. Conclusions. Despite numerous studies in rats the mechanisms and site(s) of the activity are poorly understood. Dopaminergic and adrenergic pathways are thought to shorten PERT whereas serotonergic pathways lengthen its duration. Raising the brain serotonin levels in men using SSRIs helps reduce early or premature ejaculation. Rats have an absolute PERT (aPERT) during which erection and ejaculation is inhibited and a relative PERT (rPERT) when a stronger or novel stimulus can, whether such phases exist in men is unexamined. Apart from possible depressed activity in the amygdala and penile dorsal nerve and rejection of prolactin as a major factor in PERT little or no significant advance in understanding human male PERT has occurred. No evidence-based

data on women's PERT after female ejaculation exists. New investigations in young and older men utilizing brain imaging and electromagnetic tomography are priority studies to accomplish. © 2009 International Society for Sexual Medicine.

45. Knott, V., A. Millar, and D. Fisher, *Sensory gating and source analysis of the auditory P50 in low and high suppressors*. NeuroImage, 2009. **44**(3): p. 992-1000.

Summary: Impairments in sensory gating in schizophrenia have been reflected by diminished suppression of the scalp-recorded middle latency auditory P50 event-related potential (MLAERP) elicited by the second (S2) of a pair (S1-S2) of clicks. As understanding the functional neural substrates of aberrant gating would have important implications for schizophrenia, this study examined the location and time-course of the neural generators of the P50 MLAERP and its gating on subgroups of healthy volunteers exhibiting low (n = 12) and high (n = 12) P50 suppression. Suppressor differences were observed with S1 P50 (high > low) and S2 P50 (high < low) amplitudes, and current source density analysis with standardized Low Resolution Electromagnetic Tomography (sLORETA) evidenced an S1 P50-related activation of limbic, temporal and parietal regions in the high but not the low suppressors. Distributed source localization of the Gating Difference Wave (GDW), obtained by subtracting the S2 P50 response from the S1 P50 response, also revealed a later and sustained frontal activation to characterize high suppressors. These findings suggest that impaired gating of the kind evident in schizophrenia may involve the deficient functioning of multiple interconnected and temporally overlapping activated brain regions. Crown Copyright © 2008.

46. Khittl, B., H. Bauer, and P. Walla, *Change detection related to peripheral facial expression: An electroencephalography study*. Journal of Neural Transmission, 2009. **116**(1): p. 67-70.

Summary: The objective is to study the change detection of emotion expression by electroencephalography (EEG). A visual letter task was combined with two neutral faces. After a short break another letter task occurred whilst the peripheral faces remained or randomly changed to joy, anger or disgust. Study participants responded whether they had perceived a change in emotion expression or not. Explicit change detection elicited more positive-going EEG amplitudes than change blindness between 750 and 900 ms. A change to disgust elicited largest effects. Furthermore, evidence for implicit change detection occurred. © 2008 Springer-Verlag.

47. Karanasiou, I.S., C. Papageorgiou, E.I. Tsianaka, G.K. Matsopoulos, E.M. Ventouras, and N.K. Uzunoglu, *Behavioral and brain pattern differences between acting and observing in an auditory task*. Behavioral and Brain Functions, 2009. **5**.

Summary: Background: Recent research has shown that errors seem to influence the patterns of brain activity. Additionally current notions support the idea that similar brain mechanisms are activated during acting and observing. The aim of the present study was to examine the patterns of brain activity of actors and observers elicited upon receiving feedback information of the actor's response. Methods: The task used in the present research was an auditory identification task that included both acting and observing settings, ensuring concurrent ERP measurements of both participants. The performance of the participants was investigated in conditions of varying complexity. ERP data were analyzed with regards to the conditions of acting and observing in conjunction to correct and erroneous responses. Results: The obtained results showed that the complexity induced by cue dissimilarity between trials was a demodulating factor leading to poorer performance. The electrophysiological results suggest that feedback information results in different intensities of the ERP patterns of observers and actors depending on whether the actor had made an error or not. The LORETA source localization method yielded significantly larger electrical activity in the supplementary motor area (Brodmann area 6), the posterior cingulate gyrus (Brodmann area 31/23) and the parietal lobe (Precuneus/Brodmann area 7/5). Conclusion: These findings suggest that feedback information has a different effect on the intensities of the ERP patterns of actors and observers depending on whether the actor committed an error. Certain neural systems, including medial frontal area, posterior cingulate gyrus and precuneus may mediate these modulating effects. Further research is needed to elucidate in more detail the neuroanatomical and neuropsychological substrates of these systems. © 2009 Karanasiou et al; licensee BioMed Central Ltd.

48. Kamarajan, C., B. Porjesz, M. Rangaswamy, Y. Tang, D.B. Chorlian, A. Padmanabhapillai, R. Saunders, A.K. Pandey, B.N. Roopesh, N. Manz, A.T. Stimus, and H. Begleiter, *Brain signatures of monetary loss and gain: Outcome-related potentials in a single outcome gambling task.* Behavioural Brain Research, 2009. **197**(1): p. 62-76.

Summary: This study evaluates the event-related potential (ERP) components in a single outcome gambling task that involved monetary losses and gains. The participants were 50 healthy young volunteers (25 males and 25 females). The gambling task involved valence (loss and gain) and amount (50¢ and 10¢) as outcomes. The outcome-related negativity (ORN/N2) and outcome-related positivity (ORP/P3) were analyzed and compared across conditions and gender. Monetary gain (compared to loss) and higher amount (50¢ compared to 10¢) produced higher amplitudes and shorter latencies in both ORN and ORP components. Difference wave plots showed that earlier processing (200-400 ms) is dominated by the valence (loss/gain) while later processing (after 400 ms) is marked by the amount (50¢/10¢). Functional mapping using Low Resolution Electromagnetic Tomography (LORETA) indicated that the ORN separated the loss against gain in both genders, while the ORP activity distinguished the 50¢ against 10¢ in males. This study further strengthens the view that separate brain processes/circuitry may mediate loss and gain. Although there were no gender differences in behavioral and impulsivity scores, ORN and ORP measures for different task conditions had significant correlations with behavioral scores. This gambling paradigm may potentially offer valuable indicators to study outcome processing and impulsivity in normals as well as in clinical populations. © 2008 Elsevier B.V.

49. Joliot, M., G. Leroux, S. Dubal, N. Tzourio-Mazoyer, O. Houdé, B. Mazoyer, and L. Petit, *Cognitive inhibition of number/length interference in a Piaget-like task: Evidence by combining ERP and MEG.* Clinical Neurophysiology, 2009. **120**(8): p. 1501-1513.

Summary: Objective: We combined event-related potential (ERP) and magnetoencephalography (MEG) acquisition and analysis to investigate the electrophysiological markers of the inhibitory processes involved in the number/length interference in a Piaget-like numerical task. Methods: Eleven healthy subjects performed four gradually interfering conditions with the heuristic "length equals number" to be inhibited. Low resolution tomography reconstruction was performed on the combined grand averaged electromagnetic data at the early (N1, P1) and late (P2, N2, P3early and P3late) latencies. Every condition was analyzed at both scalp and regional brain levels. Results: The inhibitory processes were visible on the late components of the electromagnetic brain activity. A right P2-related frontal orbital activation reflected the change of strategy in the inhibitory processes. N2-related SMA/cingulate activation revealed the first occurrence of the stimuli processing to be inhibited. Both P3 components revealed the working memory processes operating in a medial temporal complex and the mental imagery processes subtended by the precuneus. Conclusions: Simultaneous ERP and MEG signal acquisition and analysis allowed to describe the spatiotemporal patterns of neural networks involved in the inhibition of the "length equals number" interference. Significance: Combining ERP and MEG ensured a sensitivity which could be reached previously only through invasive intracortical recordings. © 2009 International Federation of Clinical Neurophysiology.

50. Jaušovec, N. and K. Jaušovec, *Do women see things differently than men do?* NeuroImage, 2009. **45**(1): p. 198-207.

Summary: The aim of the study was to investigate the influence of gender on brain activity. Thirty male and 30 female respondents solved simple auditory and visual tasks while their electroencephalogram (EEG) was recorded. Also recorded was the percentage of oxygen saturation of hemoglobin (%StO2) in the respondents' frontal brain areas with near-infrared spectroscopy (NIRS). The attended task condition was based on the oddball paradigm. Respondents had to mentally count infrequent target stimuli - tones or shapes. In the unattended condition they just listened to tones or viewed different shapes. Gender related differences in EEG activity were only observed in the amplitudes of the early evoked gamma response and the P3 component. Women displayed higher amplitudes than men. A second finding was that these differences were more pronounced for the visual than for the auditory stimuli. No gender related differences were observed in the ERP latencies, as well as in the amplitudes of the P1-N1 complex, and the induced gamma response. The NIRS data showed that males in their frontal brain areas displayed a higher percentage of StO2 than did females; and males also showed a higher increase in %StO2 during task performance as compared with the resting condition. Taken all together the results suggest that the females' visual event-categorization process is more efficient than in males. The data are discussed in the theoretical framework of the evolutionary theory of human spatial sex differences. © 2008 Elsevier Inc. All rights reserved.

51. Ioannides, A.A., *Magnetoencephalography (MEG)*. Methods in Molecular Biology, 2009. **489**: p. 167-188.

Summary: Magnetoencephalography (MEG) encompasses a family of non-contact, non-invasive techniques for detecting the magnetic field generated by the electrical activity of the brain, for analyzing this MEG signal and for using the results to study brain function. The overall purpose of MEG is to extract estimates of the spatiotemporal patterns of electrical activity in the brain from the measured magnetic field outside the head. The electrical activity in the brain is a manifestation of collective neuronal activity and, to a large extent, the currency of brain function. The estimates of brain activity derived from MEG can therefore be used to study mechanisms and processes that support normal brain function in humans and help us understand why, when and how they fail. © 2009 Humana Press.

52. Hochman, E.Y., Z. Eviatar, Z. Breznitz, M. Nevat, and S. Shaul, *Source localization of error negativity: Additional source for corrected errors*. NeuroReport, 2009. **20**(13): p. 1144-1148.

Summary: Error processing in corrected and uncorrected errors was studied while participants responded to a target surrounded by flankers. Error-related negativity (ERN/NE) was stronger and appeared earlier in corrected errors than in uncorrected errors. ERN neural sources for each error type were analyzed using low-resolution electromagnetic tomography method of source localization. For corrected errors, the ERN source was located at the anterior cingulate (BA 24) and the medial and superior frontal regions (presupplementary motor area, BA 6), whereas it was located at the anterior cingulate (BA 24) for uncorrected errors. It is suggested that the anterior cingulate is the main source of the ERN with the presupplementary motor area contributing to ERN initiation only if the correct response tendency is sufficiently active to allow for full execution of a correction response. © 2009 Lippincott Williams & Wilkins, Inc.

53. Him, Y.Y., A.Y. Roh, Y. Namgoong, H.J. Jo, J.M. Lee, and J.S. Kwon, *Cortical network dynamics during source memory retrieval: Current density imaging with individual MRI*. Human Brain Mapping, 2009. **30**(1): p. 78-91.

Summary: We investigated the neural correlates of source memory retrieval using low-resolution electromagnetic tomography (LORETA) with 64 channels EEG and individual MRI as a realistic head model. Event-related potentials (ERPs) were recorded while 13 healthy subjects performed the source memory task for the voice of the speaker in spoken words. The source correct condition of old words elicited more positive-going potentials than the correct rejection condition of new words at 400-700 ms post-stimulus and the old/new effects also appeared in the right anterior region between 1,000 and 1,200 ms. We conducted source reconstruction at mean latencies of 311, 604, 793, and 1,100 ms and used statistical parametric mapping for the statistical analysis. The results of source analysis suggest that the activation of the right inferior parietal region may reflect retrieval of source information. The source elicited by the difference ERPs between the source correct and source incorrect conditions exhibited dynamic change of current density activation in the overall cortices with time during source memory retrieval. These results indicate that multiple neural systems may underlie the ability to recollect context. Hum Brain Mapp 30:78-91, 2009. © 2007 Wiley-Liss, inc.

54. Hill, H., *An event-related potential evoked by movement planning is modulated by performance and learning in visuomotor control.* Experimental Brain Research, 2009. **195**(4): p. 519-529.

Summary: Based on a previous exploratory study, the functionality of event-related potentials related to visuomotor processing and learning was investigated. Three pursuit tracking tasks (cursor control either mouse, joystick, or bimanually) revealed the greatest tracking error and greatest learning effect in the bimanual task. The smallest error without learning was found in the mouse task. Error reduction reflected visuomotor learning. In detail, target-cursor distance was reduced continuously, indicating a better fit to a changed direction, whereas response time remained at 300 ms. A central positive ERP component with an activity onset 100 ms after a directional change of the target and most likely generated in premotor areas could be assigned to response planning and execution. The magnitude of this component was modulated by within-and-between- task difficulty and size of the tracking error. Most importantly, the size of this component was sensitive to between-subject performance and increased with visuomotor learning. © 2009 Springer-Verlag.

55. Hennig-Fast, K., N.S. Werner, R. Lermer, K. Latscha, F. Meister, M. Reiser, R.R. Engel, and T. Meindl, *After facing traumatic stress: Brain activation, cognition and stress coping in policemen.* Journal of Psychiatric Research, 2009. **43**(14): p. 1146-1155.

Summary: Introduction: Resilience can be defined as the capacity to recover following stress or trauma exposure by adopting healthy strategies for dealing with trauma and stress. Although the importance of stress resilience has been recognized, the underlying neurocognitive mediators have not yet been identified. Thus, the primary goal of this study was to investigate memory-related

brain activity in traumatized policemen who attended a pre-traumatic general stress coping program. Method: Ten traumatized male police officers were compared to demographically matched non-traumatized officers (n = 15) on associative memory by using a block design paradigm. Participants with either another psychiatric comorbidity or neurological disorder were excluded. During functional brain imaging (1.5-Tesla), face-profession pairs had to be encoded twice. For subsequent retrieval the faces were presented as cue stimuli for associating the category of the prior learned profession. Additionally, clinical pattern, stress coping style, and cognitive parameters were assessed. Results: Less BOLD activation was found in the hippocampus, parahippocampal gyrus and fusiform gyrus in the trauma group when compared with the non-trauma group during encoding. This was accompanied by slower reaction times in the trauma group during retrieval. Further impairments were found in context memory and in the use of positive cognitive coping strategies. Discussion: Support was provided for the presence of memory-related disturbances in brain activity associated with trauma even in a resilient population. The contribution of the changes in stress coping ability needs to be further examined in longitudinal studies. © 2009 Elsevier Ltd. All rights reserved.

56. Gurskaya, O.E. and V.A. Ponomaryov, *Methods of localization of equivalent EEG sources in the diagnostics of protracted loss of consciousness*. Zhurnal Nevrologii i Psihiatrii imeni S.S. Korsakova, 2009. **109**(4): p. 36-42.

Summary: Results of EEG study of patients in a protracted unconscious state due to severe cranial trauma using different methods of source localization (independent component analysis, the LORETA method) are presented in order to compare their diagnostic value. Also the results of the study of somatosensory evoked potentials (SSEP) to median nerve stimulation of and EEG are compared. The independent higher frequency components of the EEG power spectrum had the higher activity in the delta-band, were localized predominantly in the frontal brain hemispheres (frontal, temporal regions), positively correlated with pathological neurodynamic SSEP changes (r=0,69; p=0,003) and negatively with the scores on the Glasgow outcome scale (r=-0,66; p=0,005).

57. Galdo-Alvarez, S., M. Lindín, and F. Díaz, *Age-related prefrontal over-recruitment in semantic memory retrieval: Evidence from successful face naming and the tip-of-the-tongue state*. Biological Psychology, 2009. **82**(1): p. 89-96.

Summary: Studies that have attempted to determine the effects of aging on the brain neural sources of memory retrieval have reported two contrasting age effects: under-recruitment and over-recruitment of several prefrontal areas. However, the causes for these effects are still a matter of debate. In order to study the underlying factors that cause the effects, we compared brain activation in young and older adults, in a successful word retrieval condition, and a failed word retrieval condition: the tip-of-the-tongue state. For this, we used the event-related potentials technique and neural source estimation with low-resolution

tomographies. The results showed that the older adults did not display under-recruitment in any brain area in comparison with the young adults. However, they displayed additional prefrontal activation that varied depending on the processing stage and the condition, which supports the hypothesis of selective over-recruitment in older adults. © 2009 Elsevier B.V. All rights reserved.

58. Esposito, F., C. Mulert, and R. Goebel, *Combined distributed source and single-trial EEG-fMRI modeling: Application to effortful decision making processes*. NeuroImage, 2009. **47**(1): p. 112-121.

Summary: Single-trial coupling of simultaneously recorded EEG and fMRI time-series can be used to generate fMRI patterns of brain activity with high spatial resolution from EEG responses with high temporal resolution. A forced choice reaction task under different effort conditions has been previously used to demonstrate single-trial EEG-fMRI coupling effects for an early ERP component (N1: 70-150 ms) measured on a single scalp channel (Cz), thereby providing the first multi-modal evidence of early anterior cingulate cortex (ACC) activation in effortful decision making (Mulert, C., Seifert, C., Leicht, G., Kirsch, V., Ertl, M., Karch, S., Moosmann, M., Lutz, J., Möller, H.J., Hegerl, U., Pogarell, O., Jäger, L., 2008. Single-trial coupling of EEG and fMRI reveals the involvement of early anterior cingulate cortex activation in effortful decision making. Neuroimage 42, 158-168.). In this work, we searched for "effort-specific" ERP-N1 sources and explored their single-trial EEG-fMRI correlations for discovering "source-specific" inter-modality coupling effects. To this end, we performed a whole-cortex distributed ERP analysis and used the local source power trial-by-trial variation as an input for single-trial EEG-fMRI coupling analysis. We found a high-effort-specific ERP-N1 source in the ACC and statistically significant differential EEG-fMRI coupling spots in five cortical regions, including the ACC. Our results provide new insights about the neural origins of effort-specific EEG and fMRI response modulations in a choice reaction task and confirm the central role of early ACC activation in motivation-related decision making processes; we discuss the importance of combining distributed source modeling with single-trial coupling for enriching the interpretation of EEG-fMRI patterns. © 2009 Elsevier Inc. All rights reserved.

59. Esposito, F., A. Aragri, T. Piccoli, G. Tedeschi, R. Goebel, and F. Di Salle, *Distributed analysis of simultaneous EEG-fMRI time-series: modeling and interpretation issues*. Magnetic Resonance Imaging, 2009. **27**(8): p. 1120-1130.

Summary: Functional magnetic resonance imaging (fMRI) and electroencephalography (EEG) represent brain activity in terms of a reliable anatomical localization and a detailed temporal evolution of neural signals. Simultaneous EEG-fMRI recordings offer the possibility to greatly enrich the significance and the interpretation of the single modality results because the same neural processes are observed from the same brain at the same time. Nonetheless, the different physical nature of the measured signals by the two techniques renders the coupling not always straightforward, especially in cognitive experiments where spatially localized and distributed effects coexist and evolve temporally at different temporal scales. The purpose of this article is to illustrate the combination of simultaneously recorded EEG and fMRI signals exploiting the principles of EEG distributed source modeling. We define a common source space for fMRI and EEG signal projection and gather a conceptually unique framework for the spatial and temporal comparative analysis. We illustrate this framework in a graded-load working-memory simultaneous EEG-fMRI experiment based on the n-back task where sustained load-dependent changes in the blood-oxygenation-level-dependent (BOLD) signals during continuous item memorization co-occur with parametric changes in the EEG theta power induced at each single item. In line with previous studies, we demonstrate on two single-subject cases how the presented approach is capable of colocalizing in midline frontal regions two phenomena simultaneously observed at different temporal scales, such as the sustained negative changes in BOLD activity and the parametric EEG theta synchronization. We discuss the presented approach in relation to modeling and interpretation issues typically arising in simultaneous EEG-fMRI studies. © 2009 Elsevier Inc. All rights reserved.

60. Duru, A.D., A. Ademoglu, and T. Demiralp, *Analysis of brain electrical topography by spatio-temporal wavelet decomposition*. Mathematical and Computer Modelling, 2009. **49**(11-12): p. 2224-2235.

Summary: Currently, the Functional Magnetic Resonance Imaging (fMRI), Positron Emission Tomography (PET), and Electroencephalography (EEG) recordings are the major techniques of neuroimaging. The EEG with its highest temporal resolution is still a crucial measurement for localization of activities arising from the electrical behaviour of the brain. A scalp topographic map for an EEG may be a superposition of several simpler subtopographic maps, each resulting from an individual electrical source located at a certain depth. Furthermore, this source may have a temporal characteristic as an oscillation or a rhythm that extends in a certain time window which has been a basis of assumption for the time-frequency analysis methods. A method for the spatio-temporal wavelet decomposition of multichannel EEG data is proposed which facilitates the localization of electrical sources separate and/or overlapping on a continuum of time, frequency and space domains. The subtopographic maps asociated with each of these individual components are then used in the MUSIC source localization algorithm. The validations are performed on simulated EEG data. Spatio-temporal wavelet decomposition as a preprocessing method improves the source localization by simplifying the topographic data formed by the superposition of EEG generators, having possible combinations of temporal, frequency and/or spatial overlappings. Spatio-temporal analysis of EEG will help enhance the accuracy of dipole source reconstruction in neuroimaging. © 2008 Elsevier Ltd. All rights reserved.

61. de Munck, J.C. and F. Bijma, *Three-way matrix analysis, the MUSIC algorithm and the coupled dipole model*. Journal of Neuroscience Methods, 2009. **183**(1): p. 63-71.

Summary: The inverse problem of multi-channel MEG/EEG data is considered as a parameter estimation problem. The stability of the solution of the inverse problem, which decreases with the number of included dipoles, can be improved by either adding constraints to the model parameters, or by adding more data of related data sets. The latter approach was taken by Bijma et al. [Bijma F, de Munck JC, Böcker KBE, Huizenga HM, Heethaar RM. The coupled dipole model: an integrated model for multiple MEG/EEG data sets. NeuroImage 2004;23(3):890-904; Bijma F, de Munck JC, Huizenga HM, Heethaar RM, Nehorai A. Simultaneous estimation and testing in multiple MEG data sets. IEEE Trans SP 2005;53(9):3449-60] by introducing coupling matrices that link dipole parameters and source time functions of different data sets. Here, the theoretical foundations of the coupled dipole model are explored and the MUSIC algorithm is generalised to the analysis of multiple related data sets. Similar to the MUSIC algorithm, the number of sources and the number of constraints are derived from the data by considering the minimum possible residual error as a function of the number of sources and constraints. However, contrary to the MUSIC algorithm, where the minimum residual error can be obtained from an SVD analysis of a two-way data matrix, here we deal with multiple data sets and therefore three-way matrix analysis is used. From a simulation study it appears that the number of sources and constraints can be clearly determined from a generalised SVD analysis. The generalisation of the MUSIC algorithm to three-way data gives reasonable estimates of the dipole parameters. These results can be used in the simultaneous analysis of MEG/EEG data of multiple subjects, multiples data sets of the same subject or models where subsequent trials of data show habituation effects. © 2009 Elsevier B.V. All rights reserved.

62. Czigler, I. and L. Pató, *Unnoticed regularity violation elicits change-related brain activity*. Biological Psychology, 2009. **80**(3): p. 339-347.

Summary: Event-related brain electric activity (ERP) was investigated to unnoticed visual changes. The orientation of grid elements (vertical or horizontal) changed after the presentation of 10-15 identical stimuli. The grid patterns were task irrelevant, and were presented in the background of a shape discrimination task. During the first half of the session, participants were unaware of the stimulus change. However, in comparison to the ERPs to the fifth identical stimuli, stimulus change elicited posterior negativities in the 270-375 ms range (visual mismatch negativity, vMMN). With participants instructed on the stimulus change, negativities emerged with earlier onset and with wider distribution. When stimulus change was preceded by only two identical stimuli, there were no such ERP effects. As the results show, a longer sequence of identical unattended stimuli may establish the memory representation of stimulus regularity, and violation of regularity is indicated by posterior negative ERP components (vMMN). © 2008 Elsevier B.V. All rights reserved.

63. Cuspineda Bravo, E.R., C. Machado, T. Virues, E. Martínez-Montes, A. Ojeda, P.A. Valdés, J. Bosch, and L. Valdes, *Source analysis of alpha rhythm reactivity using LORETA imaging with 64-channel EEG and individual MRI*. Clinical EEG and Neuroscience, 2009. **40**(3): p. 150-156.

Summary: Conventional EEG and quantitative EEG visual stimuli (close-open eyes) reactivity analysis have shown their usefulness in clinical practice; however studies at the level of EEG generators are limited. The focus of the study was visual reactivity of cortical resources in healthy subjects and in a stroke patient. The 64 channel EEG and T1 magnetic resonance imaging (MRI) studies were obtained from 32 healthy subjects and a middle cerebral artery stroke patient. Low Resolution Electromagnetic Tomography (LORETA) was used to estimate EEG sources for both close eyes (CE) vs. open eyes (OE) conditions using individual MRI. The t-test was performed between source spectra of the two conditions. Thresholds for statistically significant t values were estimated by the local false discovery rate (lfdr) method. The Z transform was used to quantify the differences in cortical reactivity between the patient and healthy subjects. Closed-open eyes alpha reactivity sources were found mainly in posterior regions (occipito-parietal zones), extended in some cases to anterior and thalamic regions. Significant cortical reactivity sources were found in frequencies different from alpha (lower t-values). Significant changes at EEG reactivity sources were evident in the damaged brain hemisphere. Reactivity changes were also found in the "healthy" hemisphere when compared with the normal population. In conclusion, our study of brain sources of EEG alpha reactivity provides information that is not evident in the usual topographic analysis.

64. Cuetos, F., A. Barbón, M. Urrutia, and A. Domínguez, *Determining the time course of lexical frequency and age of acquisition using ERP*. Clinical Neurophysiology, 2009. **120**(2): p. 285-294.

Summary: Objective: The main goal of the present study was to dissociate the effects on reading of frequency, age of acquisition (AoA) and imageability using the evoked response potential paradigm. Method: Twenty participants read words from three experimental conditions: high and low frequency, late and early age of acquisition and high and low imageability. Results: High frequency words produced more positive mean amplitude than low frequency words in the 175-360 ms post-stimulus onset time window and late AoA produced more negative amplitudes than early AoA in the 400-610 ms window. Imageability did not produce any effect in any time window tested. Brain electromagnetic tomography showed the most activated cortical areas for each category of stimuli. Conclusions: The lexical frequency of words seems to affect an early phase in the recognition process, perhaps at the level of the orthographic input lexicon, while AoA was observed at a later stage, indicating that this variable influence processing at a semantic level or at the links between semantics and phonology. Significance: EEG permits the researcher to investigate the time course, and approximate location in the brain, of psycholinguistic variables. © 2008 International Federation of Clinical Neurophysiology.

65. Corrigan, N.M., T. Richards, S.J. Webb, M. Murias, K. Merkle, N.M. Kleinhans, L.C. Johnson, A. Poliakov, E. Aylward, and G. Dawson, *An investigation of the relationship between fmri and erp source localized measurements of brain activity during face processing*. Brain Topography, 2009. **22**(2): p. 83-96.

Summary: Brain activity patterns during face processing have been extensively explored with functional magnetic resonance imaging (fMRI) and event-related potentials (ERPs). ERP source localization adds a spatial dimension to the ERP time series recordings, which allows for a more direct comparison and integration with fMRI findings. The goals for this study were (1) to compare the spatial descriptions of neuronal activity during face processing obtained with fMRI and ERP source localization using low-resolution electromagnetic tomography (LORETA), and (2) to use the combined information from source localization and fMRI to explore how the temporal sequence of brain activity during face processing is summarized in fMRI activation maps. fMRI and high-density ERP data were acquired in separate sessions for 17 healthy adult males for a face and object processing task. LORETA statistical maps for the comparison of viewing faces and viewing houses were coregistered and compared to fMRI statistical maps for the same conditions. The spatial locations of face processing-sensitive activity measured by fMRI and LORETA were found to overlap in a number of areas including the bilateral fusiform gyri, the right superior, middle and inferior temporal gyri, and the bilateral precuneus. Both the fMRI and LORETA solutions additionally demonstrated activity in regions that did not overlap. fMRI and LORETA statistical maps of face processing-sensitive brain activity were found to converge spatially primarily at LORETA solution latencies that were within 18 ms of the N170 latency. The combination of data from these techniques suggested that electrical brain activity at the latency of the N170 is highly represented in fMRI statistical maps. © 2009 Springer Science+Business Media, LLC.

66. Clemens, B., P. Piros, M. Bessenyei, E. Varga, S. Puskás, and I. Fekete, *The electrophysiological "delayed effect" of focal interictal epileptiform discharges. A low resolution electromagnetic tomography (LORETA) study*. Epilepsy Research, 2009. **85**(2-3): p. 270-278.

Summary: Collating the findings regarding the role of focal interictal epileptiform discharges (IEDs) on CNS functions raises the possibility that IEDs might have negative impact that outlasts the duration of the spike-and-wave complexes. The aim of this study was the electrophysiological demonstration of the "delayed effect" of the IEDs. 19-channel, linked-ears referenced, digital waking EEG records of 11 children (aged 6-14 years, eight with idiopathic, three with cryptogenic focal epilepsy, showing a single spike focus) were retrospectively selected from our database. A minimum of 20 (preferably, 30), 2-s epochs containing a single focal spike-and-wave complex were selected (Spike epochs). Thereafter, Postspike-1 (Ps1), Postspike-2 (Ps2) and Postspike-3 (Ps3) epochs were selected, representing the first and second seconds (Ps1), the third and

fourth seconds (Ps2) and the fifth and sixth seconds (Ps3) after the Spike epoch, respectively. Interspike epochs (Is) were selected at a distance at least 10 s after the Spike epoch. Individual analysis: the frequency of interest (FOI = the individual frequency of the wave component of the IEDs), and the region of interest (ROI = the site of the IEDs) were identified by reading the raw EEG waveform and the instant power spectrum. Very narrow band LORETA (low resolution electromagnetic tomography) analysis at the FOI and ROI was carried out. Age-adjusted, Z-transformed LORETA "activity" (=current source density, ampers/meters squared) was compared in the Spike, Ps1, Ps2, Ps3 and Is epochs. Findings: the greatest (uppermost pathological) Z-scores and the greatest spatial extension of the LORETA-abnormality were always found in the Spike epochs, followed by the gradual decrease of activity in terms of severity and spatial extension in the Ps1, Ps2, Ps3 epochs. The lowest (baseline) level and extension of the abnormality was found in the Is epochs. Group analysis: average values of activity across the patients were computed for the temporal decrease of the abnormality. Findings: a clear tendency for the decrease of abnormality was demonstrated. Conclusion: the "delayed effect" of the IEDs was demonstrated electrophysiologically and quantified. The method may be utilized in the individual assessment of the effect of IEDs on cortical activity, the degree and temporo-spatial extension of the abnormality. © 2009 Elsevier B.V. All rights reserved.

67. Ceballos, N.A., L.O. Bauer, and R.J. Houston, *Recent EEG and ERP findings in substance abusers*. Clinical EEG and Neuroscience, 2009. **40**(2): p. 122-128.

Summary: Research on electroencephalographic (EEG) correlates of substance use has a long history. The present paper provides a review of recent studies - 2001 to the present - with a focus on EEG findings in human participants characterized by a history of chronic substance use, abuse or dependence. In some areas (e.g., alcohol and cocaine dependence), the field has attempted to build upon earlier work by incorporating different methodologies or pursuing research questions of a transdisciplinary nature. New areas of inquiry, such as the investigation of EEG differences among users of ecstasy (MDMA) and methamphetamine, have emerged, primarily as a result of an alarming rise in popularity of these drugs.

68. Catena, A., G. Houghton, B. Valdés, and L.J. Fuentes, *Unmasking word processing with ERPs: Two novel linear techniques for the estimation of temporally overlapped waveforms*. Brain Topography, 2009. **22**(1): p. 60-71.

Summary: Masked priming experiments are frequently used to study automatic aspects of word processing. Direct measures of such processing obtained with functional neuroimaging techniques (ERPs, fMRI, etc.) need to isolate the neural activation related to relevant events when they are rapidly followed by others (a situation found in other popular paradigms such as the attentional blink and repetition blindness). Here we examine the assumption of "simple insertion", which underlies the use of subtraction to isolate components of temporally

overlapping waveforms. We propose two novel linear methods and illustrate how they extract temporal and spatial ERP components that the subtraction method fails to detect. We show this through the analysis of ERP data from a masked semantic priming procedure. The new techniques reveal activation generated by unconscious (masked) prime words as early as 100 ms and 200 ms post stimulus-onset; a pattern which simple subtraction fails to detect. © 2009 Springer Science+Business Media, LLC.

69. Carbonell, F., K.J. Worsley, N.J. Trujillo-Barreto, and M. Vega-Hernandez, *The geometry of time-varying cross-correlation random fields*. Computational Statistics and Data Analysis, 2009. **53**(9): p. 3291-3304.

Summary: The goal of this paper is to assess the P-value of local maxima of time-varying cross-correlation random fields. The motivation for this comes from an electroencephalography (EEG) experiment, where one seeks connectivity between all pairs of voxels inside the brain at each time point of the recording window. In this way, we extend the results of [Cao, J., Worsley, K.J., 1999b. The geometry of correlation fields with an application to functional connectivity of the brain. The Annals of Applied Probability 9 (4), 1021-1057] by searching for high correlations not only over all pairs of voxels, but over all time points as well. We apply our results to an EEG data set of a face recognition paradigm. Our analysis determines those time instants for which there are significantly correlated regions involved in face recognition. © 2009 Elsevier B.V. All rights reserved.

70. Carbonell, F., K.J. Worsley, and N.J. Trujillo-Barreto, *On the Fisher's Z transformation of correlation random fields*. Statistics and Probability Letters, 2009. **79**(6): p. 780-788.

Summary: One of the most interesting problems studied in Random Field Theory (RFT) is to approximate the distribution of the maximum of a random field. This problem usually appears in a general hypothesis testing framework, where the statistics of interest are the maximum of a random field of a known distribution. In this paper, we use the RFT approach to compare two independent correlation random fields, R1 and R2. Our statistics of interest are the maximum of a random field G, resulting from the difference between the Fisher's Z transformation of R1 and R2, respectively. The Fisher's Z transformation guarantees a Gaussian distribution at each point of G but, unfortunately, G is not transformed into a Gaussian random field. Hence, standard results of RFT for Gaussian random fields are not longer available for G. We show here that the distribution of the maximum of G can still be approximated by the distribution of the maximum of a Gaussian random field, provided there is some correction by its spatial smoothness. Indeed, we present a general setting to obtain this correction. This is done by allowing different smoothness parameters for the components of G. Finally, the performance of our method is illustrated by means of both numerical simulations and real Electroencephalography data, recorded during a face recognition experimental paradigm. © 2008 Elsevier B.V. All rights reserved.

71. Bruni, O., L. Novelli, E. Finotti, A. Luchetti, G. Uggeri, D. Aricò, and R. Ferri, *All-night EEG power spectral analysis of the cyclic alternating pattern at different ages*. Clinical Neurophysiology, 2009. **120**(2): p. 248-256.

Summary: Objective: To analyze in detail the frequency content of the different EEG components of the Cyclic Alternating Pattern (CAP) in the whole sleep of pre-school and school age children compared to normal young adults. Methods: Fourteen pre-school age and 18 school age children and 16 adults were included in this study. Each participant underwent a polysomnographic overnight recording, after an adaptation night; sleep stages and CAP were scored following standard criteria. Average spectra were obtained for each CAP condition from the signal recorded from C3/A2 or C4/A1, separately in sleep stage 2 and slow-wave sleep (SWS), for each subject. Results: The analysis of the relative power density in the three groups showed that in sleep stage 2 and in SWS, CAP A1, A2, A3 subtypes had a significantly higher power in all frequency ranges in pre-school children than in adults, while school children differed mainly for the lower frequencies (<7 Hz). For non-CAP, pre-school and school children differed from adults at almost all frequencies analyzed. Generally, A1, A2 and A3 showed clear spectral differences in the three different groups of subjects with pre-school age children showing slightly less evident differences. Conclusions: CAP subtypes are characterized by clearly different spectra at different ages and also the same subtype shows a different power spectrum, during sleep stage 2 or SWS. This study shows that pre-school children have a different structure of sleep, especially from the microstructural (CAP) point of view: the differences are evident for all the CAP components and for non-CAP in almost all the frequency bands. This finding might be associated to the age-related delta decline in the 0-3 Hz frequency reported in children of the same age. Significance: Our data seem to provide information not available before and useful for the understanding of the impact of CAP on the sleep EEG neurophysiological dynamics at different ages. This type of information is crucial for a more adequate interpretation of data provided by a growing number of studies analyzing CAP in groups of pediatric patients. © 2008 International Federation of Clinical Neurophysiology.

72. Brookings, T., S. Ortigue, S. Grafton, and J. Carlson, *Using ICA and realistic BOLD models to obtain joint EEG/fMRI solutions to the problem of source localization*. NeuroImage, 2009. **44**(2): p. 411-420.

Summary: We develop two techniques to solve for the spatio-temporal neural activity patterns using Electroencephalogram (EEG) and Functional Magnetic Resonance Imaging (fMRI) data. EEG-only source localization is an inherently underconstrained problem, whereas fMRI by itself suffers from poor temporal resolution. Combining the two modalities transforms source localization into an overconstrained problem, and produces a solution with the high temporal resolution of EEG and the high spatial resolution of fMRI. Our first method uses fMRI to regularize the EEG solution, while our second method uses Independent Components Analysis (ICA) and realistic models of Blood Oxygen-Level Dependent (BOLD) signal to relate the EEG and fMRI data. The second method allows us to treat the fMRI and EEG data on equal footing by fitting simultaneously a solution to both data types. Both techniques avoid the need for ad hoc assumptions about the distribution of neural activity, although ultimately the second method provides more accurate inverse solutions. © 2008 Elsevier Inc. All rights reserved.

73. Bolstad, A., B.V. Veen, and R. Nowak, *Space-time event sparse penalization for magneto-/electroencephalography*. NeuroImage, 2009. **46**(4): p. 1066-1081.

Summary: This article presents a new spatio-temporal method for M/EEG source reconstruction based on the assumption that only a small number of events, localized in space and/or time, are responsible for the measured signal. Each space-time event is represented using a basis function expansion which reflects the most relevant (or measurable) features of the signal. This model of neural activity leads naturally to a Bayesian likelihood function which balances the model fit to the data with the complexity of the model, where the complexity is related to the number of included events. A novel Expectation-Maximization algorithm which maximizes the likelihood function is presented. The new method is shown to be effective on several MEG simulations of neurological activity as well as data from a self-paced finger tapping experiment. © 2009 Elsevier Inc. All rights reserved.

74. Bocquillon, P., K. Dujardin, N. Betrouni, V. Phalempin, E. Houdayer, J.L. Bourriez, P. Derambure, and W. Szurhaj, *Attention impairment in temporal lobe epilepsy: A neurophysiological approach via analysis of the P300 wave*. Human Brain Mapping, 2009. **30**(7): p. 2267-2277.

Summary: Purpose: Attention is often impaired in temporal lobe epilepsy (TLE). The P300 wave (an endogenous, event-related potential) is a correlate of attention which is usually recorded during an "oddball paradigm," where the subject is instructed to detect an infrequent target stimulus presented amongst frequent, standard stimuli. Modifications of the P300 wave's latency and amplitude in TLE have been suggested, but it is still not known whether the source regions also differ. Our hypothesis was that temporal lobe dysfunction would modify the P3 source regions in TLE patients. Methods: A comparative, high density, 128-channel electroencephalographic analysis of the characteristics of P300 (P3b latency and amplitude) was performed in 10 TLE patients and 10 healthy controls during auditory and visual oddball paradigms. The P3b sources were localized on individual 3D MR images using the LORETA method and intergroup statistical comparisons were performed using SPM2® software. Results: Our main results (in both individual analyses and intergroup comparisons) revealed a reduction in temporal (and more particularly mesiotemporal) sources and, to a lesser extent, frontal sources in TLE patients, compared with controls. Discussion: This reduction may reflect direct, local cortical dysfunction caused by the epileptic focus or more complex interference between epileptic networks and normal attentional pathways. © 2008 Wiley-Liss, Inc.

75. Barton, M.J., P.A. Robinson, S. Kumar, A. Galka, H.F. Durrant-Whyte, J. Guivant, and T. Ozaki, *Evaluating the performance of Kalman-filter-based EEG source localization*. IEEE Transactions on Biomedical Engineering, 2009. **56**(1): p. 122-136.

Summary: Electroencephalographic (EEG) source localization is an important tool for noninvasive study of brain dynamics, due to its ability to probe neural activity more directly, with better temporal resolution than other imaging modalities. One promising technique for solving the EEG inverse problem is Kalman filtering, because it provides a natural framework for incorporating dynamic EEG generation models in source localization. Here, a recently developed inverse solution is introduced, which uses spatiotemporal Kalman filtering tuned through likelihood maximization. Standard diagnostic tests for objectively evaluating Kalman filter performance are then described and applied to inverse solutions for simulated and clinical EEG data. These tests, employed for the first time in Kalman-filter-based source localization, check the statistical properties of the innovation and validate the use of likelihood maximization for filter tuning. However, this analysis also reveals that the filter's existing space- and time-invariant process model, which contains a single fixed-frequency resonance, is unable to completely model the complex spatiotemporal dynamics of EEG data. This finding indicates that the algorithm could be improved by allowing the process model parameters to vary in space. © 2006 IEEE.

76. Badzakova-Trajkov, G., K.J. Barnett, K.E. Waldie, and I.J. Kirk, *An ERP investigation of the Stroop task: The role of the cingulate in attentional allocation and conflict resolution*. Brain Research, 2009. **1253**(C): p. 139-148.

Summary: The majority of studies support a role of the anterior cingulate cortex (ACC) in the attentional control necessary for conflict resolution in the Stroop task; however, the time course of activation and the neural substrates underlying the Stroop task remain contentious. We used high-density EEG to record visual-evoked potentials from 16 healthy subjects while performing a manual version of the traditional Stroop colour-word task. Difference waveforms for congruent-control and incongruent-control conditions were similar in amplitude and had a similar spatial distribution in the time window of 260-430 ms post stimulus onset. Source estimation indicated particularly middle cingulate involvement in congruent-control and incongruent-control difference waveforms. In contrast, the difference waveform for the incongruent-congruent contrast was observed later (in the time window of 370-480 ms), had a different spatial distribution, and source estimation indicated that the anterior cingulate underlies this difference waveform. As congruent-control and incongruent-control differences have a similar timeframe and cingulate source, we propose that this indicates early attentional allocation processes. That is, the identification of two sources of information (the word and the colour it is printed in) and the selective attention to one. The later peak in the incongruent-congruent difference wave, originating in anterior cingulate, likely reflects identification (and subsequent resolution) of conflict in the two sources of information. © 2008 Elsevier B.V. All rights reserved.

77. Aramaki, M., M. Besson, R. Kronland-Martinet, and S. Ystad, *Timbre perception of sounds from impacted materials: Behavioral, electrophysiological and acoustic approaches*. Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics), 2009. **5493 LNCS**: p. 1-17.

Summary: In this paper, timbre perception of sounds from 3 different impacted materials (Wood, Metal and Glass) was examined using a categorization task. Natural sounds were recorded, analyzed and resynthesized and a sound morphing process was applied to construct sound continua between different materials. Participants were asked to categorize the sounds as Wood, Metal or Glass. Typical sounds for each category were defined on the basis of the behavioral data. The temporal dynamics of the neural processes involved in the categorization task were then examined for typical sounds by measuring the changes in brain electrical activity (Event-Related brain Potentials, ERPs). Analysis of the ERP data revealed that the processing of Metal sounds differed significantly from Glass and Wood sounds as early as 150 ms and up to 700 ms. The association of behavioral, electrophysiological and acoustic data allowed us to investigate material categorization: the importance of damping was confirmed and additionally, the relevancy of spectral content of sounds was discussed. © 2009 Springer Berlin Heidelberg.

78. Adjamian, P., M. Sereda, and D.A. Hall, *The mechanisms of tinnitus: Perspectives from human functional neuroimaging*. Hearing Research, 2009. **253**(1-2): p. 15-31.

Summary: In this review, we highlight the contribution of advances in human neuroimaging to the current understanding of central mechanisms underpinning tinnitus and explain how interpretations of neuroimaging data have been guided by animal models. The primary motivation for studying the neural substrates of tinnitus in humans has been to demonstrate objectively its representation in the central auditory system and to develop a better understanding of its diverse pathophysiology and of the functional interplay between sensory, cognitive and affective systems. The ultimate goal of neuroimaging is to identify subtypes of tinnitus in order to better inform treatment strategies. The three neural mechanisms considered in this review may provide a basis for TI classification. While human neuroimaging evidence strongly implicates the central auditory system and emotional centres in TI, evidence for the precise contribution from the three mechanisms is unclear because the data are somewhat inconsistent. We consider a number of methodological issues limiting the field of human neuroimaging and recommend approaches to overcome potential inconsistency in results arising from poorly matched participants, lack of appropriate controls and low statistical power. © 2009 Elsevier B.V. All rights reserved.

79. Zvyagintsev, M., H. Thönnessen, J. Dammers, F. Boers, and K. Mathiak, *An automatic procedure for the analysis of electric and magnetic mismatch negativity based on anatomical brain mapping*. Journal of Neuroscience Methods, 2008. **168**(2): p. 325-333.

Summary: Data processing techniques in electroencephalography (EEG) and magnetoencephalography (MEG) need user interactions. However, particularly in clinical applications, fast and objective data processing is important. Here we present an observer-independent method for EEG and MEG analysis of mismatch negativity (MMN) that allows reliable estimation of source activity based on objective anatomical references. The procedure integrates several steps including artifact rejection, source estimation and statistical analysis. It enables the evaluation of source activity in a fully automatic and unsupervised manner. To test its feasibility we obtained EEG and MEG responses in an auditory oddball paradigm in 12 healthy volunteers. The automatized method of EEG and MEG data analysis estimated source activity. The automatically detected MMN was closely comparable with the results obtained by a user-controlled method based on the dipole fitting. The presented workflow can be performed easily, rapidly, and reliably. This development may open new fields in research and clinical applications of source-based EEG and MEG. © 2007 Elsevier B.V. All rights reserved.

80. Zouch, W., A. Taleb-Ahmed, A. Ben Hamida, J.L. Bourriez, and P. Derambure, *Smooth WMN-FOCUSS method for EEG dipoles localisation*. Proceedings of IWSSIP 2008 - 15th International Conference on Systems, Signals and Image Processing, 2008: p. 457-460.

Summary: The new WMN-FOCUSS method is a combination between the Weighted Minimum Norm "WMN" method and the iterative FOCaI Underdetermined System Solver "FOCUSS" one. The initialisation step is very important since it is an iterative method. In this paper, we propose an amelioration of the WMN-FOCUSS by smoothing the current density distribution given by WMN before the initialisation of the iterative process. To reduce the divergence risk, smoothing the first iteration of the WMN-FOCUSS method is also proposed. To evaluate the standard and the smooth WMN-FOCUSS methods, we present a study of the localisation error and the robustness against the noise. The found results show that our method is able to give a good reconstruction of the simulated dipole with small localisation error even with an addition of a white gaussian noise.

81. Zhang, Y., W. van Drongelen, M. Kohrman, and B. He, *Three-dimensional brain current source reconstruction from intra-cranial ECoG recordings*. NeuroImage, 2008. **42**(2): p. 683-695.

Summary: We have investigated 3-dimensional brain current density reconstruction (CDR) from intracranial electrocorticogram (ECoG) recordings by means of finite element method (FEM). The brain electrical sources are modeled

by a current density distribution and estimated from the ECoG signals with the aid of a weighted minimum norm estimation algorithm. A series of computer simulations were conducted to evaluate the performance of ECoG-CDR by comparing with the scalp EEG based CDR results. The present computer simulation results indicate that the ECoG-CDR provides enhanced performance in localizing single dipole sources which are located in regions underneath the implanted subdural ECoG grids, and in distinguishing and imaging multiple separate dipole sources, in comparison to the CDR results as obtained from the scalp EEG under the same conditions. We have also demonstrated the applicability of the present ECoG-CDR method to estimate 3-dimensional current density distribution from the subdural ECoG recordings in a human epilepsy patient. Eleven interictal epileptiform spikes (seven from the frontal region and four from parietal region) in an epilepsy patient undergoing surgical evaluation were analyzed. The present promising results indicate the feasibility and applicability of the developed ECoG-CDR method of estimating brain sources from intracranial electrical recordings, with detailed forward modeling using FEM. © 2008 Elsevier Inc. All rights reserved.

82. Zhang, Y., S. Feutl, U. Hauser, C. Richter-Witte, P. Schmorl, H.M. Emrich, and D.E. Dietrich, *Clinical correlates of word recognition memory in obsessive-compulsive disorder: An event-related potential study*. Psychiatry Research - Neuroimaging, 2008. **162**(3): p. 262-272.

Summary: Memory disturbances found in obsessive-compulsive disorder (OCD) may partially be related to dysfunction of cortico-subcortical circuits. However, it is still unknown how OCD symptomatology is related to memory processing. To explore this question, event-related potentials (ERPs) were recorded in a continuous word-recognition paradigm in OCD patients with either severe or moderate scores on the Yale-Brown Obsessive-Compulsive Scale (Y-BOCS) (group S and group M, n = 8 each) and in normal healthy controls (n = 16). Typically ERPs to repeated items are characterized by more positive waveforms beginning approximately 250 ms post-stimulus. This "old/new effect" has been shown to be relevant for memory processing. The early old/new effect (ca. 300-500 ms) with a frontal distribution is proposed to be a neural correlate of familiarity-based recognition. The late old/new effect (post-500 ms) is assumed to reflect conscious memory retrieval processes. The OCD group S showed a normal early old/new effect and a reduced late old/new effect compared with group M and the control group, but no difference was found between group M and the control group. Source analyses for the late old/new effect showed statistically reduced cerebral activation in the anterior cingulate for OCD group S in contrast to the control group. Additionally, the early old/new effect in OCD group S was negatively correlated with the Y-BOCS total scores, and the late old/new effect was negatively correlated with obsession sub-scores. The severely, not moderately, ill OCD patients showed an impaired conscious recollection of the word-to-be-remembered, which suggested an impairment of working memory capacity in these patients due to a dysfunction in the frontal and cingulate cortex. © 2007 Elsevier Ireland Ltd. All rights reserved.

83. Zariffa, J. and M.R. Popovic, *Solution space reduction in the peripheral nerve source localization problem using forward field similarities*. Journal of Neural Engineering, 2008. **5**(2): p. 191-202.

Summary: Improving our ability to localize bioelectric sources within a peripheral nerve would help us to monitor the control signals flowing to and from any limb or organ. This technology would provide a useful neuroscience tool, and could perhaps be incorporated into a neuroprosthesis interface. We propose to use measurements from a multi-contact nerve cuff to solve an inverse problem of bioelectric source localization within the peripheral nerve. Before the inverse problem can be addressed, the forward problem is solved using finite element modeling. A fine mesh improves the accuracy of the forward problem solution, but increases the number of variables to be solved for in the inverse problem. To alleviate this problem, variables corresponding to mesh elements that are not distinguishable by the measurement setup are grouped together, thus reducing the dimension of the inverse problem without impacting on the forward problem accuracy. A quantitative criterion for element distinguishability is derived using the columns of the leadfield matrix and information about the uncertainty in the measurements. Our results indicate that the number of variables in the inverse problem can be reduced by more than half using the proposed method, without having a detrimental impact on the quality of the localization. © 2008 IOP Publishing Ltd.

84. Yoshioka, T., K. Toyama, M. Kawato, O. Yamashita, S. Nishina, N. Yamagishi, and M.A. Sato, *Evaluation of hierarchical Bayesian method through retinotopic brain activities reconstruction from fMRI and MEG signals*. NeuroImage, 2008. **42**(4): p. 1397-1413.

Summary: A hierarchical Bayesian method estimated current sources from MEG data, incorporating an fMRI constraint as a hierarchical prior whose strength is controlled by hyperparameters. A previous study [Sato, M., Yoshioka, T., Kajihara, S., Toyama, K., Goda, N., Doya, K., Kawato, M., 2004. Hierarchical Bayesian estimation for MEG inverse problem. Neuroimage 23, 806-826] demonstrated that fMRI information improves the localization accuracy for simulated data. The goal of the present study is to confirm the usefulness of the hierarchical Bayesian method by the real MEG and fMRI experiments using visual stimuli with a fan-shaped checkerboard pattern presented in four visual quadrants. The proper range of hyperparameters was systematically analyzed using goodness of estimate measures for the estimated currents. The robustness with respect to false-positive activities in the fMRI information was also evaluated by using noisy priors constructed by adding artificial noises to real fMRI signals. It was shown that with appropriate hyperparameter values, the retinotopic organization and temporal dynamics in the early visual area were reconstructed, which were in a close correspondence with the known brain imaging and electrophysiology of the humans and monkeys. The false-positive effects of the noisy priors were suppressed by using appropriate hyperparameter values. The hierarchical Bayesian method also was capable of reconstructing

retinotopic sequential activation in V1 with fine spatiotemporal resolution, from MEG data elicited by sequential stimulation of the four visual quadrants with the fan-shaped checker board pattern at much shorter intervals (150 and 400 ms) than the temporal resolution of fMRI. These results indicate the potential capability for the hierarchical Bayesian method combining MEG with fMRI to improve the spatiotemporal resolution of noninvasive brain activity measurement. © 2008 Elsevier Inc.

85. Yorio, A., A. Tabullo, A. Wainselboim, P. Barttfeld, and E. Segura, *Event-related potential correlates of perceptual and functional categories: Comparison between stimuli matching by identity and equivalence*, in *Neuroscience Letters*. 2008. p. 113-118.

86. Xu, P., Y. Tian, X. Lei, X. Hu, and D. Yao, *Equivalent charge source model based iterative maximum neighbor weight for sparse EEG source localization*. Annals of Biomedical Engineering, 2008. **36**(12): p. 2051-2067.

Summary: How to localize the neural electric activities within brain effectively and precisely from the scalp electroencephalogram (EEG) recordings is a critical issue for current study in clinical neurology and cognitive neuroscience. In this paper, based on the charge source model and the iterative re-weighted strategy, proposed is a new maximum neighbor weight based iterative sparse source imaging method, termed as CMOSS (Charge source model based Maximum neighbOr weight Sparse Solution). Different from the weight used in focal underdetermined system solver (FOCUSS) where the weight for each point in the discrete solution space is independently updated in iterations, the new designed weight for each point in each iteration is determined by the source solution of the last iteration at both the point and its neighbors. Using such a new weight, the next iteration may have a bigger chance to rectify the local source location bias existed in the previous iteration solution. The simulation studies with comparison to FOCUSS and LORETA for various source configurations were conducted on a realistic 3-shell head model, and the results confirmed the validation of CMOSS for sparse EEG source localization. Finally, CMOSS was applied to localize sources elicited in a visual stimuli experiment, and the result was consistent with those source areas involved in visual processing reported in previous studies. © 2008 Biomedical Engineering Society.

87. Wu, C., I.J. Kirk, J.P. Hamm, and V.K. Lim, *The neural networks involved in pitch labeling of absolute pitch musicians*. NeuroReport, 2008. **19**(8): p. 851-854.

Summary: Investigating the neural substrates of auditory processing of absolute pitch musicians has relevance for understanding the capabilities of the human brain for plasticity. Electroencephalography was used to examine the N1 of auditory-evoked potentials from absolute pitch musicians, nonabsolute pitch musicians, and nonmusicians during tone labeling tasks with and without presentation of a reference tone. Source localization using low-resolution

electromagnetic tomography revealed that when labeling tones without a reference, absolute pitch musicians generated greater activity than nonabsolute pitch musicians in the left and right hemispheres. This suggests that when required to label tones without an external reference, absolute pitch musicians have the ability to recruit a greater network than nonabsolute pitch musicians or nonmusicians. © 2008 Lippincott Williams & Wilkins, Inc.

88. Wan, X., A. Sekiguchi, S. Yokoyama, J. Riera, and R. Kawashima, *Electromagnetic source imaging: Backus-Gilbert resolution spread function-constrained and functional MRI-guided spatial filtering*. Human Brain Mapping, 2008. **29**(6): p. 627-643.

Summary: Electromagnetic source imaging techniques are usually limited by their low spatial resolution, even though these techniques have high temporal resolution. Our heuristic analysis shows that the spatial ambiguity of electromagnetic source localization arises from interference from other sources. In this paper, we suggest a new inverse solution based on the principle of spatial filtering to effectively suppress the interference from other sources, especially from the far sources. By means of this approach, functional MRI information can also be effectively integrated into the inverse solution to further improve spatial accuracy of source localization. Most importantly, the results of source localization by this approach are not significantly biased by incompatible fMRI information. Our simulations and experimental results using electroencephalography based on a realistic head model show that the Backus-Gilbert resolution spread function-constrained and functional MRI-guided spatial filtering suggested in this paper provide high spatial accuracy and resolution of source localization, even in the presence of multiple simultaneously active sources. © 2007 Wiley-Liss, Inc.

89. Walla, P., C. Duregger, K. Greiner, S. Thurner, and K. Ehrenberger, *Multiple aspects related to self-awareness and the awareness of others: An electroencephalography study*. Journal of Neural Transmission, 2008. **115**(7): p. 983-992.

Summary: The effect of possessive pronouns on the encoding of pronoun-noun associations (e.g., my garden) was investigated using the electroencephalography (EEG). Following an alphabetical, semantic and a contextual encoding instruction depth of noun processing was varied within three separate experiments in order to manipulate the grade of awareness related to verbal information processing. Only for the semantic encoding task (lexical decision) response time was significantly longer for nouns associated with the pronoun "mein" (German for "my") than for nouns associated with the pronoun "ein" (German for "a") although pronouns were not to be consciously processed at all. Following recognition tests related to nouns (without their previously associated pronouns) revealed no significant differences related to the number of correctly identified repeated nouns (hits) depending on the kind of previously associated pronoun. The analysis of neurophysiological data revealed a time range between about 250 ms and 400 ms after stimulus onset within which significant pronoun x electrode interactions occurred. No interaction with depth of word processing was found. Overlaid EEG curves, t maps and low resolution brain electromagnetic tomography (LORETA) demonstrate that in this time range "mein" and "sein" associated conditions elicit similar brain activity, both more negative, compared to the "ein" associated condition over occipital electrodes. On the other hand, at left temporal sites the "mein" condition elicited more negative potentials than both other conditions. It is interpreted that EEG recordings reveal two relevant areas, which are sensitive to the concept of a person (as represented by a personal pronoun) between about 250 ms and 400 ms after stimulus onset. One area is located in the occipital region and can distinguish between personal engagement and a neutral condition and the other area is located in the temporal region and is able to distinguish between oneself and somebody else. Together with our previous MEG results (Walla et al. in Neuropsychologia 45:796-809, 2007) we want to combine the inferences in the frame of the "multiple aspects" hypothesis related to research on self-awareness and the awareness of others. © 2008 Springer-Verlag.

90. Ventouras, E.M., P.Y. Ktonas, H. Tsekou, T. Paparrigopoulos, I. Kalatzis, and C.R. Soldatos, *Slow and fast EEG sleep spindle component extraction using Independent Component Analysis*. 8th IEEE International Conference on BioInformatics and BioEngineering, BIBE 2008, 2008.

Summary: Sleep spindles are groups of rhythmic activity, with a waxing-waning morphology, and are considered a hallmark of stage 2 of the sleep electroencephalogram (EEG). They are present predominantly in stages 2, 3 and 4 of the sleep EEG. Spatial analysis of sleep spindle scalp EEG and EEG inverse problem solutions have provided evidence for the existence of two distinct sleep spindle types, "slow" and "fast" spindles at approximately 12 and 14 Hz, respectively. The present study aimed at processing sleep spindles with Independent Component Analysis (ICA) in order to investigate the possibility of extracting spindle "components" corresponding to separate EEG activity patterns. The EEG activity underlying the components was also investigated, using the Low-Resolution Brain Electromagnetic Tomography (LORETA) technique, inverting the 21-channel EEG recordings to cortical current sources. Results indicate separability and stability of current sources related to sleep spindle "components" reconstructed from separate groups of Independent Components (ICs).

91. Vega-Hernández, M., E. Martínez-Montes, J.M. Sánchez-Bornot, A. Lage-Castellanos, and P.A. Valdés-Sosa, *Penalized Least Squares methods for solving the EEG Inverse Problem*. Statistica Sinica, 2008. **18**(4): p. 1535-1551.

Summary: Most of the known solutions (linear and nonlinear) of the ill-posed EEG Inverse Problem can be interpreted as the estimated coefficients in a penalized regression framework. In this work we present a general formulation of this problem as a Multiple Penalized Least Squares model, which encompasses many of the previously known methods as particular cases (e.g., Minimum Norm, LORETA). New types of inverse solutions arise since recent advances in the field of penalized regression have made it possible to deal with non-convex penalty functions, which provide sparse solutions (Fan and Li (2001)). Moreover, a generalization of this approach allows the use of any combination of penalties based on 11 or 12-norms, leading to solutions with combined properties such as smoothness and sparsity. Synthetic data is used to explore the benefits of non-convex penalty functions (e.g., LASSO, SCAD and LASSO Fusion) and mixtures (e.g., Elastic Net and LASSO Fused) by comparing them with known solutions in terms of localization error, blurring and visibility. Real data is used to show that a mixture model (Elastic Net) allows for tuning the spatial resolution of the solution to range from very concentrated to very blurred sources.

92. van Leeuwen, T., P. Been, M. van Herten, F. Zwarts, B. Maassen, and A. van der Leij, *Two-month-old infants at risk for dyslexia do not discriminate /bAk/ from /dAk/: A brain-mapping study*. Journal of Neurolinguistics, 2008. **21**(4): p. 333-348.

Summary: Dyslexics have problems with categorization of speech sounds, in particular when rapid temporal processing is involved such as in formant transitions of stop-consonants. Infants are already sensitive to such auditory features, but here we show that precursors of impaired categorization are already present in the brain responses of two-month-old infants at familial risk for dyslexia. Natural speech stimuli (/bAk/ and /dAk/), at either side of the phoneme boundary, induced multiple mismatch responses in control infants under pre-attentive and pre-cognitive conditions. Infants at-risk showed an attenuated early mismatch response and an absent late one, in addition to diminished cortical activity in the left hemisphere. These results are consistent with a temporal processing deficit in the infants at risk and may point to an early precursor of the disorder. © 2007.

93. Trujillo-Barreto, N.J., E. Aubert-Vázquez, and W.D. Penny, *Bayesian M/EEG source reconstruction with spatio-temporal priors*. NeuroImage, 2008. **39**(1): p. 318-335.

Summary: This article proposes a Bayesian spatio-temporal model for source reconstruction of M/EEG data. The usual two-level probabilistic model implicit in most distributed source solutions is extended by adding a third level which describes the temporal evolution of neuronal current sources using time-domain General Linear Models (GLMs). These comprise a set of temporal basis functions which are used to describe event-related M/EEG responses. This places M/EEG analysis in a statistical framework that is very similar to that used for PET and fMRI. The experimental design can be coded in a design matrix, effects of interest characterized using contrasts and inferences made using posterior probability maps. Importantly, as is the case for single-subject fMRI analysis, trials are treated as fixed effects and the approach takes into account between-trial variance, allowing valid inferences to be made on single-subject data. The proposed probabilistic model is efficiently inverted by using the Variational Bayes framework under a convenient mean-field approximation (VB-GLM). The new method is tested with biophysically realistic simulated data and the results are compared to those obtained with traditional spatial approaches like the popular Low Resolution Electromagnetic TomogrAphy (LORETA) and minimum variance Beamformer. Finally, the VB-GLM approach is used to analyze an EEG data set from a face processing experiment. © 2007 Elsevier Inc. All rights reserved.

94. Tislerova, B., M. Brunovsky, J. Horacek, T. Novak, M. Kopecek, P. Mohr, and V. Krajca, *LORETA functional imaging in antipsychotic-naive and olanzapine-, clozapine- and risperidone-treated patients with schizophrenia*. Neuropsychobiology, 2008. **58**(1): p. 1-10.

Summary: The aim of our study was to detect changes in the distribution of electrical brain activity in schizophrenic patients who were antipsychotic naive and those who received treatment with clozapine, olanzapine or risperidone. We included 41 subjects with schizophrenia (antipsychotic naive = 11; clozapine = 8; olanzapine = 10; risperidone = 12) and 20 healthy controls. Low-resolution brain electromagnetic tomography was computed from 19-channel electroencephalography for the frequency bands delta, theta, alpha-1, alpha-2, beta-1, beta-2 and beta-3. We compared antipsychotic-naive subjects with healthy controls and medicated patients. (1) Comparing antipsychotic-naive subjects and controls we found a general increase in the slow delta and theta frequencies over the fronto-temporo-occipital cortex, particularly in the temporolimbic structures, an increase in alpha-1 and alpha-2 in the temporal cortex and an increase in beta-1 and beta-2 in the temporo-occipital and posterior limbic structures. (2) Comparing patients who received clozapine and those who were antipsychotic naive, we found an increase in delta and theta frequencies in the anterior cingulate and medial frontal cortex, and a decrease in alpha-1 and beta-2 in the occipital structures. (3) Comparing patients taking olanzapine with those who were antipsychotic naive, there was an increase in theta frequencies in the anterior cingulum, a decrease in alpha-1, beta-2 and beta-3 in the occipital cortex and posterior limbic structures, and a decrease in beta-3 in the frontotemporal cortex and anterior cingulum. (4) In patients taking risperidone, we found no significant changes from those who were antipsychotic naive. Our results in antipsychotic-naive patients are in agreement with existing functional findings. Changes in those taking clozapine and olanzapine versus those who were antipsychotic naive suggest a compensatory mechanism in the neurobiological substrate for schizophrenia. The lack of difference in risperidone patients versus antipsychotic-naive subjects may relate to risperidone's different pharmacodynamic mechanism. Copyright © 2008 S. Karger AG.

95. Tian, Y. and D. Yao, *A study on the neural mechanism of inhibition of return by the event-related potential in the Go/Nogo task*. Biological Psychology, 2008. **79**(2): p. 171-178.

Summary: Inhibition of return (IOR) is a slowed response to a stimulus at recently cued locations when stimulus-onset asynchronies (SOAs) are longer than 250 ms. Using an uninformative peripheral cued Go/Nogo (commit/withdrawal response) task experiment, this study aimed to characterize the neural mechanism of IOR by studying not only the early event-related potentials (ERPs), P1 and N1, but also the late ERPs, Go/Nogo-N2 and P3. Scalp topographies and LORETA showed that the changes in P1 and N1, the cueing effects, were distributed mainly over the dorsal occipito-parietal areas, such as the bilateral middle occipital gyrus and the occipital portion of the cuneus. The changes in the late Nogo-N2 and P3 were distributed mainly over frontal-central areas, such as the right medial frontal gyrus. The Nogo-N2 was smaller and earlier in valid trials than in invalid trials, suggesting that the late component related to IOR was modulated by response preparation inhibition. The Nogo-P3 was larger and later in valid trials than in invalid trials, perhaps indicating that the control system (FEF) was free from an inhibitory marker in the cued locations. These data support a mechanism of IOR consisting of both sensory inhibition and response preparation inhibition. © 2008 Elsevier B.V. All rights reserved.

96. Thompson, T., T. Steffert, T. Ros, J. Leach, and J. Gruzelier, *EEG applications for sport and performance*. Methods, 2008. **45**(4): p. 279-288.

Summary: One approach to understanding processes that underlie skilled performing has been to study electrical brain activity using electroencephalography (EEG). A notorious problem with EEG is that genuine cerebral data is often contaminated by artifacts of non-cerebral origin. Unfortunately, such artifacts tend to be exacerbated when the subject is in motion, meaning that obtaining reliable data during exercise is inherently problematic. These problems may explain the limited number of studies using EEG as a methodological tool in the sports sciences. This paper discusses how empirical studies have generally tackled the problem of movement artifact by adopting alternative paradigms which avoid recording during actual physical exertion. Moreover, the specific challenges that motion presents to obtaining reliable EEG data are discussed along with practical and computational techniques to confront these challenges. Finally, as EEG recording in sports is often underpinned by a desire to optimise performance, a brief review of EEG-biofeedback and peak performance studies is also presented. A knowledge of practical aspects of EEG recording along with the advent of new technology and increasingly sophisticated processing models offer a promising approach to minimising, if perhaps not entirely circumventing, the problem of obtaining reliable EEG data during motion. © 2008 Elsevier Inc. All rights reserved.

97. Taylor, P.C.J., V. Walsh, and M. Eimer, *Combining TMS and EEG to study cognitive function and cortico-cortico interactions*. Behavioural Brain Research, 2008. **191**(2): p. 141-147.

Summary: There has long been an interest in exploring the functional dynamics of the brain's connectivity during cognitive processing, and some recent methodological developments now allow us to test important long-standing hypotheses. This review focuses on the recent development of combined online transcranial magnetic stimulation and electroencephalography (TMS-EEG) and on new studies that have employed this combination to study causal interactions between neural areas involved in perception and cognition. © 2008 Elsevier B.V. All rights reserved.

98. Spyrou, L. and S. Sanei, *Source localization of event-related potentials incorporating spatial notch filters*. IEEE Transactions on Biomedical Engineering, 2008. **55**(9): p. 2232-2239.

Summary: A novel algorithm for the localization of event-related potential (ERP) sources within the brain is proposed here. In this technique, spatial notch filters are developed to exploit the multichannel electroencephalogram data together with a model of ERP with variable parameters in order to accurately localize the corresponding ERP signal sources. The algorithm is robust in the presence of reasonably high noise. The performance of the proposed system has been compared to that of linear constrained minimum variance (LCMV) beamformer for different noise and correlation levels and its superiority has been demonstrated. © 2006 IEEE.

99. Šóš, P., M. Brunovský, J. Horáček, M. Bareš, and M. Kopeček, *Utilization of cordance analysis and electromagnetic tomography in monitoring changes of electric brain activity during depressive disorder treatment*. Využití kordanční analýzy a elektromagnetické tomografie ke sledování změn elektrické mozkové aktivity během léčby depresivní poruchy, 2008. **12**(3): p. 167-171.

Summary: The case report of a depressed patient demonstrates the use of QEEG information in the prediction of a treatment response to an antidepressant and possibly of the maintenance of this response. Resting EEG record of depressive patient, having responded to the new antidepressive treatment (venlafaxine), was analyzed after 1, 4 and 14 weeks using the methods of quantitative electroencephalography (QEEG): cordance analysis and electromagnetic tomography (sLORETA - standardized Low-Resolution Electromagnetic Tomography). Decrease in prefrontal EEG theta cordance was found after the first week of treatment (by the time, when no clinical evidence of improvement was apparent) and the response sustainment correlated with increasing and spreading trend of theta activity (4-8 Hz) current density in dorsal cingulum.

100. Serruya, M.D. and M.J. Kahana, *Techniques and devices to restore cognition*. Behavioural Brain Research, 2008. **192**(2): p. 149-165.

Summary: Executive planning, the ability to direct and sustain attention, language and several types of memory may be compromised by conditions such as stroke, traumatic brain injury, cancer, autism, cerebral palsy and Alzheimer's disease. No medical devices are currently available to help restore these cognitive functions. Recent findings about the neurophysiology of these conditions in

humans coupled with progress in engineering devices to treat refractory neurological conditions imply that the time has arrived to consider the design and evaluation of a new class of devices. Like their neuromotor counterparts, neurocognitive prostheses might sense or modulate neural function in a non-invasive manner or by means of implanted electrodes. In order to paint a vision for future device development, it is essential to first review what can be achieved using behavioral and external modulatory techniques. While non-invasive approaches might strengthen a patient's remaining intact cognitive abilities, neurocognitive prosthetics comprised of direct brain-computer interfaces could in theory physically reconstitute and augment the substrate of cognition itself. © 2008 Elsevier B.V. All rights reserved.

101. Seitz, R.J., R. Schäfer, D. Scherfeld, S. Friederichs, K. Popp, H.J. Wittsack, N.P. Azari, and M. Franz, *Valuating other people's emotional face expression: a combined functional magnetic resonance imaging and electroencephalography study*. Neuroscience, 2008. **152**(3): p. 713-722.

Summary: Reading the facial expression of other people is a fundamental skill for social interaction. Human facial expressions of emotions are readily recognized but may also evoke the same experiential emotional state in the observer. We used event-related functional magnetic resonance imaging and multi-channel electroencephalography to determine in 14 right-handed healthy volunteers (29±6 years) which brain structures mediate the perception of such a shared experiential emotional state. Statistical parametric mapping showed that an area in the dorsal medial frontal cortex was specifically activated during the perception of emotions that reflected the seen happy and sad emotional face expressions. This area mapped to the pre-supplementary motor area which plays a central role in control of behavior. Low resolution brain electromagnetic tomography-based analysis of the encephalographic data revealed that the activation was detected 100 ms after face presentation onset lasting until 740 ms. Our observation substantiates recently emerging evidence suggesting that the subjective perception of an experiential emotional state-empathy-is mediated by the involvement of the dorsal medial frontal cortex. © 2008 IBRO.

102. Schulz, E., U. Maurer, S. van der Mark, K. Bucher, S. Brem, E. Martin, and D. Brandeis, *Impaired semantic processing during sentence reading in children with dyslexia: Combined fMRI and ERP evidence*. NeuroImage, 2008. **41**(1): p. 153-168.

Summary: Developmental dyslexia is a specific disorder of reading acquisition characterized by a phonological core deficit. Sentence reading is also impaired in dyslexic readers, but whether semantic processing deficits contribute is unclear. Combining spatially and temporally sensitive neuroimaging techniques to focus on semantic processing can provide a more comprehensive characterization of sentence reading in dyslexia. We recorded brain activity from 52 children (16 with dyslexia, 31 controls) with functional magnetic resonance imaging (fMRI) and event-related potentials (ERP) in two separate counterbalanced sessions. The children silently read and occasionally judged simple sentences with semantically congruous or incongruous endings. fMRI and ERP activation during sentence reading and semantic processing was analyzed across all children and also by comparing children with dyslexia to controls. For sentence reading, we analyzed the response to all words in a sentence; for semantic processing, we contrasted responses to incongruous and congruous endings. Sentence reading was characterized by activation in a left-lateralized language network. Semantic processing was characterized by activation in left-hemispheric regions of the inferior frontal and superior temporal cortex and by an electrophysiological N400 effect after 240 ms with consistent left anterior source localization. Children with dyslexia showed decreased activation for sentence reading in inferior parietal and frontal regions, and for semantic processing in inferior parietal regions, and during the N400 effect. Together, this suggests that semantic impairment during sentence reading reduces dyslexic children's response in left anterior brain regions underlying the more phasic N400 effect and subsequently modulates the more sustained BOLD response in left inferior parietal regions. © 2008 Elsevier Inc. All rights reserved.

103. Santesso, D.L., A.E. Meuret, S.G. Hofmann, E.M. Mueller, K.G. Ratner, E.B. Roesch, and D.A. Pizzagalli, *Electrophysiological correlates of spatial orienting towards angry faces: A source localization study*. Neuropsychologia, 2008. **46**(5): p. 1338-1348.

Summary: The goal of this study was to examine behavioral and electrophysiological correlates of involuntary orienting toward rapidly presented angry faces in non-anxious, healthy adults using a dot-probe task in conjunction with high-density event-related potentials and a distributed source localization technique. Consistent with previous studies, participants showed hypervigilance toward angry faces, as indexed by facilitated response time for validly cued probes following angry faces and an enhanced P1 component. An opposite pattern was found for happy faces suggesting that attention was directed toward the relatively more threatening stimuli within the visual field (neutral faces). Source localization of the P1 effect for angry faces indicated increased activity within the anterior cingulate cortex, possibly reflecting conflict experienced during invalidly cued trials. No modulation of the early C1 component was found for affect or spatial attention. Furthermore, the face-sensitive N170 was not modulated by emotional expression. Results suggest that the earliest modulation of spatial attention by face stimuli is manifested in the P1 component, and provide insights about mechanisms underlying attentional orienting toward cues of threat and social disapproval. © 2007 Elsevier Ltd. All rights reserved.

104. Saletu, M., P. Anderer, G.M. Saletu-Zyhlarz, M. Mandl, J. Zeitlhofer, and B. Saletu, *Event-related-potential low-resolution brain electromagnetic tomography (ERP-LORETA) suggests decreased energetic resources for cognitive processing in narcolepsy*. Clinical Neurophysiology, 2008. **119**(8): p. 1782-1794.

Summary: Objective: Event-related potentials (ERPs) are sensitive measures of both perceptual and cognitive processes. The aim of the present study was to identify brain regions involved in the processes of cognitive dysfunction in narcolepsy by means of ERP tomography. Methods: In 17 drug-free patients with narcolepsy and 17 controls, ERPs were recorded (auditory odd-ball paradigm). Latencies, amplitudes and LORETA sources were determined for standard (N1 and P2) and target (N2 and P300) ERP components. Psychometry included measures of mental performance, affect and critical flicker fusion frequency (CFF). Results: In the ERPs patients demonstrated delayed cognitive N2 and P300 components and reduced amplitudes in midline regions, while N1 and P2 components did not differ from controls. LORETA suggested reduced P300 sources bilaterally in the precuneus, the anterior and posterior cingulate gyri, the ventrolateral prefrontal cortex and the parahippocampal gyrus. In psychometry, patients demonstrated deteriorated mood, increased trait anxiety, decreased CFF and a trend toward reduced general verbal memory and psychomotor activity. Conclusions: Narcoleptic patients showed prolonged information processing, as indexed by N2 and P300 latencies and decreased energetic resources for cognitive processing. Significance: Electrophysiological aberrations in brain areas related to the 'executive attention network' and the 'limbic system' may contribute to a deterioration in mental performance and mood at the behavioral level. © 2008 International Federation of Clinical Neurophysiology.

105. Roach, B.J. and D.H. Mathalon, *Event-related EEG time-frequency analysis: An overview of measures and an analysis of early gamma band phase locking in schizophrenia*. Schizophrenia Bulletin, 2008. **34**(5): p. 907-926.

Summary: An increasing number of schizophrenia studies have been examining electroencephalography (EEG) data using time-frequency analysis, documenting illness-related abnormalities in neuronal oscillations and their synchronization, particularly in the gamma band. In this article, we review common methods of spectral decomposition of EEG, time-frequency analyses, types of measures that separately quantify magnitude and phase information from the EEG, and the influence of parameter choices on the analysis results. We then compare the degree of phase locking (ie, phase-locking factor) of the gamma band (36-50 Hz) response evoked about 50 milliseconds following the presentation of standard tones in 22 healthy controls and 21 medicated patients with schizophrenia. These tones were presented as part of an auditory oddball task performed by subjects while EEG was recorded from their scalps. The results showed prominent gamma band phase locking at frontal electrodes between 20 and 60 milliseconds following tone onset in healthy controls that was significantly reduced in patients with schizophrenia (P =. 03). The finding suggests that the early-evoked gamma band response to auditory stimuli is deficiently synchronized in schizophrenia. We discuss the results in terms of pathophysiological mechanisms compromising event-related gamma phase synchrony in schizophrenia and further attempt to reconcile this finding with prior studies that failed to find this effect. © The Author 2008. Published by Oxford University Press on behalf of the Maryland Psychiatric Research Center. All rights reserved.

106. Razpurker-Apfeld, I. and H. Pratt, *Perceptual visual grouping under inattention: Electrophysiological functional imaging*. Brain and Cognition, 2008. **67**(2): p. 183-196.

Summary: Two types of perceptual visual grouping, differing in complexity of shape formation, were examined under inattention. Fourteen participants performed a similarity judgment task concerning two successive briefly presented central targets surrounded by task-irrelevant simple and complex grouping patterns. Event-related potentials (ERPs) were recorded from 22 scalp electrodes and source current density estimations were conducted for the net response to the task-irrelevant background patterns, using low-resolution electromagnetic tomography (LORETA). Although participants' subjective reports indicated that neither type of organization induced awareness, electrophysiological results showed they both evoked significant activation in occipital, parieto-temporal and frontal brain areas. Behavioral results demonstrated that only grouping of the simple pattern arose under inattention. In contrast to the complex pattern, the processing of the simple pattern was associated with an initially longer latency and higher activation beginning at 130 ms. These results support the distinction of grouping patterns differing in complexity of shape formation. © 2008 Elsevier Inc. All rights reserved.

107. Putnam, K.M., D.A. Pizzagalli, D.C. Gooding, N.H. Kalin, and R.J. Davidson, *Neural activity and diurnal variation of cortisol: Evidence from brain electrical tomography analysis and relevance to anhedonia*. Psychophysiology, 2008. **45**(6): p. 886-895.

Summary: The medial prefrontal cortex (mPFC), hippocampus, and amygdala are implicated in the regulation of affect and physiological processes, including hypothalamic-pituitary-adrenal (HPA) axis function. Anhedonia is likely associated with dysregulation of these processes. Dense-array resting electroencephalographic and cortisol were obtained from healthy and anhedonic groups. Low-resolution electromagnetic tomography was used to compute intracerebral current density. For the control group, voxelwise analyses found a relationship between current density in beta and gamma bands and steeper cortisol slope (indicative of more adaptive HPA axis functioning) in regions of the hippocampus, parahippocampal gyrus, and mPFC. For the anhedonic group, the mPFC finding was absent. Anhedonia may be characterized by disruptions of mPFC-mediated neuroendocrine regulation, which could constitute a vulnerability to the development of stress-related disorders. Copyright © 2008 Society for Psychophysiological Research.

108. Proverbio, A.M., A. Zani, and R. Adorni, *Neural markers of a greater female responsiveness to social stimuli*. BMC Neuroscience, 2008. **9**.

Summary: Background: There is fMRI evidence that women are neurally predisposed to process infant laughter and crying. Other findings show that women might be more empathic and sensitive than men to emotional facial expressions. However, no gender difference in the brain responses to persons and unanimated scenes has hitherto been demonstrated. Results: Twenty-four men and women viewed 220 images portraying persons or landscapes and ERPs were recorded from 128 sites. In women, but not in men, the N2 component (210-270) was much larger to persons than to scenes. swLORETA showed significant bilateral activation of FG (BA19/37) in both genders when viewing persons as opposed to scenes. Only women showed a source of activity in the STG and in the right MOG (extra-striate body area, EBA), and only men in the left parahippocampal area (PPA). Conclusion: A significant gender difference was found in activation of the left and right STG (BA22) and the cingulate cortex for the subtractive condition women minus men, thus indicating that women might have a greater preference or interest for social stimuli (faces and persons). © 2008 Proverbio et al; licensee BioMed Central Ltd.

109. Proverbio, A.M., A. Zani, and R. Adorni, *The left fusiform area is affected by written frequency of words*. Neuropsychologia, 2008. **46**(9): p. 2292-2299.

Summary: The recent neuroimaging literature gives conflicting evidence about whether the left fusiform gyrus (FG) might recognize words as unitary visual objects. The sensitivity of the left FG to word frequency might provide a neural basis for the orthographic input lexicon theorized by reading models [Patterson, K., Marshall, J. C., & Coltheart, M. (1985). Surface dyslexia: Cognitive and neuropsychological studies of phonological reading. London: Lawrence Erlbaum]. The goal of this study was to investigate the time course and neural correlates of word processing in right-handed readers engaged in an orthographic decision task. Three hundred and twenty Italian words of high and low written frequency and 320 non-derived legal pseudo-words were presented for 250 ms in the central visual field. ERPs were recorded from 128 scalp sites in 10 Italian University students. Behavioural data showed a word superiority effect, with faster RTs to words than pseudo-words. Left occipito/temporal N2 (240 ms) was greater to high-frequency than low-frequency words and pseudo-words. According to the swLORETA inverse solution, the underlying neural source of this effect was located in the left fusiform gyrus of the occipital lobe (X = -29, Y = -66, Z = -10, BA19) and the right superior temporal gyrus (X = 51, Y = 6, Z = -5, BA22), which are probably involved in word recognition and semantic representation, respectively. Later frontal ERP components, LPN (300-350) and P3 (400-500), also showed strong lexical sensitivity, thus suggesting implicit semantic processes. The results shed some light on the possible neural substrate of visual reading disabilities such as developmental surface dyslexia or pure alexia. © 2008 Elsevier Ltd. All rights reserved.

110. Proverbio, A.M. and R. Adorni, *Orthographic familiarity, phonological legality and number of orthographic neighbours affect the onset of ERP lexical effects*. Behavioral and Brain Functions, 2008. **4**.

Summary: Background: It has been suggested that the variability among studies in the onset of lexical effects may be due to a series of methodological differences.

In this study we investigated the role of orthographic familiarity, phonological legality and number of orthographic neighbours of words in determining the onset of word/non-word discriminative responses. Methods: ERPs were recorded from 128 sites in 16 Italian University students engaged in a lexical decision task. Stimuli were 100 words, 100 quasi-words (obtained by the replacement of a single letter), 100 pseudo-words (non-derived) and 100 illegal letter strings. All stimuli were balanced for length; words and quasi-words were also balanced for frequency of use, domain of semantic category and imageability. SwLORETA source reconstruction was performed on ERP difference waves of interest. Results: Overall, the data provided evidence that the latency of lexical effects (word/non-word discrimination) varied as a function of the number of a word's orthographic neighbours, being shorter to non-derived than to derived pseudo-words. This suggests some caveats about the use in lexical decision paradigms of quasi-words obtained by transposing or replacing only 1 or 2 letters. Our findings also showed that the left-occipito/temporal area, reflecting the activity of the left fusiform gyrus (BA37) of the temporal lobe, was affected by the visual familiarity of words, thus explaining its lexical sensitivity (word vs. non-word discrimination). The temporo-parietal area was markedly sensitive to phonological legality exhibiting a clear-cut discriminative response between illegal and legal strings as early as 250 ms of latency. Conclusion: The onset of lexical effects in a lexical decision paradigm depends on a series of factors, including orthographic familiarity, degree of global lexical activity, and phonologic legality of non-words. © 2008 Proverbio and Adorni; licensee BioMed Central Ltd.

111. Pratt, H., A. Starr, H.J. Michalewski, N. Bleich, and N. Mittelman, *The auditory P50 component to onset and offset of sound*. Clinical Neurophysiology, 2008. **119**(2): p. 376-387.

Summary: Objective: The auditory Event-Related Potentials (ERP) of component P50 to sound onset and offset have been reported to be similar, but their magnetic homologue has been reported absent to sound offset. We compared the spatio-temporal distribution of cortical activity during P50 to sound onset and offset, without confounds of spectral change. Methods: ERPs were recorded in response to onsets and offsets of silent intervals of 0.5 s (gaps) appearing randomly in otherwise continuous white noise and compared to ERPs to randomly distributed click pairs with half second separation presented in silence. Subjects were awake and distracted from the stimuli by reading a complicated text. Measures of P50 included peak latency and amplitude, as well as source current density estimates to the clicks and sound onsets and offsets. Results: P50 occurred in response to noise onsets and to clicks, while to noise offset it was absent. Latency of P50 was similar to noise onset (56 ms) and to clicks (53 ms). Sources of P50 to noise onsets and clicks included bilateral superior parietal areas. In contrast, noise offsets activated left inferior temporal and occipital areas at the time of P50. Source current density was significantly higher to noise onset than offset in the vicinity of the temporo-parietal junction. Conclusions: P50 to sound offset is absent compared to the distinct P50 to sound onset and to clicks,

at different intracranial sources. P50 to stimulus onset and to clicks appears to reflect preattentive arousal by a new sound in the scene. Sound offset does not involve a new sound and hence the absent P50. Significance: Stimulus onset activates distinct early cortical processes that are absent to offset. © 2007 International Federation of Clinical Neurophysiology.

112. Pourtois, G., S. Delplanque, C. Michel, and P. Vuilleumier, *Beyond conventional event-related brain potential (ERP): Exploring the time-course of visual emotion processing using topographic and principal component analyses*. Brain Topography, 2008. **20**(4): p. 265-277.

Summary: Recent technological advances with the scalp EEG methodology allow researchers to record electric fields generated in the human brain using a large number of electrodes or sensors (e.g. 64-256) distributed over the head surface (multi-channel recording). As a consequence, such high-density ERP mapping yields fairly dense ERP data sets that are often hard to analyze comprehensively or to relate straightforwardly to specific cognitive or emotional processes, because of the richness of the recorded signal in both the temporal (millisecond time-resolution) and spatial (multidimensional topographic information) domains. Principal component analyses (PCA) and topographic analyses (combined with distributed source localization algorithms) have been developed and successfully used to deal with this complexity, now offering powerful alternative strategies for data-driven analyses in complement to more traditional ERP analyses based on waveforms and peak measures. In this paper, we first briefly review the basic principles of these approaches, and then describe recent ERP studies that illustrate how they can inform about the precise spatio-temporal dynamic of emotion processing. These studies show that the perception of emotional visual stimuli may produce both quantitative and qualitative changes in the electric field configuration recorded at the scalp level, which are not apparent when using conventional ERP analyses. Additional information gained from these approaches include the identification of a sequence of successive processing stages that may not fully be reflected in ERP waveforms only, and the segregation of multiple or partly overlapping neural events that may be blended within a single ERP waveform. These findings highlight the added value of such alternative analyses when exploring the electrophysiological manifestations of complex and distributed mental functions, as for instance during emotion processing. © 2008 Springer Science+Business Media, LLC.

113. Polezzi, D., L. Lotto, I. Daum, G. Sartori, and R. Rumiati, *Predicting outcomes of decisions in the brain*. Behavioural Brain Research, 2008. **187**(1): p. 116-122.

Summary: When making decisions, the outcomes of different choices play an important role. Feedback is mainly processed in terms of gains and losses. It is as yet unclear whether this distinction holds for predictable as well as unpredictable outcomes. Using ERPs, the present study aimed to determine whether predictable and unpredictable outcomes are coded differently in the brain.

Participants had to choose between one of two options: the certain option was always associated with a gain of 10€, while the uncertain option entailed a gain of 30€ or a loss of 10€, with a probability of 50% each. Overall, subjects showed a clear preference for the certain option, a tendency which became more pronounced during the course of the experiment. An early ERP component, the P200, reflected the predictability of outcomes, which was critical for the subsequent decisions. The later feedback related negativity (FRN) reflected the known distinction between gains and losses, while the N500 again reflected differential processing of predictable and unpredictable outcomes. Neither FRN nor the N500 were significantly related to behaviour. Predictability appears to play a central role in outcome evaluation. © 2007 Elsevier B.V. All rights reserved.

114. Polezzi, D., I. Daum, E. Rubaltelli, L. Lotto, C. Civai, G. Sartori, and R. Rumiati, *Mentalizing in economic decision-making*. Behavioural Brain Research, 2008. **190**(2): p. 218-223.

Summary: In the Ultimatum Game, participants typically reject monetary offers they consider unfair even if the alternative is to gain no money at all. In the present study, ERPs were recorded while subjects processed different offers of a proposer. In addition to clearly fair and unfair offers, mid-value offers which cannot be easily classified as fair or unfair and therefore involve more elaborate decision making were analyzed. A fast initial distinction between fair and other kinds of offers was reflected by amplitude of the feedback related negativity (FRN). Mid-value offers were associated with longer RTs, and a larger N350 amplitude. In addition, source analyses revealed a specific involvement of the superior temporal gyrus and the inferior parietal lobule during processing of mid-value offers compared to offers categorized clearly as fair or unfair, suggesting a contribution of mentalizing about the intention of the proposer to the decision making process. Taken together, the present findings support the idea that economic decisions are significantly affected by non-rational factors, trying to narrow the gap between formal theory and the real decisional behaviour. © 2008 Elsevier B.V. All rights reserved.

115. Plummer, C., A.S. Harvey, and M. Cook, *EEG source localization in focal epilepsy: Where are we now?* Epilepsia, 2008. **49**(2): p. 201-218.

Summary: Electroencephalographic source localization (ESL) by noninvasive means is an area of renewed interest in clinical epileptology. This has been driven by innovations in the computer-assisted modeling of dipolar and distributed sources for the investigation of focal epilepsy; a process fueled by the ever-increasing computational power available to researchers for the analysis of scalp EEG recordings. However, demonstration of the validity and clinical utility of these mathematically derived source modeling techniques has struggled to keep pace. This review evaluates the current clinical "fitness" of ESL as applied to the focal epilepsies by examining some of the key studies performed in the field, with emphasis given to clinical work published in the last five years. In doing so, we discuss why ESL techniques have not made an impact on routine epilepsy practice, underlining some of the current problems and controversies in the field. We conclude by examining where ESL currently sits alongside magnetoencephalography and combined EEG-functional magnetic resonance imaging in the investigation of focal epilepsy. © 2008 International League Against Epilepsy.

116. Osterhout, L., A. Poliakov, K. Inoue, J. McLaughlin, G. Valentine, I. Pitkanen, C. Frenck-Mestre, and J. Hirschensohn, *Second-language learning and changes in the brain*. Journal of Neurolinguistics, 2008. **21**(6): p. 509-521.

Summary: Presumably, second-language (L2) learning is mediated by changes in the brain. Little is known about what changes in the brain, how the brain changes, or when these changes occur during learning. Here, we illustrate by way of example how modern brain-based methods can be used to discern some of the changes that occur during L2 learning. Preliminary results from three studies indicate that classroom-based L2 instruction can result in changes in the brain's electrical activity, in the location of this activity within the brain, and in the structure of the learners' brains. These changes can occur during the earliest stages of L2 acquisition. © 2008 Elsevier Ltd. All rights reserved.

117. Olivares-Carreño, E.I. and J. Iglesias-Dorado, *Long-latency evoked potentials and mnemonic processing of faces and words*. Potenciales evocados de larga latencia y procesamiento mnésico de caras y palabras, 2008. **47**(12): p. 624-630.

Summary: Introduction. Evoked potentials are real-time electrophysiological markers of cognitive operations and especially mnemonic processes. The N400 wave has traditionally been studied to characterise the processes involved in memorising verbal material. To investigate the existence of specific memory processes for each information domain, functional analogues of this wave were examined during the processing of non-verbal stimuli, such as faces. Aim. Using an inter-subject design, the classic verbal N400 wave was compared with its functional analogue during the processing of faces in a contextual preactivation task adapted to the visual domain of faces. Subjects and methods. After several sessions dedicated to learning a set of faces, another evoked potential recording session was held in order to analyse the effects of the existence of structural inconsistencies in these stimuli and to compare them, with regard to their topographic distribution and neural generators, with those observed in the classic verbal N400 task. Results. A verbal N400 wave was observed with a (slightly right) centroparietal distribution, and this response was distinguished from another negative wave obtained during the processing of facial inconsistencies in the same group of participants, with a predominantly occipital localisation and differentiated neural generators. Conclusions. These findings support the hypothesis of the specificity of the neural mechanisms involved in the mnemonic processing of faces and words, which is in line with the neurocognitive models that suggest the independence or modularity of memory processes in different domains of information. © 2008, Revista de Neurología.

118. Noirhomme, Q., R.I. Kitney, and B. Macq, *Single-trial EEG source reconstruction for brain-computer interface*. IEEE Transactions on Biomedical Engineering, 2008. **55**(5): p. 1592-1601.

Summary: A new way to improve the classification rate of an EEG-based brain-computer interface (BCI) could be to reconstruct the brain sources of EEG and to apply BCI methods to these derived sources instead of raw measured electrode potentials. EEG source reconstruction methods are based on electrophysiological information that could improve the discrimination between BCI tasks. In this paper, we present an EEG source reconstruction method for BCI. The results are compared with results from raw electrode potentials to enable direct evaluation of the method. Features are based on frequency power change and Bereitschaft potential. The features are ranked with mutual information before being fed to a proximal support vector machine. The dataset IV of the BCI competition II and data from four subjects serve as test data. Results show that the EEG inverse solution improves the classification rate and can lead to results comparable to the best currently known methods. © 2006 IEEE.

119. Nir, R.R., R. Lev, R. Moont, Y. Granovsky, E. Sprecher, and D. Yarnitsky, *Neurophysiology of the Cortical Pain Network: Revisiting the Role of S1 in Subjective Pain Perception Via Standardized Low-Resolution Brain Electromagnetic Tomography (sLORETA)*. Journal of Pain, 2008. **9**(11): p. 1058-1069.

Summary: Multiple studies have supported the usefulness of standardized low-resolution brain electromagnetic tomography (sLORETA) in localizing generators of scalp-recorded potentials. The current study implemented sLORETA on pain event-related potentials, primarily aiming at validating this technique for pain research by identifying well-known pain-related regions. Subsequently, we pointed at investigating the still-debated and ambiguous topic of pain intensity coding at these regions, focusing on their relative impact on subjective pain perception. sLORETA revealed significant activations of the bilateral primary somatosensory (SI) and anterior cingulate cortices and of the contralateral operculoinsular and dorsolateral prefrontal (DLPFC) cortices ($P < .05$ for each). Activity of these regions, excluding DLPFC, correlated with subjective numerical pain scores ($P < .05$ for each). However, a multivariate regression analysis ($R = .80$; $P = .024$) distinguished the contralateral SI as the only region whose activation magnitude significantly predicted the subjective perception of noxious stimuli ($P = .020$), further substantiated by a reduced regression model ($R = .75$, $P = .008$). Based on (1) correspondence of the pain-activated regions identified by sLORETA with the acknowledged imaging-based pain-network and (2) the contralateral SI proving to be the most contributing region in pain intensity coding, we found sLORETA to be an appropriate tool for relevant pain research and further substantiated the role of SI in pain perception. Perspective: Because

the literature of pain intensity coding offers inconsistent findings, the current article used a novel tool for revisiting this controversial issue. Results suggest that it is the activation magnitude of SI, which solely establishes the significant correlation with subjective pain ratings, in accordance with the classical clinical thinking, relating SI lesions to diminished perception of pain. Although this study cannot support a causal relation between SI activation magnitude and pain perception, such relation might be insinuated. © 2008 American Pain Society.

120. Mulert, C., O. Pogarell, and U. Hegerl, *Simultaneous EEG-fMRI: Perspectives in psychiatry*. Clinical EEG and Neuroscience, 2008. **39**(2): p. 61-64.

Summary: Neurophysiological findings such as reduced amplitudes of the P300 potential in patients with schizophrenia are among the most robust findings in biological psychiatry. An enormous literature with findings of abnormal central processing in psychiatric diseases has been acquired during the last decades. However, the benefit of this research has been limited in part due to the unresolved problem of precise and correct localization of the underlying neural generators. The difficulty of correct localization is due to the fact that different constellations of cortical neuroelectric generators can produce identical EEG activity. Therefore, even concerning several major event related potentials no generally accepted knowledge about their cerebral generation exists. While correct localization can easily be obtained by imaging methods based on hemodynamic changes such as functional magnetic resonance imaging (fMRI), these techniques can not distinguish between different aspects of neural activity such as oscillation modes or stages of information processing that are only some milliseconds apart. Accordingly, the integration of simultaneous measurements of EEG and fMRI has become a methodological key issue today. EEG-fMRI may prove to be crucial in providing much deeper understanding of brain activity over the next decades. This review summarizes the basic physiology, methodological issues and interesting applications in psychiatry.

121. Moazami-Goudarzi, M., J. Sarnthein, L. Michels, R. Moukhtieva, and D. Jeanmonod, *Enhanced frontal low and high frequency power and synchronization in the resting EEG of parkinsonian patients*. NeuroImage, 2008. **41**(3): p. 985-997.

Summary: Oscillatory and coherent EEG activity is increasingly recognized as a fundamental hallmark of cortical integrative functions. We aimed to study deviations from the norm of different resting EEG parameters in Parkinson's disease (PD) patients. We compared spectral parameters of the resting EEG of PD patients (n = 24, median age 67 years) to those of healthy controls (n = 34, median age 62 years). On average, the patient group exhibited higher spectral power over the frequency range of 2-100 Hz, and the dominant peak was shifted towards lower frequencies. Maximal differences appeared in the 6-9 Hz theta band in all electrodes. Frontal electrodes contributed most to this difference in the 4-6 Hz theta, 12-18 Hz beta and 30-45 Hz gamma bands. On an individual

basis, the combination of six spectral power band parameters discriminated between patient and control groups and 72% of all subjects were classified correctly. Using LORETA source analysis, the generators of this power difference were localized to fronto-insulo-temporal cortical areas in the theta and beta bands, and to interhemispheric frontal (supplementary motor area, SMA) and cingulate areas in the 30-45 Hz gamma band. We calculated spectral coherence between electrode pairs in a frontal, central and parietal region of interest (ROI). In the frontal ROI, coherence was enhanced significantly in the patient group in the theta, high beta and gamma bands. In the parietal ROI, patients showed lower coherence around 10 Hz. We demonstrate a deviation from the norm of different resting EEG parameters in PD patients. This evidence can be integrated in the context of a pathophysiological chain reaction initiated in the substantia nigra and resulting in a cortical aberrant dynamics rooted in enhanced dysrhythmic thalamocortical interactions. © 2008 Elsevier Inc. All rights reserved.

122. Marzetti, L., C. Del Gratta, and G. Nolte, *Understanding brain connectivity from EEG data by identifying systems composed of interacting sources*. NeuroImage, 2008. **42**(1): p. 87-98.

Summary: In understanding and modeling brain functioning by EEG/MEG, it is not only important to be able to identify active areas but also to understand interference among different areas. The EEG/MEG signals result from the superimposition of underlying brain source activities volume conducted through the head. The effects of volume conduction produce spurious interactions in the measured signals. It is fundamental to separate true source interactions from noise and to unmix the contribution of different systems composed by interacting sources in order to understand interference mechanisms. As a prerequisite, we consider the problem of unmixing the contribution of uncorrelated sources to a measured field. This problem is equivalent to the problem of unmixing the contribution of different uncorrelated compound systems composed by interacting sources. To this end, we develop a principal component analysis-based method, namely, the source principal component analysis (sPCA), which exploits the underlying assumption of orthogonality for sources, estimated from linear inverse methods, for the extraction of essential features in signal space. We then consider the problem of demixing the contribution of correlated sources that comprise each of the compound systems identified by using sPCA. While the sPCA orthogonality assumption is sufficient to separate uncorrelated systems, it cannot separate the individual components within each system. To address that problem, we introduce the Minimum Overlap Component Analysis (MOCA), employing a pure spatial criterion to unmix pairs of correlates (or coherent) sources. The proposed methods are tested in simulations and applied to EEG data from human μ and α rhythms. © 2008 Elsevier Inc. All rights reserved.

123. Ma, X. and J. Zou, *Combined source simulation method-Fictitious medium method for solving anisotropic EEG problems*. ISAPE 2008 - The 8th

International Symposium on Antennas, Propagation and EM Theory Proceedings, 2008: p. 925-928.

Summary: An electroencephalography (EEG) problem in bio-electromagnetics is to estimate dipolar current sources inside the brain from the measured electric potential distribution on the scalp surface. Traditional linear algorithms are the low-resolution electromagnetic tomography algorithms (LORETA) including improved ones. It is easy to solve isotropic EEG problems by means of them. But the skull conductivity is anisotropic obviously. In this paper, proposed is a source simulation method combined with the fictitious medium method for solving the anisotropic skull layer problem to obtain the electric potential and field intensity on the cortex. Then it can be connected with LORETA. A good agreement between the numerical result and analytical result of the 4-layer spherical head model has been observed. It is shown that this method is effective and feasible. Its prominent advantages are simple and timesaving. And this numerical computation method is suitable for not only spherical head models but also realistic head models with the thin anisotropic layer. © 2008 IEEE.

124. Lorenzo-López, L., E. Amenedo, R.D. Pascual-Marqui, and F. Cadaveira, *Neural correlates of age-related visual search decline: A combined ERP and sLORETA study*. NeuroImage, 2008. **41**(2): p. 511-524.

Summary: Differences in the neural systems underlying visual search processes for young (n = 17, mean age 19.6 ± 1.9) and older (n = 22, mean age 68.5 ± 6) subjects were investigated combining the Event-Related Potential (ERP) technique with standardized Low-Resolution brain Electromagnetic Tomography (sLORETA) analyses. Behavioral results showed an increase in mean reaction times (RTs) and a reduction in hit rates with age. The ERPs were significantly different between young and older subjects at the P3 component, showing longer latencies and lower amplitudes in older subjects. These ERP results suggest an age-related decline in the intensity and speed of visual processing during visual search that imply a reduction in attentional resources with normal aging. The sLORETA data revealed a significantly reduced neural differentiation in older subjects, who recruited bilateral prefrontal regions in a nonselective manner for the different search arrays. Finally, sLORETA between-group comparisons revealed that relative to young subjects, older subjects showed significantly reduced activity in anterior cingulate cortex as well as in numerous limbic and occipitotemporal regions contributing to visual search processes. These findings provide evidence that the neural circuit supporting this cognitive process is vulnerable to normal aging. All these attentional factors could contribute to poorer performance of older compared to young subjects in visual search tasks. © 2008 Elsevier Inc. All rights reserved.

125. Liu, Z. and B. He, *fMRI-EEG integrated cortical source imaging by use of time-variant spatial constraints*. NeuroImage, 2008. **39**(3): p. 1198-1214.

Summary: In response to the need of establishing a high-resolution spatiotemporal neuroimaging technique, tremendous efforts have been focused on developing multimodal strategies that combine the complementary advantages of high-spatial-resolution functional magnetic resonance imaging (fMRI) and high-temporal-resolution electroencephalography (EEG) or magnetoencephalography (MEG). A critical challenge to the fMRI-EEG/MEG integration lies in the spatial mismatches between fMRI activations and instantaneous electrical source activities. Such mismatches are fundamentally due to the fact that fMRI and EEG/MEG signals are generated and collected in highly different time scales. In this paper, we propose a new theoretical framework to solve the problem of fMRI-EEG integrated cortical source imaging. The new framework has two principal technical advancements. First, by assuming a linear neurovascular coupling, a method is derived to quantify the fMRI signal in each voxel as proportional to the time integral of the power of local electrical current during the period of event-related potentials (ERP). Second, the EEG inverse problem is solved for every time instant using an adaptive Wiener filter, in which the prior time-variant source covariance matrix is estimated by combining the quantified fMRI responses and the segmented EEG signals before response averaging. A series of computer simulations were conducted to evaluate the proposed methods in terms of imaging the instantaneous cortical current density (CCD) distribution and estimating the source time courses with a millisecond temporal resolution. As shown in the simulation results, the instantaneous CCD reconstruction by using the proposed fMRI-EEG integration method was robust against both fMRI false positives and false negatives while retaining a spatial resolution nearly as high as that of fMRI. The proposed method could also reliably estimate the source waveforms when multiple sources were temporally correlated or uncorrelated, or were sustained or transient, or had some features in frequency or phase, or had even more complicated temporal dynamics. Moreover, applying the proposed method to real fMRI and EEG data acquired in a visual experiment yielded a time series of reconstructed CCD images, in agreement with the traditional view of hierarchical visual processing. In conclusion, the proposed method provides a reliable technique for the fMRI-EEG integration and represents a significant advancement over the conventional fMRI-weighted EEG (or MEG) source imaging techniques and is also applicable to the fMRI-MEG integrated source imaging. © 2007 Elsevier Inc. All rights reserved.

126. Li, W., R.E. Zinbarg, S.G. Boehm, and K.A. Paller, *Neural and behavioral evidence for affective priming from unconsciously perceived emotional facial expressions and the influence of trait anxiety.* Journal of Cognitive Neuroscience, 2008. **20**(1): p. 95-107.

Summary: Affective judgments can often be influenced by emotional information people unconsciously perceive, but the neural mechanisms responsible for these effects and how they are modulated by individual differences in sensitivity to threat are unclear. Here we studied subliminal affective priming by recording brain potentials to surprise faces preceded by 30-msec happy or fearful prime faces. Participants showed valence-consistent changes in affective ratings of surprise faces, although they reported no knowledge of prime-face expressions, nor could they discriminate between prime-face expressions in a forced-choice test. In conjunction with the priming effect on affective evaluation, larger occipital P1 potentials at 145-175 msec were found with fearful than with happy primes, and source analyses implicated the bilateral extrastriate cortex in this effect. Later brain potentials at 300-400 msec were enhanced with happy versus fearful primes, which may reflect differential attentional orienting. Personality testing for sensitivity to threat, especially social threat, was also used to evaluate individual differences potentially relevant to subliminal affective priming. Indeed, participants with high trait anxiety demonstrated stronger affective priming and greater P1 differences than did those with low trait anxiety, and these effects were driven by fearful primes. Results thus suggest that unconsciously perceived affective information influences social judgments by altering very early perceptual analyses, and that this influence is accentuated to the extent that people are oversensitive to threat. In this way, perception may be subject to a variety of influences that govern social preferences in the absence of concomitant awareness of such influences. © 2008 Massachusetts Institute of Technology.

127. Lee, H.K., D.H. Park, H.S. Shin, and S.C. Hong, *Comparison of low resolution electromagnetic tomography imaging between subjects with mild and severe obstructive sleep apnea syndrome: A preliminary study*. Psychiatry Investigation, 2008. **5**(1): p. 45-51.

Summary: Objective: The purpose of this study was to identify the regions of the brain associated with recurrent nocturnal chronic hypoxic episodes in patients with untreated obstructive sleep apnea syndrome (OSAS) using low-resolution electromagnetic tomography (LORETA) and quantitative electroencephalography (QEEG). Methods: Nocturnal polysomnograph (NPSG) and subsequent morning electroencephalograph (EEG) were measured in 20 subjects with OSAS. Mild (n=10 ages 39.5 ± 12.1 years) and severe (n=10 ages 41.7 ± 13.6 years) right-handed male OSAS subjects were selected by interview and questionnaires including the NPSG, Beck Depression Inventory, Beck Anxiety Inventory, Epworth Sleepiness Scale, and Pittsburgh Sleep Quality Index. The LORETA and QEEG were compared between the severe and mild OSAS groups by frequency bands (delta 1-3 Hz, theta 4-7 Hz, alpha 8-12 Hz, betal 13-18 Hz, beta2 19-21 Hz, beta3 22-30 Hz, and total 1-30 Hz) made by spectral analysis during resting with the eyes closed. Results: The LORETA analysis showed decreased alpha activity at the right posterior cingulate gyrus (Brodmann area 23) in cases with severe OSAS compared to mild OSAS (p<0.05). For the QEEG, the absolute power of the alpha activity (8-12 Hz) was decreased in P3 (p=0.047), PZ (p=0.039) and O2 (p=0.04) in cases with severe OSAS compared to mild OSAS cases. The LORETA and QEEG analyses had similar results with regard to band, activation and location. Conclusion: The decreased activity of the alpha frequency in the right posterior cingulate gyrus, in patients with severe OSAS compared to those with mild OSAS, suggests that chronic repeated short-term hypoxia during sleep, in

OSAS, could provoke cortical brain dysfunction associated with cognitive dysfunction such as memory and attention. Copyright © 2008 Official Journal of Korean Neuropsychiatric Association.

128. Lavric, A., G.A. Mizon, and S. Monsell, *Neurophysiological signature of effective anticipatory task-set control: A task-switching investigation*. European Journal of Neuroscience, 2008. **28**(5): p. 1016-1029.

Summary: Changing between cognitive tasks requires a reorganization of cognitive processes. Behavioural evidence suggests this can occur in advance of the stimulus. However, the existence or detectability of an anticipatory task-set reconfiguration process remains controversial, in part because several neuroimaging studies have not detected extra brain activity during preparation for a task switch relative to a task repeat. In contrast, electrophysiological studies have identified potential correlates of preparation for a task switch, but their interpretation is hindered by the scarcity of evidence on their relationship to performance. We aimed to: (i) identify the brain potential(s) reflecting effective preparation for a task-switch in a task-cuing paradigm that shows clear behavioural evidence for advance preparation, and (ii) characterize this activity by means of temporal segmentation and source analysis. Our results show that when advance preparation was effective (as indicated by fast responses), a protracted switch-related component, manifesting itself as widespread posterior positivity and concurrent right anterior negativity, preceded stimulus onset for ~ 300 ms, with sources primarily in the left lateral frontal, right inferior frontal and temporal cortices. When advance preparation was ineffective (as implied by slow responses), or made impossible by a short cue-stimulus interval (CSI), a similar component, with lateral prefrontal generators, peaked ~300 ms poststimulus. The protracted prestimulus component (which we show to be distinct from P3 or contingent negative variation, CNV) also correlated over subjects with a behavioural measure of preparation. Furthermore, its differential lateralization for word and picture cues was consistent with a role for verbal self-instruction in preparatory task-set reconfiguration. © The Authors (2008).

129. Kopecek, M., B. Tislerova, P. Sos, M. Bares, T. Novak, V. Krajca, and M. Brunovsky, *QEEG changes during switch from depression to hypomania/mania: A case report*. Neuroendocrinology Letters, 2008. **29**(3): p. 295-302.

Summary: Background: QEEG cordance and low-resolution electromagnetic tomography (LORETA) are relatively new applications of QEEG. Four small-scale studies have shown that decreases of QEEG prefrontal theta cordance after the first week on new antidepressants predict clinical response to treatment in patients with unipolar depression. Methods: We calculated prefrontal theta cordance and changes in 3D distribution of brain electrical activity using LORETA in the case of a 54-year old man experiencing his third depressive episode. Results: We did not detect a decrease of prefrontal theta cordance after one week of new treatment and the patient did not respond to this therapy after four weeks. However, we observed a decrease of prefrontal theta cordance after the first week of clomipramine therapy. Manic symptoms emerged after two weeks of clomipramine treatment. A decrease of prefrontal theta cordance preceded the clomipramine induced switch to hypomania during the next episode of depression also. LORETA before and during clomipramine therapies detected a significant increase of theta in the right postcentralis gyrus in the parietal lobe, and a borderline increase of alfa2 in the right middle frontal gyrus. Discussion: In a patient with bipolar spectrum disorder we found that a treefold change in theta prefrontal cordance preceded mood changes in a similar way as in patients with unipolar depression. We speculate that the changes detected by LORETA can attributed to the anticholinergic activity of clomipramine and the specific effects of a mood switch. Our data suggest that the new applications of QEEG can be sensitive to mood changes and have potential in bipolar disorder research. © 2008 Neuroendocrinology Letters.

130. Khemakhem, R., W. Zouch, A. Taleb-Ahmed, and A.B. Hamida, *A new combining approach to localizing the EEG activity in the brain: WMN and LORETA solution*. BioMedical Engineering and Informatics: New Development and the Future - Proceedings of the 1st International Conference on BioMedical Engineering and Informatics, BMEI 2008, 2008. **1**: p. 821-824.

Summary: Estimation of cerebral electric activity from the scalp electroencephalogram EEG requires a solution to the EEG inverse problem. We propose a new approach which consists in combining two methods in order to locate the brain electric activity: 'Weighted Minimum Norm' 'WMN' and 'LOw Resolution brain Electromagnetic TomogrAphy' 'LORETA'. The idea that we propose is to used the current density distribution estimated by the WMN method in order to initialize the LORETA method. A comparative study of three different inverse methods, WMN, LORETA and WMN-LORETA is presented. We compare the results found with existing methods LORETA and WMN. The results reveal that WMN-LORETA is able to reconstruct a three-dimensional source distribution with a degree of localization compared to the other methods. © 2008 IEEE.

131. Khemakhem, R., A.B. Hamida, A. Ahmed-Taleb, and P. Derambure, *New hybrid method for the 3D reconstruction of neuronal activity in the brain*. Proceedings of IWSSIP 2008 - 15th International Conference on Systems, Signals and Image Processing, 2008: p. 405-408.

Summary: Estimation of the electrical cartography on the scalp surface requires a solution to the EEG inverse problem, but, there is no unique solution to this problem. In this paper we present Standardized LOw Resolution brain Electromagnetic TomogrAphy "sLORETA", the FOCaI Underdetermined System Solver "FOCUSS", and the new combination solution "sLORET A-FOCUSS" methods. The purpose of this paper is to present the technical details of these methods, and give some comparison between them. The results demonstrate that using each method, we obtain different results given the reconstruction in 3D of the cerebral activity in the brain from where we evaluate the efficiency of the sLORETA-FOCUSS method to reconstruct a three dimensional source distribution with smaller localization and a minimum of localization error.

132. Khader, P., T. Schicke, B. Röder, and F. Rösler, *On the relationship between slow cortical potentials and BOLD signal changes in humans*. International Journal of Psychophysiology, 2008. **67**(3): p. 252-261.

Summary: This review summarizes experimental studies that investigated the relationship between DC-recorded slow event-related potentials (slow waves) of the electroencephalogram (EEG) and the hemodynamic BOLD response, as measured with functional magnetic resonance imaging (fMRI). Slow waves have been found to accompany a large number of cognitive processes in a systematic and topographically specific way, and have thus been successfully employed in psychophysiological experiments to dissociate cognitive functions by means of their slow wave topography. Recently, however, several independent studies, using different experimental paradigms, suggest the existence of another feature of slow waves, i.e., a close relationship with the fMRI BOLD response. Some of these studies found couplings between slow waves and BOLD signals in various brain regions, using simultaneous EEG-fMRI recordings. Others found similar task-related activation patterns of slow waves (i.e., scalp topographies) and BOLD responses (i.e., activated voxel profiles), as well as corresponding parametric increases of signal strength with increasing task difficulty. The close relationship between slow waves and BOLD responses reported here concerns a low frequency range of the EEG signal (< 1 Hz) that has so far received less attention in studies on the correspondence between EEG and fMRI than the higher frequencies, and therefore adds to the various findings obtained at higher EEG frequencies. Implications for the use of slow waves for neuroscientific research are discussed. © 2007 Elsevier B.V. All rights reserved.

133. Hyun, J.S., S.C. Kam, and O.Y. Kwon, *Changes of cerebral current source by audiovisual erotic stimuli in premature ejaculation patients*. Journal of Sexual Medicine, 2008. **5**(6): p. 1474-1481.

Summary: Introduction. Premature ejaculation (PE) is one of the most common forms of male sexual dysfunction. The mechanisms of PE remain poorly understood, despite its high prevalence. Aim. To investigate the pathophysiology and casuses of PE in the central nervous system, we tried to observe the changes in brain current source distribution by audiovisual induction of sexual arousal. Methods. Electroencephalograpies were recorded in patients with PE (45.0 ± 10.3 years old, N = 18) and in controls (45.6 ± 9.8 years old, N = 18) during four 10-minute segments of resting, watching a music video excerpt, resting, and watching an erotic video excerpt. Five artifact-free 5-second segments were used to obtain cross-spectral low-resolution brain electromagnetic tomography (LORETA) images. Main Outcome Measures. Statistical nonparametric maps (SnPM) were obtained to detect the current density changes of six frequency bands between the erotic video session and the music video session in each

group. Comparisons were also made between the two groups in the erotic video session. Results. In the SnPM of each spectrum in patients with PE, the current source density of the alpha band was significantly reduced in the right precentral gyrus, the right insula, and both superior parietal lobules ($P < 0.01$). Comparing the two groups in the erotic video session, the current densities of the beta-2 and -3 bands in the PE group were significantly decreased in the right parahippocampal gyrus and left middle temporal gyrus (P & lt;0.01). Conclusions. Neuronal activity in the right precental gyrus, the right insula, both the superior parietal lobule, the right parahippocampal gyrus, and the left middle temporal gyrus may be decreased in PE patients upon sexual arousal. Further studies are needed to evaluate the meaning of decreased neuronal activities in PE patients. © 2008 International Society for Sexual Medicine.

134. Hori, T., K. Ogawa, T. Abe, and H. Nittono, *Brain potentials related to rapid eye movements and dreaming during REM sleep: A short review of psychophysiological correlates*. Sleep and Biological Rhythms, 2008. **6**(3): p. 128-138.

Summary: Many sleep researchers have examined dream image-generation, which occurs during rapid eye movement (REM) sleep. Furthermore, activation of brain regions related to rapid eye movements during human REM sleep has been reported. Although recent brain imaging techniques have high spatial resolution, their temporal resolution is limited. Consequently, the spatio-temporal structures of brain activities related to rapid eye movement remain largely unknown. This article presents a short review of findings of recent studies that have used brain potentials related to rapid eye movement to examine dream image-generation processes. Brain potentials related to rapid eye movement are obtained using averaged electroencephalography (EEG) that is time-locked to the onset or offset of rapid eye movement. First, based on findings related to presaccadic and pre-REM brain potentials, we discuss why eyes move during REM sleep. Second, the relationship of lambda-like potentials, which occur immediately after the cessation of rapid eye movement, to generation of visual dream images, is discussed. Third, enhancement of gamma-band EEG activity occurring immediately after the offset of rapid eye movement is discussed in terms of information-binding of dream images. Finally in this review, preparatory activation of emotion and memory circuits before the onset of rapid eye movement is discussed in terms of contextual setting of the dream story. © 2008 The Author Journal compilation © 2008 Japanese Society of Sleep Research.

135. Holz, E.M., M. Doppelmayr, W. Klimesch, and P. Sauseng, *EEG correlates of action observation in humans*. Brain Topography, 2008. **21**(2): p. 93-99.

Summary: To investigate electrophysiological correlates of action observation electroencephalogram (EEG) was recorded while participants observed repetitive biological (human) or non-biological movements (at a rate of 2 Hz). Steady-state evoked potentials were analyzed and their neural sources were investigated using low resolution electromagnetic tomography analysis (LORETA). Results revealed significantly higher activation in the primary motor and premotor cortex, supplementary motor area as well as the posterior parietal cortices during observation of biological movements, supporting mirror properties of cortical motor neurons. In addition interregional communication was analyzed. Increased coherence for distributed networks at delta (0.5-4 Hz) and lower alpha (8-10 Hz) frequencies were obtained suggesting integration and functional coupling between the activated cortical regions during human action observation. © 2008 Springer Science+Business Media, LLC.

136. Holmes, A.J. and D.A. Pizzagalli, *Spatiotemporal dynamics of error processing dysfunctions in major depressive disorder*. Archives of General Psychiatry, 2008. **65**(2): p. 179-188.

Summary: Context: Depression is characterized by executive dysfunctions and abnormal reactions to errors; however, little is known about the brain mechanisms that underlie these deficits. Objective: To examine whether abnormal reactions to errors in patients with major depressive disorder (MDD) are associated with exaggerated paralimbic activation and/or a failure to recruit subsequent cognitive control to account for mistakes in performance. Design: Between February 15, 2005, and January 19, 2006, we recorded 128-channel event-related potentials while study participants performed a Stroop task, modified to incorporate performance feedback. Setting: Patients with MDD and healthy comparison subjects were recruited from the general community. Participants: Study participants were 20 unmedicated patients with MDD and 20 demographically matched comparison subjects. Main Outcome Measures: The error-related negativity and error positivity were analyzed through scalp and source localization analyses. Functional connectivity analyses were conducted to investigate group differences in the spatiotemporal dynamics of brain mechanisms that underlie error processing. Results: Relative to comparison subjects, patients with MDD displayed significantly lower accuracy after incorrect responses, larger error-related negativity, and higher current density in the rostral anterior cingulate cortex (ACC) and medial prefrontal cortex (PFC) (Brodmann area 10/32) 80 milliseconds after committing an error. Functional connectivity analyses revealed that for the comparison subjects, but not the patients with MDD, rostral ACC and medial PFC activation 80 milliseconds after committing an error predicted left dorsolateral PFC (Brodmann area 8/9) activation 472 milliseconds after committing an error. Conclusions: Unmedicated patients with MDD showed reduced accuracy and potentiated error-related negativity immediately after committing errors, highlighting dysfunctions in the automatic detection of unfavorable performance outcomes. New analytic procedures allowed us to show that abnormal reaction to committing errors was accompanied by hyperactivation in rostral ACC and medial PFC regions 80 milliseconds after committing errors and a failure to recruit dorsolateral PFC-based cognitive control. Future studies are warranted to investigate whether these dysfunctions might foster the emergence and maintenance of negative processing biases and thus increase vulnerability to depression. ©2008 American Medical Association. All rights reserved.

137. Holmes, A.J. and D.A. Pizzagalli, *Response conflict and frontocingulate dysfunction in unmedicated participants with major depression.* Neuropsychologia, 2008. **46**(12): p. 2904-2913.

Summary: Individuals with major depressive disorder (MDD) often exhibit impaired executive function, particularly in experimental tasks that involve response conflict and require adaptive behavioral adjustments. Prior research suggests that these deficits might be due to dysfunction within frontocingulate pathways implicated in response conflict monitoring and the recruitment of cognitive control. However, the temporal unfolding of conflict monitoring impairments in MDD remains poorly understood. To address this issue, we recorded 128-channel event-related potentials while 20 unmedicated participants with MDD and 20 demographically matched, healthy controls performed a Stroop task. Compared to healthy controls, MDD subjects showed larger Stroop interference effects and reduced N2 and N450 amplitudes. Source localization analyses at the time of maximal N450 activity revealed that MDD subjects had significantly reduced dorsal anterior cingulate cortex (dACC; Brodmann area 24/32) and left dorsolateral prefrontal cortex (Brodmann area 10/46) activation to incongruent relative to congruent trials. Consistent with the heterogeneous nature of depression, follow-up analyses revealed that depressed participants with the lowest level of conflict-related dACC activation 620 ms post-stimulus were characterized by the largest Stroop interference effects (relatively increased slowing and reduced accuracy for incongruent trials). Conversely, MDD participants with relatively stronger dACC recruitment did not differ from controls in terms of interference effects. These findings suggest that for some, but not all individuals, MDD is associated with impaired performance in trials involving competition among different response options, and reduced recruitment of frontocingulate pathways implicated in conflict monitoring and cognitive control. © 2008 Elsevier Ltd. All rights reserved.

138. Hensch, T., U. Herold, K. Diers, D. Armbruster, and B. Brocke, *Reliability of intensity dependence of auditory-evoked potentials*. Clinical Neurophysiology, 2008. **119**(1): p. 224-236.

Summary: Objective: Intensity dependence of auditory-evoked potentials (IAEP) is a suggested indicator of serotonergic neurotransmission. In contrast to its clinical renaissance, the reliability of IAEP has only been examined in a few studies, most of which are limited due to the possibly confounding effects of age and gender. Therefore, the present study examines different reliabilities of various IAEP parameterizations while controlling for age and gender. Methods: Auditory-evoked potentials were recorded from 166 students. Of these 37 women and 25 men were retested after three weeks. Results: Test-retest and odd-even reliabilities were remarkable at Cz in both females ($r = .88/.86$) and males ($r = .82/.79$). Reliabilities were higher in women, higher with linear than median

slopes and best at Cz. Bisection of sweep number, split-half reliability, the second run, and lower intensities revealed lower reliabilities. Conclusions: Reliabilities at Cz can reach the same level as previously reported by dipole-source-localization methods, if sufficient sweep number and linear slopes are applied. Significance: Based on theoretical arguments and current data, the continued use of the easy and rapidly done single-channel IAEP is suggested, although ideally in combination with multi-channel source-localization methods. This would be seminal for a drafted program standardizing IAEP to further improve its clinical utility. © 2007 International Federation of Clinical Neurophysiology.

139. Haufe, S., V.V. Nikulin, A. Ziehe, K.R. Müller, and G. Nolte, *Combining sparsity and rotational invariance in EEG/MEG source reconstruction*. NeuroImage, 2008. **42**(2): p. 726-738.

Summary: We introduce Focal Vector Field Reconstruction (FVR), a novel technique for the inverse imaging of vector fields. The method was designed to simultaneously achieve two goals: a) invariance with respect to the orientation of the coordinate system, and b) a preference for sparsity of the solutions and their spatial derivatives. This was achieved by defining the regulating penalty function, which renders the solutions unique, as a global ℓ_1-norm of local ℓ_2-norms. We show that the method can be successfully used for solving the EEG inverse problem. In the joint localization of 2-3 simulated dipoles, FVR always reliably recovers the true sources. The competing methods have limitations in distinguishing close sources because their estimates are either too smooth (LORETA, Minimum ℓ_1-norm) or too scattered (Minimum ℓ_2-norm). In both noiseless and noisy simulations, FVR has the smallest localization error according to the Earth Mover's Distance (EMD), which is introduced here as a meaningful measure to compare arbitrary source distributions. We also apply the method to the simultaneous localization of left and right somatosensory N20 generators from real EEG recordings. Compared to its peers FVR was the only method that delivered correct location of the source in the somatosensory area of each hemisphere in accordance with neurophysiological prior knowledge. © 2008 Elsevier Inc. All rights reserved.

140. Haiman, G., H. Pratt, and A. Miller, *Brain responses to verbal stimuli among multiple sclerosis patients with pseudobulbar affect*. Journal of the Neurological Sciences, 2008. **271**(1-2): p. 137-147.

Summary: Purpose: To characterize the brain activity and associated cortical structures involved in pseudobulbar affect (PBA), a condition characterized by uncontrollable episodes of emotional lability in patients with multiple sclerosis (MS). Methods: Behavioral responses and event related potentials (ERP) in response to subjectively significant and neutral verbal stimuli were recorded from 33 subjects in 3 groups: 1) MS patients with PBA (MS + PBA); 2) MS patients without PBA (MS); 3) Healthy control subjects (HC). Statistical non-parametric mapping comparisons of ERP source current density distributions between groups were conducted separately for subjectively significant and for neutral

stimuli. Results: Behavioral responses showed more impulsive performance in patients with PBA. As expected, almost all ERP waveform comparisons between the MS groups and controls were significant. Source analysis indicated significantly distinct activation in MS + PBA in the vicinity of the somatosensory and motor areas in response to neutral stimuli, and at pre-motor and supplementary motor areas in response to subjectively significant stimuli. Both subjectively significant and neutral stimuli evoked higher current density in MS + PBA compared to both other groups. Conclusions: PBA of MS patients involves cortical structures related to sensory-motor and emotional processing, in addition to overactive involvement of motor cortical areas in response to neutral stimuli. Significance: These results may suggest that a 'disinhibition' of a "gate control"-type mechanism for emotional expression may lead to the lower emotional expression threshold of pseudobulbar affect. © 2008 Elsevier B.V. All rights reserved.

141. Godinho, F., M. Frot, C. Perchet, M. Magnin, and L. Garcia-Larrea, *Pain influences hedonic assessment of visual inputs.* European Journal of Neuroscience, 2008. **27**(9): p. 2219-2228.

Summary: It is acknowledged that the emotional state created by visual inputs can modulate the way we feel pain; however, little is known about how acute pain influences the emotional assessment of what we see. In this study healthy subjects scored affective images while receiving painful or innocuous electrical shocks. Painful stimuli did not make unpleasant images more unpleasant, but rendered pleasant pictures significantly less pleasant. Brain responses to visual inputs (64-channels electroencephalogram) mirrored behavioural results, showing pain-induced effects in the orbitofrontal cortex, the subgenual portion of the cingulate gyrus, the anterior prefrontal and the temporal cortices, exclusively during presentation of pleasant images. In addition to this specific effect on pleasant pictures, pain also produced non-specific effects upon all categories of images, engaging cerebral areas associated with attention, alertness and motor preparation (middle-cingulate, supplemental motor, prefrontal cortex). Thus, pain appears to have a dual influence on visual processing: a non-specific effect related to orienting phenomena; and a more specific action exerted on supra-modal limbic areas involved in the production of affective states. The latter correlated with changes in the subjective appraisal of visual stimuli, and may underlie not only the change in their subjective assessment but also reactive processes aimed at coping with unpleasant contexts. © The Authors (2008).

142. Gianotti, L.R.R., G. Künig, P.L. Faber, D. Lehmann, R.D. Pascual-Marqui, K. Kochi, and U. Schreiter-Gasser, *Rivastigmine effects on EEG spectra and three-dimensional LORETA functional imaging in Alzheimer's disease.* Psychopharmacology, 2008. **198**(3): p. 323-332.

Summary: Objective: The objective of the study is to investigate the electrocortical and the global cognitive effects of 3 months rivastigmine medication in a group of mild to moderate Alzheimer's disease patients.

Materials and methods: Multichannel EEG and cognitive performances measured with the Mini Mental State Examination in a group of 16 patients with mild to moderate Alzheimer's Disease were collected before and 3 months after the onset of rivastigmine medication. Results: Spectral analysis of the EEG data showed a significant power decrease in the delta and theta frequency bands during rivastigmine medication, i.e., a shift of the power spectrum towards 'normalization'. Three-dimensional low resolution electromagnetic tomography (LORETA) functional imaging localized rivastigmine effects in a network that includes left fronto-parietal regions, posterior cingulate cortex, bilateral parahippocampal regions, and the hippocampus. Moreover, a correlation analysis between differences in the cognitive performances during the two recordings and LORETA-computed intracortical activity showed, in the alpha1 frequency band, better cognitive performance with increased cortical activity in the left insula. Conclusion: The results point to a 'normalization' of the EEG power spectrum due to medication, and the intracortical localization of these effects showed an increase of cortical activity in frontal, parietal, and temporal regions that are well-known to be affected in Alzheimer's disease. The topographic convergence of the present results with the memory network proposed by Vincent et al. (J. Neurophysiol. 96:3517-3531, 2006) leads to the speculation that in our group of patients, rivastigmine specifically activates brain regions that are involved in memory functions, notably a key symptom in this degenerative disease. © 2008 Springer-Verlag.

143. Galka, A., T. Ozaki, H. Muhle, U. Stephani, and M. Siniatchkin, *A data-driven model of the generation of human EEG based on a spatially distributed stochastic wave equation*. Cognitive Neurodynamics, 2008. **2**(2): p. 101-113.

Summary: We discuss a model for the dynamics of the primary current density vector field within the grey matter of human brain. The model is based on a linear damped wave equation, driven by a stochastic term. By employing a realistically shaped average brain model and an estimate of the matrix which maps the primary currents distributed over grey matter to the electric potentials at the surface of the head, the model can be put into relation with recordings of the electroencephalogram (EEG). Through this step it becomes possible to employ EEG recordings for the purpose of estimating the primary current density vector field, i.e. finding a solution of the inverse problem of EEG generation. As a technique for inferring the unobserved high-dimensional primary current density field from EEG data of much lower dimension, a linear state space modelling approach is suggested, based on a generalisation of Kalman filtering, in combination with maximum-likelihood parameter estimation. The resulting algorithm for estimating dynamical solutions of the EEG inverse problem is applied to the task of localising the source of an epileptic spike from a clinical EEG data set; for comparison, we apply to the same task also a non-dynamical standard algorithm. © 2008 Springer Science+Business Media B.V.

144. Fisher, D.J., A. Labelle, and V.J. Knott, *The right profile: Mismatch negativity in schizophrenia with and without auditory hallucinations as*

measured by a multi-feature paradigm. Clinical Neurophysiology, 2008. **119**(4): p. 909-921.

Summary: Objective: To examine pre-attentive acoustic change detection in schizophrenia patients with and without auditory hallucinations via mismatch negativity (MMN) extracted from a multi-feature paradigm. Methods: This study examined the electroencephalograph (EEG)-derived MMN, recorded across 32 sites, in 12 hallucinating patients (HPs) with schizophrenia, 12 non-hallucinating patients (NPs) with schizophrenia and 12 healthy controls (HCs). MMN was recorded in response to a multi-feature MMN paradigm [Näätänen, R., et al., 2004. The mismatch negativity (MMN): towards the optimal paradigm. Clin. Neurophys. 115, 140-144] which employs frequency, duration, intensity, location and gap deviants. Differences in source localization were probed using standardized low resolution brain electromagnetic tomography (sLORETA). Results: HPs showed significantly smaller MMNs to duration deviants compared to HCs and NPs, as well as smaller MMNs to intensity deviants compared to HCs. Regionalized differences between HCs and each of the patient groups were observed in response to frequency deviants. There were no significant group effects for location or gap deviants, or for MMN latency. Source localization using sLORETA showed no significant differences in MMN generator location across groups for any of the deviant stimuli. Conclusions: The often-reported robust MMN deficit to duration deviants may be specific to schizophrenia patients afflicted with auditory hallucinations. Furthermore, by using symptom-specific groups, novel deficits of pre-attentive auditory processing, such as that observed to intensity deviants in HPs, may be revealed. Significance: The differential responding observed between both groups of patients with schizophrenia has implications for automatic processing within the auditory cortex of hallucinating patients and suggests that care must be taken when recruiting participants in studies involving schizophrenia to ensure consistent, replicable results. © 2007 International Federation of Clinical Neurophysiology.

145. Esslen, M., S. Metzler, R. Pascual-Marqui, and L. Jancke, *Pre-reflective and reflective self-reference: A spatiotemporal EEG analysis*. NeuroImage, 2008. **42**(1): p. 437-449.

Summary: Functional imaging studies consistently support the role of the medial prefrontal cortex to be a part of a functional network of reflective self-awareness. The current study introduces a new linguistic task which (1) directly compares self-reference and other-reference, and (2) separates pre-reflective from reflective aspects of self-awareness. Twenty-six healthy volunteers evaluated trait adjectives in reference to the self or a close friend while a continuous 30-channel EEG was recorded. Low-resolution brain electromagnetic tomography (LORETA) was used for statistical brain imaging. As expected, the direct comparison of self-reference to other-reference revealed the MPFC to be significant and strongly more active during the self-reference condition. Pre-reflective aspects of self seem to be implemented to a greater degree in the ventral, reflective aspects of the self in dorsal parts of the MPFC. In the pre-reflective self condition, brain

areas that receive homeostatic afferents from somatic and visceral sensation of the body such as the insula and the somatosensory cortex were strongly activated as early as 134 ms after stimulus onset. The right inferior parietal lobe seems to be involved in self-referential processing in general. © 2007.

146. Duru, A.D. and A. Ademoglu, *Source localization of subtopographies decomposed by radial basis functions*. Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics), 2008. **5128 LNCS**: p. 108-115.

Summary: Functional neuroimaging methods give the opportunity of investigating human brain functioning. Mostly used functional neuroimaging techniques include Electroencephalogram (EEG), functional magnetic resonance imaging (fMRI), positron emission tomography (PET) and optical imaging. Among these techniques EEG has the best time resolution, while fMRI has the best spatial resolution. High temporal resolution of EEG is an attractive property for neuroimaging studies. EEG inverse problem is needed to be solved in order to identify the locations and the strength of the electrical sources forming EEG/ERP topographies. Low spatial resolution of the scalp topography causes this localization problem more complicated. In this paper, a spatial preprocessing method, which separates a topography into two or more subtopographies is proposed. The decomposition procedure is based on defining a spatial map with radial basis functions which forms the subtopographies. A simulated data is used to exhibit the advantage of using this decomposition technique prior to EEG source localization. It is shown that the accuracy of the source localization problem is improved by using the subtopographies instead of using the raw topography. © 2008 Springer-Verlag Berlin Heidelberg.

147. Doppelmayr, M., T. Finkenzeller, and P. Sauseng, *Frontal midline theta in the pre-shot phase of rifle shooting: Differences between experts and novices*. Neuropsychologia, 2008. **46**(5): p. 1463-1467.

Summary: In the present study the time course of frontal midline theta (Fmθ) during the aiming period in rifle shooting was investigated. Experts (n = 8) and novices (n = 10) had to shoot repeatedly while EEG was recorded, and the time course of Fmθ during the aiming period was significantly different between the two groups, showing a steady increase of power for the last 3 s before the shot only for experts, but not for novices. Source analysis (LORETA) indicated a significantly stronger theta activity for experts strictly located at the anterior cingulate area and medial frontal cortex, locations well known for focused attention. The results suggest that experts and novices use different strategies during the aiming period. While novices keep a relatively constant amount of attention to the target, experts are able to increase attention exactly to the time point of the trigger pull. © 2008 Elsevier Ltd. All rights reserved.

148. Ding, L. and B. He, *Sparse source imaging in electroencephalography with accurate field modeling*. Human Brain Mapping, 2008. **29**(9): p. 1053-1067.

Summary: We have developed a new L1-norm based generalized minimum norm estimate (GMNE) and have fully characterized the concept of sparseness regularization inherited in the proposed algorithm, which is termed as sparse source imaging (SSI). The new SSI algorithm corrects inaccurate source field modeling in previously reported L1-norm GMNEs and proposes that sparseness a priori should only be applied to the regularization term, not to the data term in the formulation of the regularized inverse problem. A new solver to the newly developed SSI has been adopted and known as the second-order cone programming. The new SSI is assessed by a series of simulations and then evaluated using somatosensory evoked potential (SEP) data with both scalp and subdural recordings in a human subject. The performance of SSI is compared with other L1-norm GMNEs and L2-norm GMNEs using three evaluation metrics, i.e., localization error, orientation error, and strength percentage. The present simulation results indicate that the new SSI has significantly improved performance in all evaluation metrics, especially in the metric of orientation error. L2-norm GMNEs show large orientation errors because of the smooth regularization. The previously reported L1-norm GMNEs show large orientation errors due to the inaccurate source field modeling. The SEP source imaging results indicate that SSI has the best accuracy in the prediction of subdural potential field as validated by direct subdural recordings. The new SSI algorithm is also applicable to MEG source imaging. © 2007 Wiley-Liss, Inc.

149. Ding, L., *A novel sparse source imaging in reconstructing extended cortical current sources*. Proceedings of the 30th Annual International Conference of the IEEE Engineering in Medicine and Biology Society, EMBS'08 - "Personalized Healthcare through Technology", 2008: p. 4555-4558.

Summary: We have developed a new sparse source imaging (SSI) method with the use of the Ll-norm in EEG inverse problems to reconstruct extended cortical current sources. The new SSI method explores the sparseness in cortical current density variation maps (the transform domain) other than in the cortical current density maps (the original domain) from previously reported SSI methods. The new SSI is assessed by a series of computer simulations. The performance of SSI is compared with the well-known L2-norm MNE using the AUC metric. Our present simulation data indicate that the new SSI has significantly improved performance in reconstructing extended cortical current sources and estimating their cortical extents. The L2-norm MNE shows relatively poor performance in the same source imaging tasks. The new SSI method is also applicable to MEG source imaging. © 2008 IEEE.

150. Diaconescu, A.O., N. Kovacevic, and A.R. McIntosh, *Modality-independent processes in cued motor preparation revealed by cortical potentials*. NeuroImage, 2008. **42**(3): p. 1255-1265.

Summary: We used event-related potentials (ERPs) in a crossmodal stimulus-response compatibility paradigm to identify modality-independent aspects of rule processing and cued response facilitation. Participants responded to a lateralized

target with the ipsilateral (compatible) or contralateral (incompatible) hand. Cue-target modality and cue-target order were manipulated. The cue preceded the target in half of the trials, and the target preceded the cue in the other half. For half of the participants, a visual cue signalled the response rule to an auditory target, while in other half, an auditory cue signalled the response rule to a visual target. Behavioural results showed a significant cue facilitation effect with response times faster for trials when the cue preceded the target, regardless of cue-target modality. The overall fastest response times were obtained in auditory cue-visual target trials. We performed groupwise independent component analysis of the cortical potentials and identified two modality-independent spatiotemporal patterns related to experimental effects. The first pattern, which resembled the early part of a contingent-negative waveform, was associated with response rule processing, regardless of cue-target presentation order and modality. The second pattern showed amplitude modulations that were dependent on stimulus modality. However, this pattern also correlated with faster response times only when the cue preceded the target and regardless of cue-target modality. Source analysis suggested that the response rule processing pattern originated from the posterior parietal, motor and cingulate regions. The pattern associated with the cue-first facilitation effect originated from cingulate and medial frontal regions. The effects carried by both patterns showed temporal overlap in the interval between the first and second stimulus presentation, but with differences in their relation to response rule processing and behavioural facilitation. © 2008 Elsevier Inc. All rights reserved.

151. Dhar, M., P.H. Been, R.B. Minderaa, and M. Althaus, *Distinct information processing characteristics in dyslexia and ADHD during a covert orienting task: An event-related potential study*. Clinical Neurophysiology, 2008. **119**(9): p. 2011-2025.

Summary: Objective: A visuo-spatial orienting task was used to investigate the individual and joint contribution of the presence of dyslexia and attention-deficit hyperactivity disorder (ADHD) to information processing. Methods: Sixteen control, 17 dyslexic, 16 ADHD, and 15 comorbid adults performed the task, comprising a valid, invalid, and no-cue condition. Performance measures were errors and reaction time (RT). A negative potential in response to cues and targets (N2), and a positive potential in response to targets (P3) were derived from the EEG. A 2 × 2 design was used with the factors dyslexic/non-dyslexic, and ADHD/non-ADHD. Results: Dyslexic participants demonstrated a smaller cue-related N2, yet a greater target-related N2 in the valid condition. ADHD participants were discriminated by the P3 difference between the invalid and valid conditions. Comorbids differed from ADHD mainly in invalid-valid RT, and were similar to dyslexics in target N2 processing. Conclusions: Dyslexics were impaired in early information processing, and participants with ADHD differed for later processing stages. Significance: This is the first ERP study of attentional processes in dyslexia to incorporate an ADHD and a comorbid group. Its results may contribute to differentiation of these clinical groups. © 2008 International Federation of Clinical Neurophysiology.

152. Desseilles, M., T. Dang-Vu, M. Schabus, V. Sterpenich, P. Maquet, and S. Schwartz, *Neuroimaging insights into the pathophysiology of sleep disorders*. Sleep, 2008. **31**(6): p. 777-794.

Summary: Neuroimaging methods can be used to investigate whether sleep disorders are associated with specific changes in brain structure or regional activity. However, it is still unclear how these new data might improve our understanding of the pathophysiology underlying adult sleep disorders. Here we review functional brain imaging findings in major intrinsic sleep disorders (i.e., idiopathic insomnia, narcolepsy, and obstructive sleep apnea) and in abnormal motor behavior during sleep (i.e., periodic limb movement disorder and REM sleep behavior disorder). The studies reviewed include neuroanatomical assessments (voxel-based morphometry, magnetic resonance spectroscopy), metabolic/functional investigations (positron emission tomography, single photon emission computed tomography, functional magnetic resonance imaging), and ligand marker measurements. Based on the current state of the research, we suggest that brain imaging is a useful approach to assess the structural and functional correlates of sleep impairments as well as better understand the cerebral consequences of various therapeutic approaches. Modern neuroimaging techniques therefore provide a valuable tool to gain insight into possible pathophysiological mechanisms of sleep disorders in adult humans.

153. Crevecoeur, G., H. Hallez, P. Van Hese, Y. D'Asseler, L. Dupré, and R. Van de Walle, *EEG source analysis using space mapping techniques*. Journal of Computational and Applied Mathematics, 2008. **215**(2): p. 339-347.

Summary: The electroencephalogram (EEG) measures potential differences, generated by electrical activity in brain tissue, between scalp electrodes. The EEG potentials can be calculated by the quasi-static Poisson equation in a certain head model. It is well known that the electrical dipole (source) which best fits the measured EEG potentials is obtained by an inverse problem. The dipole parameters are obtained by finding the global minimum of the relative residual energy (RRE). For the first time, the space mapping technique (SM technique) is used for minimizing the RRE. The SM technique aims at aligning two different simulation models: a fine model, accurate but CPU-time expensive, and a coarse model, computationally fast but less accurate than the fine one. The coarse model is a semi-analytical model, the so-called three-shell concentric sphere model. The fine model numerically solves the Poisson equation in a realistic head model. If we use the aggressive space mapping (ASM) algorithm, the errors on the dipole location are too large. The hybrid aggressive space mapping (HASM) on the other hand has better convergence properties, yielding a reduction in dipole location errors. The computational effort of HASM is greater than ASM but smaller than using direct optimization techniques. © 2007 Elsevier B.V. All rights reserved.

154. Crevecoeur, G., H. Hallez, P. Van Hese, Y. D'Asseler, L. Dupré, and R. Van de Walle, *A hybrid algorithm for solving the EEG inverse problem from spatio-*

temporal EEG data. Medical and Biological Engineering and Computing, 2008. **46**(8): p. 767-777.

Summary: Epilepsy is a neurological disorder caused by intense electrical activity in the brain. The electrical activity, which can be modelled through the superposition of several electrical dipoles, can be determined in a non-invasive way by analysing the electro-encephalogram. This source localization requires the solution of an inverse problem. Locally convergent optimization algorithms may be trapped in local solutions and when using global optimization techniques, the computational effort can become expensive. Fast recovery of the electrical sources becomes difficult that way. Therefore, there is a need to solve the inverse problem in an accurate and fast way. This paper performs the localization of multiple dipoles using a global-local hybrid algorithm. Global convergence is guaranteed by using space mapping techniques and independent component analysis in a computationally efficient way. The accuracy is locally obtained by using the Recursively Applied and Projected-MUltiple Signal Classification (RAP-MUSIC) algorithm. When using this hybrid algorithm, a four times faster solution is obtained. © International Federation for Medical and Biological Engineering 2008.

155. Coutin-Churchman, P. and R. Moreno, *Intracranial current density (LORETA) differences in QEEG frequency bands between depressed and non-depressed alcoholic patients*. Clinical Neurophysiology, 2008. **119**(4): p. 948-958.

Summary: Objective: To assess possible differences in intracranial source distribution of surface QEEG power between depressed and non-depressed alcoholic patients in order to find any symptom-related topographic features of physiopathologic relevance. Methods: Low-Resolution Electromagnetic Tomography (LORETA) for the delta, theta, alpha and beta bands of EEG spectra was estimated from 38 alcoholic patients, 20 with and 18 without clinical depression, in which QEEG showed decreased slow and increased beta activity diffusely. Statistical non-parametric mapping was used to compare depressed and non-depressed groups. Measures of intracranial current density in individual patients at areas of significant differences were correlated with BDI scores. Results: Patients with clinical depression showed areas of significantly lower current density than non-depressed patients in delta band at left anterior temporal, left midtemporal (including amygdala and hippocampus), and both frontopolar cortices mostly on the right; and in theta band at bilateral parietal lobe, anterior cingulate and medial frontal cortex. No differences were found at alpha and beta band. Intracranial current density in delta band at left parahippocampal, left midfrontal cortex and right frontopolar cortex was negatively correlated with BDI score. Theta band also showed negative correlations with BDI at sites of significant differences. Conclusions: Diffusely decreased delta and theta activity in the surface QEEG of alcoholic patients has a different intracranial distribution linked to the presence or not of clinical depression that seems to reveal a dysfunctional neuronal state at several specific

limbic and other cortical locations that have been related to a specific clinical disorder such as depression. Significance: These results provided further evidence on the effects of depression in the context of alcohol dependence, in this case decreased slow activity as a possible marker of neuronal damage secondary to alcohol toxicity, clinically expressed as depressive symptoms when present in structures that are known to be related to clinical depression. © 2008 International Federation of Clinical Neurophysiology.

156. Cosandier-Rimélé, D., I. Merlet, J.M. Badier, P. Chauvel, and F. Wendling, *The neuronal sources of EEG: Modeling of simultaneous scalp and intracerebral recordings in epilepsy.* NeuroImage, 2008. **42**(1): p. 135-146.

Summary: In many applications which make use of EEG to investigate brain functions, a central question is often to relate the recorded signals to the spatio-temporal organization of the underlying neuronal sources of activity. A modeling attempt to quantitatively investigate this imperfectly known relationship is reported. The proposed plausible model of EEG generation relies on an accurate representation of the neuronal sources of activity. It combines both an anatomically realistic description of the spatial features of the sources (convoluted dipole layer) and a physiologically relevant description of their temporal activities (coupled neuronal populations). The model was used in the particular context of epileptiform activity (interictal spikes) to interpret simultaneously generated scalp and intracerebral EEG. Its integrative properties allowed for the bridging between source-related parameters (spatial extent, location, synchronization) and the properties of resulting EEG signals (amplitude of spikes, amplitude gradient along intracerebral electrodes, topography over scalp electrodes). The sensitivity of both recording modalities to source-related parameters was also studied. The model confirmed that the cortical area involved in interictal spikes is rather large. Its relative location with respect to recording electrodes was found to strongly influence the properties of EEG signals as the source geometry is a critical parameter. The influence, on simulated signals, of the synchronization degree between neuronal populations within the epileptic source was also investigated. The model revealed that intracerebral EEG can reflect epileptic activities corresponding to weak synchronization between neuronal populations of the epileptic patch. These results, as well as the limitations of the model, are discussed. © 2008 Elsevier Inc. All rights reserved.

157. Clemens, B., P. Piros, M. Bessenyei, M. Tóth, K. Hollódy, and I. Kondákor, *Imaging the cortical effect of lamotrigine in patients with idiopathic generalized epilepsy: A low-resolution electromagnetic tomography (LORETA) study.* Epilepsy Research, 2008. **81**(2-3): p. 204-210.

Summary: Purpose: Anatomical localization of the cortical effect of lamotrigine (LTG) in patients with idiopathic generalized epilepsy (IGE). Methods: 19 patients with untreated IGE were investigated. EEG was recorded in the untreated condition and 3 months later when LTG treatment abolished the seizures. 19-channel EEG was recorded, and a total of 2 min artifact-free, waking

EEG was processed to low-resolution electromagnetic tomography (LORETA) analysis. Activity (that is, current source density, A/m2) was computed in four frequency bands (delta, theta, alpha, and beta), for 2394 voxels that represented the cortical gray matter and the hippocampi. Group differences between the untreated and treated conditions were computed for the four bands and all voxels by multiple t-tests for interdependent datasets. The results were presented in terms of anatomical distribution and statistical significance. Results: $p < 0.01$ (uncorrected) changes (decrease of activity) emerged in the theta and the alpha bands. Theta activity decreased in a large cluster of voxels including parts of the temporal, parietal, occipital cortex bilaterally, and in the transverse temporal gyri, insula, hippocampus, and uncus on the right side. Alpha activity decreased in a relatively smaller cortical area involving the right temporo-parietal junction and surrounding parts of the cortex, and part of the insula on the right side. Conclusions: LTG decreased theta activity in several cortical areas where abnormally increased theta activity had been found in a prior study in another cohort of untreated IGE patients [Clemens, B., Bessenyei, M., Piros, P., Tóth, M., Seress, L., Kondákor, I., 2007b. Characteristic distribution of interictal brain electrical activity in idiopathic generalized epilepsy. Epilepsia 48, 941-949]. These LTG-related changes might be related to the decrease of seizure propensity in IGE. © 2008 Elsevier B.V. All rights reserved.

158. Clemens, B., J. Bánk, P. Piros, M. Bessenyei, S. Veto, M. Tóth, and I. Kondákor, *Three-dimensional localization of abnormal EEG activity in migraine: A low resolution electromagnetic tomography (LORETA) study of migraine patients in the pain-free interval.* Brain Topography, 2008. **21**(1): p. 36-42.

Summary: Investigating the brain of migraine patients in the pain-free interval may shed light on the basic cerebral abnormality of migraine, in other words, the liability of the brain to generate migraine attacks from time to time. Twenty unmedicated "migraine without aura" patients and a matched group of healthy controls were investigated in this explorative study. 19-channel EEG was recorded against the linked ears reference and was on-line digitized. 60 × 2-s epochs of eyes-closed, waking-relaxed activity were subjected to spectral analysis and a source localization method, low resolution electromagnetic tomography (LORETA). Absolute power was computed for 19 electrodes and four frequency bands (delta: 1.5-3.5 Hz, theta: 4.0-7.5 Hz, alpha: 8.0-12.5 Hz, beta: 13.0-25.0 Hz). LORETA "activity" (=current source density, ampers/meters squared) was computed for 2394 voxels and the above specified frequency bands. Group comparison was carried out for the specified quantitative EEG variables. Activity in the two groups was compared on a voxel-by-voxel basis for each frequency band. Statistically significant (uncorrected $P < 0.01$) group differences were projected to cortical anatomy. Spectral findings: there was a tendency for more alpha power in the migraine that in the control group in all but two (F4, C3) derivations. However, statistically significant ($P < 0.01$, Bonferroni-corrected) spectral difference was only found in the right occipital region. The main LORETA-finding was that voxels with $P < 0.01$ differences were crowded in anatomically contiguous cortical areas. Increased alpha activity was found in a cortical area including part of the precuneus, and the posterior part of the middle temporal gyrus in the right hemisphere. Decreased alpha activity was found bilaterally in medial parts of the frontal cortex including the anterior cingulate and the superior and medial frontal gyri. Neither spectral analysis, nor LORETA revealed statistically significant differences in the delta, theta, and beta bands. LORETA revealed the anatomical distribution of the cortical sources (generators) of the EEG abnormalities in migraine. The findings characterize the state of the cerebral cortex in the pain-free interval and might be suitable for planning forthcoming investigations. © 2008 Springer Science+Business Media, LLC.

159. Chiu, P.H., A.J. Holmes, and D.A. Pizzagalli, *Dissociable recruitment of rostral anterior cingulate and inferior frontal cortex in emotional response inhibition*. NeuroImage, 2008. **42**(2): p. 988-997.

Summary: The integrity of decision-making under emotionally evocative circumstances is critical to navigating complex environments, and dysfunctions in these processes may play an important role in the emergence and maintenance of various psychopathologies. The goal of the present study was to examine the spatial and temporal dynamics of neural responses to emotional stimuli and emotion-modulated response inhibition. High-density event-related brain potentials (ERPs) were measured as participants (N = 25) performed an emotional Go/NoGo task that required button presses to words of a "target" emotional valence (i.e., positive, negative, neutral) and response inhibition to words of a different "distractor" valence. Using scalp ERP analyses in conjunction with source-localization techniques, we identified distinct neural responses associated with affective salience and affect-modulated response inhibition, respectively. Both earlier (~ 300 ms) and later (~700 ms) ERP components were enhanced with successful response inhibition to emotional distractors. Only ERPs to target stimuli differentiated affective from neutral cues. Moreover, source localization analyses revealed right ventral lateral prefrontal cortex (VLPFC) activation in affective response inhibition regardless of emotional valence, whereas rostral anterior cingulate activation (rACC) was potentiated by emotional valence but was not modulated by response inhibition. This dissociation was supported by a significant Region × Trial Type × Emotion interaction, confirming that distinct regional dynamics characterize neural responses to affective valence and affective response-inhibition. The results are discussed in the context of an emerging affective neuroscience literature and implications for understanding psychiatric pathologies characterized by a detrimental susceptibility to emotional cues, with an emphasis on major depressive disorder. © 2008 Elsevier Inc. All rights reserved.

160. Chan, A.S., Y.M.Y. Han, and M.C. Cheung, *Electroencephalographic (EEG) measurements of mindfulness-based triarchic body-pathway relaxation technique: A pilot study*. Applied Psychophysiology Biofeedback, 2008. **33**(1): p. 39-47.

Summary: Objective: The "Triarchic body-pathway relaxation technique" (TBRT) is a form of ancient Chinese mindfulness-based meditation professed to give rise to positive emotions and a specific state of consciousness in which deep relaxation and internalized attention coexist. The purpose of this study was to examine the EEG pattern generated during the practice of this mindfulness exercise, and compare it to music listening which has been shown to induce positive emotions. Methods: Nineteen college students (aged 19-22 years) participated in the study. Each participant listened to both the TBRT and music audiotapes while EEG was recorded. The order of presentation was counterbalanced to avoid order effect. Two EEG indicators were used: (1) alpha asymmetry index, an indicator for left-sided anterior activation, as measure of positive emotions, and (2) frontal midline theta activity, as a measure for internalized attention. Results: Increased left-sided activation, a pattern associated with positive emotions, was found during both TBRT exercise and music conditions. However, only TBRT exercise was shown to exhibit greater frontal midline theta power, a pattern associated with internalized attention. Conclusions: These results provided evidence to support that the TBRT gives rise to positive emotional experience, accompanied by focused internalized attention. © 2008 Springer Science+Business Media, LLC.

161. Casarotto, S., A.M. Bianchi, E. Ricciardi, C. Gentili, N. Vanello, M. Guazzelli, P. Pietrini, G.A. Chiarenza, and S. Cerutti, *Spatiotemporal dynamics of single-letter reading: A combined ERP-FMRI study*. Archives Italiennes de Biologie, 2008. **146**(2): p. 83-105.

Summary: This work investigates the neural correlates of single-letter reading by combining event-related potentials (ERPs) and functional magnetic resonance imaging (fMRI), thus exploiting their complementary spatiotemporal resolutions. Three externally-paced reading tasks were administered with an event-related design: passive observation of letters and symbols and active reading aloud of letters. ERP and fMRI data were separately recorded from 8 healthy adults during the same experimental conditions. Due to the presence of artifacts in the EEG signals, two subjects were discarded from further analysis. Independent Component Analysis was applied to ERPs, after dimensionality reduction by Principal Component Analysis: some independent components were clearly related to specific reading functions and the associated current density distributions in the brain were estimated with Low Resolution Electromagnetic Tomography Analysis method (LORETA). The impulse hemodynamic response function was modeled as a linear combination of linear B-spline functions and fMRI statistical analysis was performed by multiple linear regression. fMRI and LORETA maps were superimposed in order to identify the overlapping activations and the activated regions specifically revealed by each modality. The results showed the existence of neuronal networks functionally specific for letter processing and for explicit verbal-motor articulation, including the temporo-parietal and frontal regions. Overlap between fMRI and LORETA results was observed in the inferior temporal-middle occipital gyrus, suggesting that this area has a crucial and multifunctional role for linguistic and reading processes, likely because its spatial location and strong interconnection with the main visual and auditory sensory systems may have favored its specialization in grapheme-phoneme matching.

162. Cannon, R., J. Lubar, and D. Baldwin, *Self-perception and experiential schemata in the addicted brain*. Applied Psychophysiology Biofeedback, 2008. **33**(4): p. 223-238.

Summary: This study investigated neurophysiological differences between recovering substance abusers (RSA) and controls while electroencephalogram (EEG) was continuously recorded during completion of a new assessment instrument. The participants consisted of 56 total subjects; 28 RSA and 28 non-clinical controls (C). The participants completed the self-perception and experiential schemata assessment (SPESA) and source localization was compared utilizing standardized low-resolution electromagnetic tomography (sLORETA). The data show significant differences between groups during both the assessment condition and baselines. A pattern of alpha activity as estimated by sLORETA was shown in the right amygdala, uncus, hippocampus, BA37, insular cortex and orbitofrontal regions during the SPESA condition. This activity possibly reflects a circuit related to negative perceptions of self formed in specific neural pathways. These pathways may be responsive to the alpha activity induced by many substances by bringing the brain into synchrony if only for a short time. In effect this may represent the euphoria described by substance abusers. © 2008 Springer Science+Business Media, LLC.

163. Brosch, T., D. Sander, G. Pourtois, and K.R. Scherer, *Beyond fear: Rapid spatial orienting toward positive emotional stimuli: Research article*. Psychological Science, 2008. **19**(4): p. 362-370.

Summary: There is much empirical evidence for modulation of attention by negative - particularly fear-relevant - emotional stimuli. This modulation is often explained in terms of a fear module. Appraisal theories of emotion posit a more general mechanism, predicting attention capture by stimuli that are relevant for the needs and goals of the organism, regardless of valence. To examine the brain-activation patterns underlying attentional modulation, we recorded event-related potentials from 20 subjects performing a dot-probe task in which the cues were fear-inducing and nurturance-inducing stimuli (i.e., anger faces and baby faces). Highly similar validity modulation was found for the P1 time-locked to target onset, indicating early attentional capture by both positive and negative emotional stimuli. Topographic segmentation analysis and source localization indicate that the same amplification process is involved whether attention orienting is triggered by negative, fear-relevant stimuli or positive, nurturance-relevant stimuli. These results confirm that biological relevance, and not exclusively fear, produces an automatic spatial orienting toward the location of a stimulus. Copyright © 2008 Association for Psychological Science.

164. Brookes, M.J., K.J. Mullinger, C.M. Stevenson, P.G. Morris, and R. Bowtell, *Simultaneous EEG source localisation and artifact rejection during concurrent fMRI by means of spatial filtering*. NeuroImage, 2008. **40**(3): p. 1090-1104.

Summary: The simultaneous application of functional MRI and EEG represents an attractive, non-invasive technique for the combined measurement of electrical and haemodynamic activity in the human brain. Simultaneous EEG/fMRI provides a brain imaging modality with millimeter spatial accuracy, and millisecond temporal resolution. However, simultaneously acquired measurements are difficult due to the artifacts that are induced in the EEG by both the temporally varying field gradients used in MRI, and also blood flow effects. In this paper we apply an EEG beamformer spatial filter to EEG data recorded simultaneously with fMRI. We show, using this technique, that it is possible to localise accurately electrical effects in the brain, and that the localisation of driven oscillatory responses in the human visual cortex are spatially co-incident with the fMRI BOLD response. We also show how the beamformer can be used to extract timecourses of electrical activity from areas of interest in the brain. Such timecourses have millisecond time resolution. Finally, we show that in addition to source localisation, the beamformer spatial filter acts to reject interference in EEG signals, thus increasing the effective signal to noise ratio of electrical measurements. We show that the EEG-beamformer can eliminate effectively the ballistocardiogram artifact as well as residual gradient artifacts that remain in EEG data following correction using averaged artifact subtraction techniques. © 2008.

165. Boyle, Y., W. El-Deredy, E. Martínez Montes, D.E. Bentley, and A.K.P. Jones, *Selective modulation of nociceptive processing due to noise distraction*. Pain, 2008. **138**(3): p. 630-640.

Summary: This study investigates the effects of noise distraction on the different components and sources of laser-evoked potentials (LEPs) whilst attending to either the spatial component (localisation performance task) or the affective component (unpleasantness rating task) of pain. LEPs elicited by CO2 laser stimulation of the right forearm were recorded from 64 electrodes in 18 consenting healthy volunteers. Subjects reported either pain location or unpleasantness, in the presence and absence of distraction by continuous 85 dBa white noise. Distributed sources of the LEP peaks were identified using Low Resolution Electromagnetic Tomography (LORETA). Pain unpleasantness ratings and P2 (430 ms) peak amplitude were significantly reduced by distraction during the unpleasantness task, whereas the localisation ability and the corresponding N1/N2 (310 ms) peak amplitude remained unchanged. Noise distraction (at 310 ms) reduced activation in the anterior cingulate cortex (ACC) and precuneus during attention to localisation and unpleasantness, respectively. This suggests a complimentary role for these two areas in the control of attention to pain. In contrast, activation of the occipital pole and SII were enhanced by noise during the localisation and unpleasantness task, respectively, suggesting that the presence of noise was associated with increased spatial attentional load.

This study has shown selective modulation of affective pain processing by noise distraction, indicated by a reduction in the unpleasantness ratings and P2 peak amplitude and associated activity within the medial pain system. These results show that processing of the affective component of pain can be differentially modulated by top-down processes, providing a potential mechanism for therapeutic intervention. © 2008 International Association for the Study of Pain.

166. Blum, J., K. Lutz, R. Pascual-Marqui, K. Murer, and L. Jäncke, *Coherent intracerebral brain oscillations during learned continuous tracking movements*. Experimental Brain Research, 2008. **185**(3): p. 443-451.

Summary: The aim of the present study was to assess changes in electroencephalogram (EEG) phase locking between fronto-parietal areas, including the frontal and parietal motor areas, during audiomotor learning of continuous tracking movements. Subjects learned to turn a steering wheel according to a given trajectory in order to minimise the discrepancy between a changing foreground stimulus (controllable by the subjects) and a constant background stimulus. The results of the present study show that increasing practice of continuous tracking movements that are continuously performed in the presence of auditory feedback is not accompanied by decrease in phase locking between areas involved. Moreover, the study confirms that internally produced movements show enhanced coherent activities compared to externally guided movements and therefore suggests that the motor-parietal network is more engaged during internally produced than externally produced movements. © 2007 Springer-Verlag.

167. Bellebaum, C. and I. Daum, *Learning-related changes in reward expectancy are reflected in the feedback-related negativity*. European Journal of Neuroscience, 2008. **27**(7): p. 1823-1835.

Summary: The feedback-related negativity (FRN) has been hypothesized to be linked to reward-based learning. While many studies have shown that the FRN only occurs in response to unexpected negative outcomes, the relationship between the magnitude of negative prediction errors and FRN amplitude remains a matter of debate. The present study aimed to elucidate this relationship with a new behavioural procedure that allowed subjects to predict precise reward probabilities by learning an explicit rule. Insight into the rule did not only influence subjects' choice behaviour, but also outcome-related event-related potentials. After subjects had learned the rule, the FRN amplitude difference between non-reward and reward mirrored the magnitude of the negative prediction error, i.e. it was larger for less likely negative outcomes. Source analysis linked this effect to the anterior cingulate cortex. P300 amplitude was also modulated by outcome valence and expectancy. It was larger for positive and unexpected outcomes. It remains to be clarified, however, whether the P300 reflects a positive prediction error. © The Authors (2008).

168. Beeli, G., M. Esslen, and L. Jäncke, *Time course of neural activity correlated with colored-hearing synesthesia*. Cerebral Cortex, 2008. **18**(2): p. 379-385.

Summary: Synesthesia is defined as the involuntary and automatic perception of a stimulus in 2 or more sensory modalities (i.e., cross-modal linkage). Colored-hearing synesthetes experience colors when hearing tones or spoken utterances. Based on event-related potentials we employed electric brain tomography with high temporal resolution in colored-hearing synesthetes and nonsynesthetic controls during auditory verbal stimulation. The auditory-evoked potentials to words and letters were different between synesthetes and controls at the N1 and P2 components, showing longer latencies and lower amplitudes in synesthetes. The intracerebral sources of these components were estimated with low-resolution brain electromagnetic tomography and revealed stronger activation in synesthetes in left posterior inferior temporal regions, within the color area in the fusiform gyrus (V4), and in orbitofrontal brain regions (ventromedial and lateral). The differences occurred as early as 122 ms after stimulus onset. Our findings replicate and extend earlier reports with functional magnetic resonance imaging and positron emission tomography in colored-hearing synesthesia and contribute new information on the time course in synesthesia demonstrating the fast and possibly automatic processing of this unusual and remarkable phenomenon. © 2007 The Authors.

169. Baumann, S., M. Meyer, and L. Jäncke, *Enhancement of auditory-evoked potentials in musicians reflects an influence of expertise but not selective attention*. Journal of Cognitive Neuroscience, 2008. **20**(12): p. 2238-2249.

Summary: Instrumental tones and, in some instances, simple sine-wave tones were shown to evoke stronger auditory-evoked responses in musicians compared to nonmusicians. This effect was taken as an example for plasticity in the auditory cortex elicited by training. To date, however, it is unknown whether an enlarged cortical representation for (instrumental) tones or increased neuronal activity provoked by focused attention in musicians accounts for the reported difference. In an attempt to systematically investigate the influence of attention on the processing of simple sine wave and instrumental tones, we compared auditory-evoked potentials recorded from musicians and nonmusicians. During the electroencephalogram recording, the participants were involved in tasks requiring selective attention to specific sound features such as pitch or timbre. Our results demonstrate that the effect of selective attention on the auditory event-related potential (AEP) has a different time course and shows a different topography than the reproduced effect of music expertise at the N1 component or the previously demonstrated effect at the P2 component. N1 peak potentials were unaffected by attention modulation. These results indicate that the effect of music expertise, which was traced by current density mapping to the auditory cortex, is not primarily caused by selective attention, and it supports the view that increased AEPs on tones in musicians reflect an enlarged neuronal representation for specific sound features of these tones. However, independent

from the N1-P2 complex, attention evoked an Nd-like negative component in musicians but not in nonmusicians, which suggests that plasticity also affects top-down processes. © 2008 Massachusetts Institute of Technology.

170. Barbati, G., C. Porcaro, A. Hadjipapas, P. Adjamian, V. Pizzella, G.L. Romani, S. Seri, F. Tecchio, and G.R. Barnes, *Functional source separation applied to induced visual gamma activity*. Human Brain Mapping, 2008. **29**(2): p. 131-141.

Summary: Objective of this work was to explore the performance of a recently introduced source extraction method, FSS (Functional Source Separation), in recovering induced oscillatory change responses from extra-cephalic magnetoencephalographic (MEG) signals. Unlike algorithms used to solve the inverse problem, FSS does not make any assumption about the underlying biophysical source model; instead, it makes use of task-related features (functional constraints) to estimate source/s of interest. FSS was compared with blind source separation (BSS) approaches such as Principal and Independent Component Analysis, PCA and ICA, which are not subject to any explicit forward solution or functional constraint, but require source uncorrelatedness (PCA), or independence (ICA). A visual MEG experiment with signals recorded from six subjects viewing a set of static horizontal black/white square-wave grating patterns at different spatial frequencies was analyzed. The beamforming technique Synthetic Aperture Magnetometry (SAM) was applied to localize task-related sources; obtained spatial filters were used to automatically select BSS and FSS components in the spatial area of interest. Source spectral properties were investigated by using Morlet-wavelet time-frequency representations and significant task-induced changes were evaluated by means of a resampling technique; the resulting spectral behaviours in the gamma frequency band of interest (20-70 Hz), as well as the spatial frequency-dependent gamma reactivity, were quantified and compared among methods. Among the tested approaches, only FSS was able to estimate the expected sustained gamma activity enhancement in primary visual cortex, throughout the whole duration of the stimulus presentation for all subjects, and to obtain sources comparable to invasively recorded data. © 2007 Wiley-Liss, Inc.

171. Anderer, P., B. Saletu, M. Wolzt, S. Culic, A. Assandri, F. Nannipieri, S. Rosini, and G.M. Saletu-Zyhlarz, *Double-blind, placebo-controlled, multiple-ascending-dose study on the effects of ABIO-08/01, a novel anxiolytic drug, on perception and cognition, utilizing event-related potential mapping and low-resolution brain electromagnetic tomography*. Human Psychopharmacology, 2008. **23**(3): p. 243-254.

Summary: Early pharmacological studies in animals demonstrated that ABIO-08/01, a new isoxazoline, exerted anxiolytic and anticonvulsant, but also cognition-enhancing properties. Thus, the aim of the present double-blind, placebo-controlled multiple-ascending-dose study was to investigate the effect of the new compound on event-related potentials (ERPs). In a randomized ascending-dose design for phase-1 studies, 16 young healthy male subjects aged 30.2 ± 5.7 years received three ascending drug doses (10, 20, and 40 mg) and placebo for 7 days, with a washout period of 8 days in between. Auditory ERPs were recorded pre-dose and 2 h post-dose on days 1 (acute effect) and 5 (subacute and absolute superimposed effect). Descriptive statistics with one confirmatory statement on P300 latency demonstrated a significant shortening after acute, subacute, and superimposed administration of 40 mg ABIO-08/01. While ERP amplitudes showed only minor effects, low-resolution brain electromagnetic tomography (LORETA) demonstrated that ABIO-08/01 promotes more efficient information processing by reallocating perceptual and cognitive ERP resources. Thus, our ERP studies confirm early pharmacological findings in animals of a cognition-enhancing effect of ABIO-08/01, which is interesting in the context of the anxiolytic mode of action of the compound as its CNS effects are quite different from those of anxiolytic sedatives, such as Copyright © 2008 john Wiley & Sons, Ltd.

172. Alper, K., M. Raghavan, R. Isenhart, B. Howard, W. Doyle, R. John, and L. Prichep, *Localizing epileptogenic regions in partial epilepsy using three-dimensional statistical parametric maps of background EEG source spectra*. NeuroImage, 2008. **39**(3): p. 1257-1265.

Summary: This preliminary study sought to localize epileptogenic regions in patients with partial epilepsy by analysis of interictal EEG activity utilizing variable resolution electromagnetic tomography (VARETA), a three-dimensional quantitative electroencephalographic (QEEG) frequency-domain distributed source modeling technique. The very narrow band (VNB) spectra spanned the frequency range 0.39 Hz to 19.1 Hz, in 0.39 Hz steps. These VNB spectra were compared to normative data and transformed to provide Z-scores for every scalp derivation, and the spatial distributions of the probable EEG generators of the most abnormal values were displayed on slices from a probabilistic MRI atlas. Each voxel was color-coded to represent the significance of the deviation relative to age appropriate normative values. We compared the resulting three-dimensional images to the localization of epileptogenic regions based on invasive intracranial EEG recordings of seizure onsets. The VARETA image indicated abnormal interictal spectral power values in regions of seizure onset identified by invasive monitoring, mainly in delta and theta range (1.5 to 8.0 Hz). The VARETA localization of the most abnormal voxel was congruent with the epileptogenic regions identified by intracranial recordings with regard to hemisphere in all 6 cases, and with regard to lobe in 5 cases. In contrast, abnormal findings with routine EEG agreed with invasive monitoring with regard to hemisphere in 3 cases and with regard to lobe in 2 cases. These results suggest that analysis of background interictal EEG utilizing distributed source models should be investigated further in clinical epilepsy. © 2007 Elsevier Inc. All rights reserved.

173. Alhaj, H.A., A.E. Massey, and R.H. McAllister-Williams, *Effects of cortisol on the laterality of the neural correlates of episodic memory*. Journal of Psychiatric Research, 2008. **42**(12): p. 971-981.

Summary: Alterations in the laterality of cortical activity have been shown in depressive illnesses. One possible pathophysiological mechanism for this is an effect of corticosteroids. We have previously demonstrated that endogenous cortisol concentrations correlate with the asymmetry of cortical activity related to episodic memory in healthy subjects and depressed patients. To further-examine whether this is due to a causal effect of cortisol on the laterality of episodic memory, we studied the effect of exogenous administration of cortisol in healthy subjects. Twenty-three right-handed healthy male volunteers were tested in a double-blind cross-over study. Event-related potentials (ERPs) were recorded during an episodic memory task following a four-day course of 160 mg/day cortisol or placebo. Low-resolution brain electromagnetic tomography (LORETA) was used to identify brain regions involved in the neurocognitive task. Cortisol levels were measured in saliva samples. ERP and LORETA analysis following placebo demonstrated significant left parahippocampal activation associated with successful retrieval. Cortisol led to a decrease in the mean early frontal ERP voltage and an increase in the late right ERP voltage. LORETA suggested this to be due to a significant increased late activation of the right superior frontal gyrus. There was no significant effect of cortisol on episodic memory performance. This study suggests that exogenous cortisol leads to more positive-going waveforms over the right than the left hemisphere, possibly due to increased monitoring of the products of retrieval. The results support the hypothesis of causal effects of cortisol on the laterality of cortical activity occurring during an episodic memory task. © 2007 Elsevier Ltd. All rights reserved.

174. Abe, T., K. Ogawa, H. Nittono, and T. Hori, *Neural generators of brain potentials before rapid eye movements during human REM sleep: A study using sLORETA*. Clinical Neurophysiology, 2008. **119**(9): p. 2044-2053.

Summary: Objective: Brain activity preceding rapid eye movements (REM) during human REM sleep has remained poorly understood. Slow negative brain potential (pre-REM negativity) appears before REMs. Current sources of this potential were investigated to identify brain activity immediately preceding REMs. Methods: In this study, 22 young healthy volunteers (20-25 years old) participated. Polysomnograms were recorded during normal nocturnal sleep. Brain potentials between 200 ms before and 50 ms after the onset of REMs and pseudo-triggers (3000 ms before the onset of REMs) were averaged. Standardized low-resolution brain electromagnetic tomography (sLORETA) was used to estimate current sources of pre-REM negativity. Results: Pre-REM negativity appeared with the maximal amplitude at right prefrontal sites immediately before REMs. However, this negativity did not appear before pseudo-triggers. Current sources of the pre-REM negativity were estimated in the ventromedial prefrontal cortex, uncus, insula, anterior cingulated cortex, basal forebrain, parahippocampal gyrus, premotor cortex and frontal eye field.

Conclusions: The pre-REM negativity reflects brain activity coupled with the occurrence of REMs. Results of this study suggest that emotion, memory, and motor-related brain activity might occur before REMs. Significance: Pre-REM negativity is expected to be a psychophysiological index for elucidating functions of REM sleep. © 2008 International Federation of Clinical Neurophysiology.

175. Zouch, W., R. Khemakhem, J. Boughariou, A. Taleb-Ahmed, I. Feki, A.B. Hamida, and P. Derambure, *Combining WMN and FOCUSS recursive approach to estimating the current density distribution in the brain*. Annual International Conference of the IEEE Engineering in Medicine and Biology - Proceedings, 2007: p. 598-601.

Summary: In this paper we present a new approach which combines the two methods of cerebral electric activity's localization: "Weighted Minimum Norm" (WMN) and the iterative method "FOCal Underdetermined System Solver" (FOCUSS). Our idea is to use the current density distribution estimated by the WMN method in order to initialize the weighting matrix necessary for the localization with FOCUSS method. We compare the found results with those of the traditional WMN and FOCUSS methods in term of computing time and resolution matrix. The presented results show that our approach gives a good localization of the active sources in the brain. © 2007 IEEE.

176. Zöllig, J., R. West, M. Martin, M. Altgassen, U. Lemke, and M. Kliegel, *Neural correlates of prospective memory across the lifespan*. Neuropsychologia, 2007. **45**(14): p. 3299-3314.

Summary: Overview: Behavioural data reveal an inverted U-shaped function in the efficiency of prospective memory from childhood to young adulthood to later adulthood. However, prior research has not directly compared processes contributing to age-related variation in prospective memory across the lifespan, hence it is unclear whether the same factors explain the 'rise and fall' of prospective remembering from childhood to later adulthood. The present study examined this question using a paradigm that allowed us to consider the behavioural and neural correlates of processes associated with the prospective and retrospective components of prospective memory. Methods: We compared 14 adolescents, 14 young adults, and 14 old adults in a paradigm where the prospective memory task was embedded in a semantic categorization task. Results: The behavioural data revealed an inverted U-shaped function with adolescents and old adults performing poorly relative to young adults. Analyses of the error data revealed that different processes may have contributed to failures of prospective memory in adolescents and older adults. This finding was supported by age differences in ERP-components for cue detection and post-retrieval processes. Additionally, source localization using LORETA revealed different patterns of neural recruitment for adolescents and older adults relative to younger adults. Conclusion: Our findings demonstrate that adolescents and older adults show different patterns of behavioural errors and neural recruitment for successful prospective remembering indicating that different processes may contribute to the 'rise and fall' of prospective memory across the lifespan. © 2007 Elsevier Ltd. All rights reserved.

177. Zhang, Y., U. Hauser, C. Conty, H.M. Emrich, and D.E. Dietrich, *Familial risk for depression and P3b component as a possible neurocognitive vulnerability marker*. Neuropsychobiology, 2007. **55**(1): p. 14-20.

Summary: Objective: Complex genetic mechanisms are involved in the vulnerability to depressive disorders and cognitive dysfunctions found in depression. This study was performed to explore the effect of the familial risk for depression on electrophysiological correlates of attentional functions as demonstrated by an event-related potential (ERP) go/no-go experiment. Methods: The component P3b as an indicator of target detection processing was investigated in two groups of healthy subjects with or without a family history of depression (n = 14 each). An electrophysiological source localization method (LORETA) was employed to allow a neuro-anatomical interpretation for the ERP data. Results: The group with a familial risk for depression showed a reduced P3b amplitude over left temporal areas in contrast to the control group. This two-dimensional effect was associated with a significantly reduced activation of the left middle temporal gyrus. Conclusions: The P3b amplitude decrement might represent a neurocognitive vulnerability marker for the development of depression. Copyright © 2007 S. Karger AG.

178. Zhang, J., T. Guo, Y. Xu, X. Zhao, and L. Yao, *Spatiotemporal patterns of ERP based on combined ICA-LORETA analysis*. Progress in Biomedical Optics and Imaging - Proceedings of SPIE, 2007. **6511**(PART 2).

Summary: In contrast to the FMRI methods widely used up to now, this method try to understand more profoundly how the brain systems work under sentence processing task map accurately the spatiotemporal patterns of activity of the large neuronal populations in the human brain from the analysis of ERP data recorded on the brain scalp. In this study, an event-related brain potential (ERP) paradigm to record the on-line responses to the processing of sentences is chosen as an example. In order to give attention to both utilizing the ERPs' temporal resolution of milliseconds and overcoming the insensibility of cerebral location ERP sources, we separate these sources in space and time based on a combined method of independent component analysis (ICA) and low-resolution tomography (LORETA) algorithms. ICA blindly separate the input ERP data into a sum of temporally independent and spatially fixed components arising from distinct or overlapping brain or extra-brain sources. And then the spatial maps associated with each ICA component are analyzed, with use of LORETA to uniquely locate its cerebral sources throughout the full brain according to the assumption that neighboring neurons are simultaneously and synchronously activated. Our results show that the cerebral computation mechanism underlies content words reading is mediated by the orchestrated activity of several spatially distributed brain sources located in the temporal, frontal, and parietal areas, and activate at distinct time intervals and are grouped into different statistically independent components. Thus ICA-LORETA analysis provides an encouraging and effective method to study brain dynamics from ERP.

179. Zaehle, T., L. Jancke, and M. Meyer, *Electrical brain imaging evidences left auditory cortex involvement in speech and non-speech discrimination based on temporal features*. Behavioral and Brain Functions, 2007. **3**.

Summary: Background: Speech perception is based on a variety of spectral and temporal acoustic features available in the acoustic signal. Voice-onset time (VOT) is considered an important cue that is cardinal for phonetic perception. Methods: In the present study, we recorded and compared scalp auditory evoked potentials (AEP) in response to consonant-vowel-syllables (CV) with varying voice-onset-times (VOT) and non-speech analogues with varying noise-onset-time (NOT). In particular, we aimed to investigate the spatio-temporal pattern of acoustic feature processing underlying elemental speech perception and relate this temporal processing mechanism to specific activations of the auditory cortex. Results: Results show that the characteristic AEP waveform in response to consonant-vowel-syllables is on a par with those of non-speech sounds with analogue temporal characteristics. The amplitude of the N1a and N1b component of the auditory evoked potentials significantly correlated with the duration of the VOT in CV and likewise, with the duration of the NOT in non-speech sounds. Furthermore, current density maps indicate overlapping supratemporal networks involved in the perception of both speech and non-speech sounds with a bilateral activation pattern during the N1a time window and leftward asymmetry during the N1b time window. Elaborate regional statistical analysis of the activation over the middle and posterior portion of the supratemporal plane (STP) revealed strong left lateralized responses over the middle STP for both the N1a and N1b component, and a functional leftward asymmetry over the posterior STP for the N1b component. Conclusion: The present data demonstrate overlapping spatio-temporal brain responses during the perception of temporal acoustic cues in both speech and non-speech sounds. Source estimation evidences a preponderant role of the left middle and posterior auditory cortex in speech and non-speech discrimination based on temporal features. Therefore, in congruency with recent fMRI studies, we suggest that similar mechanisms underlie the perception of linguistically different but acoustically equivalent auditory events on the level of basic auditory analysis. © 2007 Zaehle et al; licensee BioMed Central Ltd.

180. Yoshimura, M., T. Koenig, S. Irisawa, T. Isotani, K. Yamada, M. Kikuchi, G. Okugawa, T. Yagyu, T. Kinoshita, W. Strik, and T. Dierks, *A pharmaco-EEG study on antipsychotic drugs in healthy volunteers*. Psychopharmacology, 2007. **191**(4): p. 995-1004.

Summary: Rationale: Both psychotropic drugs and mental disorders have typical signatures in quantitative electroencephalography (EEG). Previous studies found that some psychotropic drugs had EEG effects opposite to the EEG effects of the mental disorders treated with these drugs (key-lock principle). Objectives: We performed a placebo-controlled pharmaco-EEG study on two conventional antipsychotics (chlorpromazine and haloperidol) and four atypical antipsychotics (olanzapine, perospirone, quetiapine, and risperidone) in healthy volunteers. We investigated differences between conventional and atypical drug effects and whether the drug effects were compatible with the key-lock principle. Methods: Fourteen subjects underwent seven EEG recording sessions, one for each drug (dosage equivalent of 1 mg haloperidol). In a time-domain analysis, we quantified the EEG by identifying clusters of transiently stable EEG topographies (microstates). Frequency-domain analysis used absolute power across electrodes and the location of the center of gravity (centroid) of the spatial distribution of power in different frequency bands. Results: Perospirone increased duration of a microstate class typically shortened in schizophrenics. Haloperidol increased mean microstate duration of all classes, increased alpha 1 and beta 1 power, and tended to shift the beta 1 centroid posterior. Quetiapine decreased alpha 1 power and shifted the centroid anterior in both alpha bands. Olanzapine shifted the centroid anterior in alpha 2 and beta 1. Conclusions: The increased microstate duration under perospirone and haloperidol was opposite to effects previously reported in schizophrenic patients, suggesting a key-lock mechanism. The opposite centroid changes induced by olanzapine and quetiapine compared to haloperidol might characterize the difference between conventional and atypical antipsychotics. © 2007 Springer-Verlag.

181. Yildiz, G., A.D. Duru, A. Ademoglu, and T. Demiralp, *Bayesian EEG dipole source localization using SA-RJMCMC on realistic head model*. Annual International Conference of the IEEE Engineering in Medicine and Biology - Proceedings, 2007: p. 4268-4272.

Summary: In this study, electroencephalography (EEG) inverse problem is formulated using Bayesian inference. The posterior probability distribution of current sources is sampled by Markov Chain Monte Carlo (MCMC) methods. Sampling algorithm is designed by combining Reversible Jump (RJ) which permits trans-dimensional iterations and Simulated Annealing (SA), a heuristic to escape from local optima. Two different approaches to EEG inverse problem, Equivalent Current Dipole (ECD) and Distributed Linear Imaging (DLI) are combined in terms of probability. EEG inverse problem is solved with this probabilistic approach using simulated data on a realistic head model. Localization errors are computed. Comparing to Multiple Signal Classification algorithm (MUSIC) and Low-Resolution Electromagnetic Tomography (LORETA), using MCMC methods with a Bayesian approach is useful for solving the EEG inverse problem. © 2007 IEEE.

182. Xu, P., Y. Tian, H. Chen, and D. Yao, *Lp norm iterative sparse solution for EEG source localization*. IEEE Transactions on Biomedical Engineering, 2007. **54**(3): p. 400-409.

Summary: How to localize the neural electric activities effectively and precisely from the scalp EEG recordings is a critical issue for clinical neurology and cognitive neuroscience. In this paper, based on the spatial sparse assumption of

brain activities, proposed is a novel iterative EEG source imaging algorithm, Lp norm iterative sparse solution (LPISS). In LPISS, the lp($p \leq 1$) norm constraint for sparse solution is integrated into the iterative weighted minimum norm solution of the underdetermined EEG inverse problem, and it is the constraint and the iteratively renewed weight that forces the inverse problem to converge to a sparse solution effectively. The conducted simulation studies with comparison to LORETA and FOCUSS for various dipoles configurations confirmed the validation of LPISS for sparse EEG source localization. Finally, LPISS was applied to a real evoked potential collected in a study of inhibition of return (IOR), and the result was consistent with the previously suggested activated areas involved in an IOR process. © 2007 IEEE.

183. Whitford, T.J., C.J. Rennie, S.M. Grieve, C.R. Clark, E. Gordon, and L.M. Williams, *Brain maturation in adolescence: Concurrent changes in neuroanatomy and neurophysiology*. Human Brain Mapping, 2007. **28**(3): p. 228-237.

Summary: Adolescence to early adulthood is a period of dramatic transformation in the healthy human brain. However, the relationship between the concurrent structural and functional changes remains unclear. We investigated the impact of age on both neuroanatomy and neurophysiology in the same healthy subjects (n = 138) aged 10 to 30 years using magnetic resonance imaging (MRI) and resting electroencephalography (EEG) recordings. MRI data were segmented into gray and white matter images and parcellated into large-scale regions of interest. Absolute EEG power was quantified for each lobe for the slow-wave, alpha and beta frequency bands. Gray matter volume was found to decrease across the age bracket in the frontal and parietal cortices, with the greatest change occurring in adolescence. EEG activity, particularly in the slow-wave band, showed a similar curvilinear decline to gray matter volume in corresponding cortical regions. An inverse pattern of curvilinearly increasing white matter volume was observed in the parietal lobe. We suggest that the reduction in gray matter primarily reflects a reduction of neuropil, and that the corresponding elimination of active synapses is responsible for the observed reduction in EEG power. © 2006 Wiley-Liss, Inc.

184. Volpe, U., A. Mucci, P. Bucci, E. Merlotti, S. Galderisi, and M. Maj, *The cortical generators of P3a and P3b: A LORETA study*. Brain Research Bulletin, 2007. **73**(4-6): p. 220-230.

Summary: The P3 is probably the most well known component of the brain event-related potentials (ERPs). Using a three-tone oddball paradigm two different components can be identified: the P3b elicited by rare target stimuli and the P3a elicited by the presentation of rare non-target stimuli. Although the two components may partially overlap in time and space, they have a different scalp topography suggesting different neural generators. The present study is aimed at defining the scalp topography of the two P3 components by means of reference-independent methods and identifying their electrical cortical generators by using the low-resolution electromagnetic tomography (LORETA). ERPs were recorded during a three-tone oddball task in 32 healthy, right-handed university students. The scalp topography of the P3 components was assessed by means of the brain electrical microstates technique and their cortical sources were evaluated by LORETA. P3a and P3b showed different scalp topography and cortical sources. The P3a electrical field had a more anterior distribution as compared to the P3b and its generators were localized in cingulate, frontal and right parietal areas. P3b sources included bilateral frontal, parietal, limbic, cingulate and temporo-occipital regions. Differences in scalp topography and cortical sources suggest that the two components reflect different neural processes. Our findings on cortical generators are in line with the hypothesis that P3a reflects the automatic allocation of attention, while P3b is related to the effortful processing of task-relevant events. © 2007 Elsevier Inc. All rights reserved.

185. Vandervert, L.R., P.H. Schimpf, and H. Liu, *How Working Memory and the Cerebellum Collaborate to Produce Creativity and Innovation*. Creativity Research Journal, 2007. **19**(1): p. 1-18.

Summary: It is proposed that (a) creativity and innovation are the result of continuously repetitive processes of working memory that are learned as cognitive control models in the cerebellum, (b) that these cerebellar control models consist of multiple-paired predictor (forward) models within the MOdular Selection and Identification for Control (MOSAIC) and hierarchical MOSAIC (HMOSAIC) cerebellar architectures that explore and test problem-solving requirements, and (c) when resulting newly formed predictor/controller models are fed forward to more efficiently control the operations of working memory, they lead to creative and innovative problem solving (including the experiences of "insight" and "intuition"). Within this framework, three of Einstein's classic autobiographical accounts of creative discovery are analyzed. It is concluded that the working memory/cerebellar explanation of creativity and innovation can begin to tie together: (1) behavioral and neuroimaging studies of working memory, (2) behavioral, clinical and neuroimaging studies of the cognitive functions of the cerebellum, and (3) autobiographical accounts of creativity. It is suggested that newly developed electromagnetic inverse techniques will be a necessary complement to functional brain imaging studies to further establish the validity of the theory. Copyright © 2007 by Lawrence Erlbaum Associates, Inc.

186. Van Leeuwen, T., P. Been, M. Van Herten, F. Zwarts, B. Maassen, and A. Van Der Leij, *Cortical categorization failure in 2-month-old infants at risk for dyslexia*. NeuroReport, 2007. **18**(9): p. 857-861.

Summary: Cortical auditory categorization was assessed in 2-month-old infants at genetic risk for dyslexia and controls. Manipulated /bAk/ and /dAk/ speech stimuli were used as frequently presented standards. The neuroelectric brain responses of the control infants were highly sensitive to the phoneme boundary that separated these stimuli, but the infants at risk showed no signs of cortical categorical perception. Cortical sources of the responses were predominantly

found in the left hemisphere for the control infants, but mainly in the right hemisphere for the infants at risk. The results demonstrate that impaired categorical perception in dyslexia is already present in infants at risk for the disorder. © 2007 Lippincott Williams & Wilkins, Inc.

187. Van De Heyning, P., P. Lefebvre, and D. De Ridder, *Tinnitus: From cochlear to cortical*. B-ENT, 2007. **3**(SUPPL. 7): p. 1-2.

Summary:

188. Tzur, G. and A. Berger, *When things look wrong: Theta activity in rule violation*. Neuropsychologia, 2007. **45**(13): p. 3122-3126.

Summary: A violation of a rule or expectation is known to evoke a phasic negative potential over the medial frontal cortex. This electrophysiological effect has been shown for incorrect mathematical equations and incongruent words at the end of sentences. The cognitive processes elicited in rule violation seem to involve violation of expectation, error detection, and conflict between competing cognitions. Consistent with the conceptual relation between rule violation and error/conflict detection, rule violation conditions should involve a power increase in the theta frequency band involving the anterior cingulate cortex (ACC). The present study verifies the connection between rule violation and theta activity using a wavelet analysis. Moreover, low resolution brain electromagnetic tomography (LORETA) source localization connects this theta activity to the ACC. Furthermore, the results show that theta activity is sensitive to the salience of the violation, that is, the degree of deviation of the conflicting/erroneous stimulus from the correct (expected) one. © 2007 Elsevier Ltd. All rights reserved.

189. Tucker, D.M., M. Brown, P. Luu, and M.D. Holmes, *Discharges in ventromedial frontal cortex during absence spells*. Epilepsy and Behavior, 2007. **11**(4): p. 546-557.

Summary: Neural mechanisms of conscious attention require thalamic control of widespread cortical networks. Absence spells involve a momentary loss of voluntary control of attention, during which the person is inactive and unresponsive. The spike-wave seizure discharges of these spells rapidly engage both cerebral hemispheres in the classic sign of a "generalized" seizure. Animal evidence suggests that spike-wave seizures are caused by a disruption of thalamic circuitry, with extensive spread to cortex through thalamocortical propagation. We applied advanced methods of electrical source analysis to dense array (256-channel) electroencephalographic recordings of spike-wave discharges of absence spells. Neither the onset nor the spread of these seizures is generalized. Rather, the slow waves of the discharges are restricted to frontotemporal networks, and the spikes represent a highly localized and stereotyped progression of electrophysiological activity in ventromedial frontal networks. Given the current knowledge of the neurophysiology of absence seizures, this specificity of the

frontal cortical discharges suggests the hypothesis that absence spells are associated with pathology in a circuit comprising ventromedial frontal cortex, rostral thalamic reticular nucleus, and limbic nuclei of the thalamus. Disrupted in absence, this circuit appears to regulate important aspects of the voluntary control of conscious attention. © 2007 Elsevier Inc. All rights reserved.

190. Toth, M., A. Kiss, P. Kosztolanyi, and I. Kondakor, *Diurnal alterations of brain electrical activity in healthy adults: A LORETA study*. Brain Topography, 2007. **20**(2): p. 63-76.

Summary: EEG background activity was investigated by low resolution brain electromagnetic tomography (LORETA) to test the diurnal alterations of brain electrical activity in healthy adults. Fourteen right-handed healthy male postgraduate medical students were examined four times (8 a.m., 2 p.m., 8 p.m. and next day 2 p.m.). LORETA was computed to localize generators of EEG frequency components. Comparing the EEG activity between 2 p.m. and 8 a.m., increased activity was seen (1) in theta band (6.5-8 Hz) in the left prefrontal, bilateral mesial frontal and anterior cingulate cortex; (2) in alpha2 band (10.5-12 Hz) in the bilateral precuneus and posterior parietal cortex as well as in the right temporo-occipital cortex; (3) in beta1-2-3 band (12.5-30 Hz) in the right hippocampus and parieto-occipital cortex, left frontal and bilateral cingulate cortex. Comparing the brain activity between 8 p.m. and 8 a.m., (1) midline theta activity disappeared; (2) increased alpha2 band activity was seen in the left hemisphere (including the left hippocampus); and (3) increased beta bands activity was found over almost the whole cortex (including both of hippocampi) with the exception of left temporo-occipital region. There were no significant changes between the background activities of 2 p.m. and next day 2 p.m. Characteristic distribution of increased activity of cortex (no change in delta band, and massive changes in the upper frequency bands) may mirror increasing activation of reticular formation and thus evoked thalamocortical feedback mechanisms as a sign of maintenance of arousal. © 2007 Springer Science+Business Media, LLC.

191. Stančák, A., H. Poláček, J. Vrána, and J. Mlynář, *Cortical oscillatory changes during warming and heating in humans*. Neuroscience, 2007. **147**(3): p. 842-852.

Summary: Warmth and heat are registered by different types of cutaneous receptors. To disentangle the cortical activation patterns of warming and heating, we analyzed the temporal evolution of the electroencephalographic 10 and 20 Hz oscillations with the time resolution of hundreds of milliseconds. Sixty heat (from 32 to 50.5 °C, rate of change 6 °C/s) and warm (from 32 to 42 °C, 6 °C/s) stimuli were applied on the right thenar using contact thermode. EEG was recorded from 111 scalp electrodes in 12 healthy subjects, and analyzed using event-related desynchronization and low-resolution electromagnetic tomography methods. During warming, the amplitudes of 10 and 20 Hz oscillations over the contralateral primary sensorimotor (SI/MI) and premotor cortices decreased,

and the amplitude of 20 Hz oscillations in the anterior cingulate and ipsilateral premotor cortex increased. Heating was associated with additional profound amplitude decreases of 10 and 20 Hz oscillations over SI/MI and premotor cortex, and by amplitude increase of 20 Hz oscillations originating in the posterior cingulate cortex. Results suggest biphasic amplitude changes of the cortical oscillations during ramp increase of temperature attributable to the periods of warming and heating. The amplitude decreases of 10 and 20 Hz oscillations in SI/MI and premotor cortex possibly aid in preparation of motor withdrawal reaction in an event that temperature should reach intolerable pain. Synchronization of the 20 Hz oscillations in the anterior and especially in the posterior cingulate cortex may aid suppression of unwanted movements. © 2007 IBRO.

192. Spyrou, L., S. Sanei, and C.C. Took, *Estimation and location tracking of the P300 subcomponents from single-trial EEG*. ICASSP, IEEE International Conference on Acoustics, Speech and Signal Processing - Proceedings, 2007. **2**.

Summary: Estimating the P300 subcomponents of Event Related Potentials (ERPs) is very important in the fields of psychiatry and neurology. The characteristics of these brain signals, such as latency, location, strength, and variation, can give useful insights of the person's condition. In particular, the signals' characteristics can aid in the diagnosis and monitoring of some specific psychiatric diseases such as schizophrenia of various stages, and can be a useful factor for their treatment. In this paper we employ a new filtering algorithm, incorporating prior knowledge of the shape of such components. Then we employ a novel localization algorithm to track the location of the P300 components trial by trial. © 2007 IEEE.

193. Sherlin, L., T. Budzynski, H. Kogan Budzynski, M. Congedo, M.E. Fischer, and D. Buchwald, *Low-resolution electromagnetic brain tomography (LORETA) of monozygotic twins discordant for chronic fatigue syndrome*. NeuroImage, 2007. **34**(4): p. 1438-1442.

Summary: Background: Previous work using quantified EEG has suggested that brain activity in individuals with chronic fatigue syndrome (CFS) and normal persons differs. Our objective was to investigate if specific frequency band-pass regions and spatial locations are associated with CFS using low-resolution electromagnetic brain tomography (LORETA). Methods: We conducted a co-twin control study of 17 pairs of monozygotic twins where 1 twin met criteria for CFS and the co-twin was healthy. Twins underwent an extensive battery of tests including a structured psychiatric interview and a quantified EEG. Eyes closed EEG frequency-domain analysis was computed and the entire brain volume was compared of the CFS and healthy twins using a multiple comparison procedure. Results: Compared with their healthy co-twins, twins with CFS differed in current source density. The CFS twins had higher delta in the left uncus and parahippocampal gyrus and higher theta in the cingulate gyrus and right superior frontal gyrus. Conclusions: These findings suggest that neurophysiological

activity in specific areas of the brain may differentiate individuals with CFS from those in good health. The study corroborates that slowing of the deeper structures of the limbic system is associated with affect. It also supports the neurobiological model that the right forebrain is associated with sympathetic activity and the left forebrain with the effective management of energy. These preliminary findings await replication. © 2006 Elsevier Inc. All rights reserved.

194. Sauseng, P., J. Hoppe, W. Klimesch, C. Gerloff, and F.C. Hummel, *Dissociation of sustained attention from central executive functions: Local activity and interregional connectivity in the theta range*. European Journal of Neuroscience, 2007. **25**(2): p. 587-593.

Summary: Human brain oscillatory activity was analysed in the electroencephalographic theta frequency range (4-7 Hz) while subjects executed complex sequential finger movements with varying task difficulty and memory load. Local frontal-midline theta activity was associated with the general level of cognitive demand, with the highest amplitudes in the most demanding condition. Using low-resolution electromagnetic tomography analysis (LORETA), this theta activity was localized in the anterior cingulate gyrus including the cingulate motor area. These results suggest that local theta activity in the anterior cingulate gyrus represents correlates of an attentional system that allocate cognitive resources. In addition, interregional connectivity in the theta frequency range was modulated by memory-related executive functions independently of task difficulty. Connectivity analyses revealed a more distributed long-range network including frontal and parietal cortices during execution of novel compared with well-trained finger movement sequences. Thus, these results are compatible with a model in which theta long-range coupling indicates integration of sensory information into executive control components of complex motor behaviour. © The Authors (2007).

195. Sandmann, P., T. Eichele, K. Specht, L. Jäncke, L.M. Rimol, H. Nordby, and K. Hugdahl, *Hemispheric asymmetries in the processing of temporal acoustic cues in consonant-vowel syllables*. Restorative Neurology and Neuroscience, 2007. **25**(3-4): p. 227-240.

Summary: Purpose: In order to examine auditory lateralization of prelexical speech processing, a dichotic listening task was performed with concurrent EEG measurement. Methods: Subjects were tested with dichotic pairs of six consonant-vowel (CV) syllables that initially started with a voiced (/ba/, /da/, /ga/) or a voiceless stop consonant (/pa/, /ta/, /ka/). Electrophysiological correlates were analyzed by a low resolution electromagnetic tomography (LORETA) approach to estimate the sources of N1 event-related potentials (ERP) in the 3D brain. Results: Behavioral and electrophysiological measures revealed different ear advantages and ERP amplitude measures for voiced and voiceless syllables. Fronto-central N1 amplitudes were larger for syllables with voiced than voiceless initial consonants. LORETA source estimates revealed a lateralization effect, with stronger leftward lateralization for voiced than voiceless CV syllables.

Conclusions: The present study demonstrates that auditory lateralization is affected by temporal cues in CV syllables. The lateralization effect suggests that functional hemispheric differences exist at an early prelexical level of speech processing. © 2007 - IOS Press and the authors. All rights reserved.

196. Saletu, M., P. Anderer, H.V. Semlitsch, G.M. Saletu-Zyhlarz, M. Mandl, J. Zeitlhofer, and B. Saletu, *Low-resolution brain electromagnetic tomography (LORETA) identifies brain regions linked to psychometric performance under modafinil in narcolepsy*. Psychiatry Research - Neuroimaging, 2007. **154**(1): p. 69-84.

Summary: Low-resolution brain electromagnetic tomography (LORETA) showed a functional deterioration of the fronto-temporo-parietal network of the right hemispheric vigilance system in narcolepsy and a therapeutic effect of modafinil. The aim of this study was to determine the effects of modafinil on cognitive and thymopsychic variables in patients with narcolepsy and investigate whether neurophysiological vigilance changes correlate with cognitive and subjective vigilance alterations at the behavioral level. In a double-blind, placebo-controlled crossover design, EEG-LORETA and psychometric data were obtained during midmorning hours in 15 narcoleptics before and after 3 weeks of placebo or 400 mg modafinil. Cognitive investigations included the Pauli Test and complex reaction time. Thymopsychic/psychophysiological evaluation comprised drive, mood, affectivity, wakefulness, depression, anxiety, the Symptom Checklist 90 and critical flicker frequency. The Multiple Sleep Latency Test (MSLT) and the Epworth Sleepiness Scale (ESS) were performed too. Cognitive performance (Pauli Test) was significantly better after modafinil than after placebo. Concerning reaction time and thymopsychic variables, no significant differences were observed. Correlation analyses revealed that a decrease in prefrontal delta, theta and alpha-1 power correlated with an improvement in cognitive performance. Moreover, drowsiness was positively correlated with theta power in parietal and medial prefrontal regions and beta-1 and beta-2 power in occipital regions. A less significant correlation was observed between midmorning EEG LORETA and the MSLT; between EEG LORETA and the ESS, the correlation was even weaker. In conclusion, modafinil did not influence thymopsychic variables in narcolepsy, but it significantly improved cognitive performance, which may be related to medial prefrontal activity processes identified by LORETA. © 2006 Elsevier Ireland Ltd. All rights reserved.

197. Rossini, P.M., S. Rossi, C. Babiloni, and J. Polich, *Clinical neurophysiology of aging brain: From normal aging to neurodegeneration*. Progress in Neurobiology, 2007. **83**(6): p. 375-400.

Summary: Physiological brain aging is characterized by a loss of synaptic contacts and neuronal apoptosis that provokes age-dependant decline of sensory processing, motor performance, and cognitive function. Neural redundancy and plastic remodelling of brain networking, also secondary to mental and physical training, promotes maintenance of brain activity in healthy elderly for everyday life and fully productive affective and intellectual capabilities. However, age is the main risk factor for neurodegenerative disorders such as Alzheimer's disease (AD) that impact on cognition. Oscillatory electromagnetic brain activity is a hallmark of neuronal network function in various brain regions. Modern neurophysiological techniques including electroencephalography (EEG), event-related potential (ERP), magnetoencephalography (MEG), and transcranial magnetic stimulation (TMS) can accurately index normal and abnormal brain aging to facilitate non-invasive analysis of cortico-cortical connectivity and neuronal synchronization of firing and coherence of rhythmic oscillations at various frequencies. The present review provides a perspective of these issues by assaying different neurophysiological methods and integrating the results with functional brain imaging findings. It is concluded that discrimination between physiological and pathological brain aging clearly emerges at the group level, with applications at the individual level also suggested. Integrated approaches utilizing neurophysiological techniques together with biological markers and structural and functional imaging are promising for large-scale, low-cost and non-invasive evaluation of at-risk populations. Practical implications of the methods are emphasized. © 2007 Elsevier Ltd. All rights reserved.

198. Rodriguez, G., C. Babiloni, A. Brugnolo, C. Del Percio, F. Cerro, F. Gabrielli, N. Girtler, F. Nobili, G. Murialdo, P.M. Rossini, D.S. Rossi, C. Baruzzi, and A.M. Ferro, *Cortical sources of awake scalp EEG in eating disorders*. Clinical Neurophysiology, 2007. **118**(6): p. 1213-1222.

Summary: Objective: To investigate quantitative EEG (qEEG) in anorexia nervosa (AN) and bulimia nervosa (BN) in comparison with healthy controls. Methods: Resting EEG was recorded in 30 healthy females (age: 27.1 ± 5.5), 16-AN females (age: 26.4 ± 9.5) and 12-BN females (age: 27.0 ± 6.3). Cortical EEG sources (delta, theta, alpha 1, alpha 2, beta 1, beta 2) were modeled by LORETA solutions. The statistical analysis was performed considering the factors Group, power Band, and region of interest (central, frontal, parietal, occipital, temporal, limbic). Results: Alpha 1 sources in central, parietal, occipital and limbic areas showed a greater amplitude in Controls versus AN and BN groups. Alpha 2 sources in parietal, occipital and limbic areas showed a greater amplitude in Controls than in both AN and BN groups. Alpha 1 sources in temporal area showed a greater amplitude in Controls compared to both the BN and AN groups as well as in the BN group compared to AN group. Central alpha 1 source correlated significantly with BMI in patients. Conclusions: These results support the hypothesis that eating disorders are related to altered mechanisms of cortical neural synchronization, especially in rolandic alpha rhythms. Significance: To our knowledge this is the first study by LORETA able to detect modifications of cortical EEG activity in eating disorders. © 2007 International Federation of Clinical Neurophysiology.

199. Rippon, G., J. Brock, C. Brown, and J. Boucher, *Disordered connectivity in the autistic brain: Challenges for the 'new psychophysiology'*. International Journal of Psychophysiology, 2007. **63**(2): p. 164-172.

Summary: In 2002, we published a paper [Brock, J., Brown, C., Boucher, J., Rippon, G., 2002. The temporal binding deficit hypothesis of autism. Development and Psychopathology 142, 209-224] highlighting the parallels between the psychological model of 'central coherence' in information processing [Frith, U., 1989. Autism: Explaining the Enigma. Blackwell, Oxford] and the neuroscience model of neural integration or 'temporal binding'. We proposed that autism is associated with abnormalities of information integration that is caused by a reduction in the connectivity between specialised local neural networks in the brain and possible overconnectivity within the isolated individual neural assemblies. The current paper updates this model, providing a summary of theoretical and empirical advances in research implicating disordered connectivity in autism. This is in the context of changes in the approach to the core psychological deficits in autism, of greater emphasis on 'interactive specialisation' and the resultant stress on early and/or low-level deficits and their cascading effects on the developing brain [Johnson, M.H., Halit, H., Grice, S.J., Karmiloff-Smith, A., 2002. Neuroimaging of typical and atypical development: a perspective from multiple levels of analysis. Development and Psychopathology 14, 521-536].We also highlight recent developments in the measurement and modelling of connectivity, particularly in the emerging ability to track the temporal dynamics of the brain using electroencephalography (EEG) and magnetoencephalography (MEG) and to investigate the signal characteristics of this activity. This advance could be particularly pertinent in testing an emerging model of effective connectivity based on the balance between excitatory and inhibitory cortical activity [Rubenstein, J.L., Merzenich M.M., 2003. Model of autism: increased ratio of excitation/inhibition in key neural systems. Genes, Brain and Behavior 2, 255-267; Brown, C., Gruber, T., Rippon, G., Brock, J., Boucher, J., 2005. Gamma abnormalities during perception of illusory figures in autism. Cortex 41, 364-376]. Finally, we note that the consequence of this convergence of research developments not only enables a greater understanding of autism but also has implications for prevention and remediation. © 2006.

200. Prox, V., D.E. Dietrich, Y. Zhang, H.M. Emrich, and M.D. Ohlmeier, *Attentional processing in adults with ADHD as reflected by event-related potentials*. Neuroscience Letters, 2007. **419**(3): p. 236-241.

Summary: Attention deficit/hyperactivity disorder (ADHD) is a well known childhood disease and well researched via event-related potentials (ERPs), but unfortunately there is little information on this illness in adults in ERPs. In the present study, 12 adults diagnosed with ADHD and 12 healthy control adults were examined with respect to ERPs in a visual Go/NoGo-experiment to gain information about target evaluation processing in these patients. Two attention-related ERP-components, the N1 and N2 were significantly increased for the ADHD adults compared to the healthy control adults. These findings were illustrated using source analysis results: In the time frame corresponding to the N1, significant increases of activity were found in the medial frontal gyrus and during the N2 time frame significant increases were detected in the lingual gyrus. The P300 showed a tendency towards decreased activity in the patient group, however, only a subsequent slow wave activity indicated significant differences. Neuronal activity related to early attentional mechanisms (N1 and N2) appears to be enhanced in ADHD patients. Together with the finding of a reduction in the P300, the data suggest that ADHD adults have learned to gather their attention more strongly than healthy adults in order to achieve the same results and compensate for their impairment. This is supported by the source analysis results which show activity in additional brain areas. © 2007 Elsevier Ireland Ltd. All rights reserved.

201. Proverbio, A.M., F. Wiedemann, R. Adorni, V. Rossi, M. Del Zotto, and A. Zani, *Dissociating object familiarity from linguistic properties in mirror word reading*. Behavioral and Brain Functions, 2007. **3**.

Summary: Background: It is known that the orthographic properties of linguistic stimuli are processed within the left occipitotemporal cortex at about 150-200 ms. We recorded event-related potentials (ERPs) to words in standard or mirror orientation to investigate the role of visual word form in reading. Word inversion was performed to determine whether rotated words lose their linguistic properties. Methods: About 1300 Italian words and legal pseudo-words were presented to 18 right-handed Italian students engaged in a letter detection task. EEG was recorded from 128 scalp sites. Results: ERPs showed an early effect of word orientation at ~150 ms, with larger N1 amplitudes to rotated than to standard words. Low-resolution brain electromagnetic tomography (LORETA) revealed an increase in N1 to rotated words primarily in the right occipital lobe (BA 18), which may indicate an effect of stimulus familiarity. N1 was greater to target than to non-target letters at left lateral occipital sites, thus reflecting the first stage of orthographic processing. LORETA revealed a strong focus of activation for this effect in the left fusiform gyrus (BA 37), which is consistent with the so-called visual word form area (VWFA). Standard words (compared to pseudowords) elicited an enhancement of left occipito/temporal negativity at about 250-350 ms, followed by a larger anterior P3, a reduced frontal N400 and a huge late positivity. Lexical effects for rotated strings were delayed by about 100 ms at occipito/temporal sites, and were totally absent at later processing stages. This suggests the presence of implicit reading processes, which were pre-attentive and of perceptual nature for mirror strings. Conclusion: The contrast between inverted and standard words did not lead to the identification of a purely linguistic brain region. This finding suggests some caveats in the interpretation of the inversion effect in subtractive paradigms. © 2007 Proverbio et al; licensee BioMed Central Ltd.

202. Pratt, H., A. Starr, H.J. Michalewski, N. Bleich, and N. Mittelman, *The N1 complex to gaps in noise: Effects of preceding noise duration and intensity*. Clinical Neurophysiology, 2007. **118**(5): p. 1078-1087.

Summary: Objective: To study the effects of duration and intensity of noise that precedes gaps in noise on the N-Complex (N1a and N1b) of Event-Related Potentials (ERPs) to the gaps. Methods: ERPs were recorded from 13 normal

subjects in response to 20 ms gaps in 2-4.5 s segments of binaural white noise. Within each segment, the gaps appeared after 500, 1500, 2500 or 4000 ms of noise. Noise intensity was either 75, 60 or 45 dBnHL. Analysis included waveform peak measurements and intracranial source current density estimations, as well as statistical assessment of the effects of pre-gap noise duration and intensity on N1a and N1b and their estimated intracranial source activity. Results: The N-Complex was detected at about 100 ms under all stimulus conditions. Latencies of N1a (at ~90 ms) and N1b (at ~150 ms) were significantly affected by duration of the preceding noise. Both their amplitudes and the latency of N1b were affected by the preceding noise intensity. Source current density was most prominent, under all stimulus conditions, in the vicinity of the temporo-parietal junction, with the first peak (N1a) lateralized to the left hemisphere and the second peak (N1b) - to the right. Additional sources with lower current density were more anterior, with a single peak spanning the duration of the N-Complex. Conclusions: The N1a and N1b of the N-Complex of the ERPs to gaps in noise are affected by both duration and intensity of the pre-gap noise. The minimum noise duration required for the appearance of a double-peaked N-Complex is just under 500 ms, depending on noise intensity. N1a and N1b of the N-Complex are generated predominantly in opposite temporo-parietal brain areas: N1a on the left and N1b on the right. Significance: Duration and intensity interact to define the dual peaked N-Complex, signaling the cessation of an ongoing sound. © 2007.

203. Pinto, B. and C.Q. Silva, *A simple method for calculating the depth of EEG sources using minimum norm estimates (MNE)*. Medical and Biological Engineering and Computing, 2007. **45**(7): p. 643-652.

Summary: Neural source localization using electroencephalographic data is usually performed using either dipolar models or minimum norm based techniques. While the former demands a priori information about the number of active sources and is particularly suitable for generators, which occupy small pieces of cortical tissue, the major drawbacks of the second approach are its dependence on the uncorrelated noise, and its tendency to localize the sources at the surface. In this paper, a simple mathematical procedure, based on the behavior of the dispersion of the minimum norm solutions, is introduced, in order to estimate the depth of the sources. The correct position of the active generators is obtained using successively deeper surfaces instead of the application of a regularization matrix, as is commonly described in the bibliography. The evaluation of this technique is performed using single and double dipolar simulated generators and two different models for the head: spherical and realistic. The results yield a mean accuracy of about 10 mm for the most disadvantageous situations studied and thus, this method seems to be very promising to handle the depth of the neural generators. © International Federation for Medical and Biological Engineering 2007.

204. Penny, W., G. Flandin, and N. Trujillo-Barreto, *Bayesian comparison of spatially regularised general linear models*. Human Brain Mapping, 2007. **28**(4): p. 275-293.

Summary: In previous work (Penny et al., [2005]: Neuroimage 24:350-362) we have developed a spatially regularised General Linear Model for the analysis of functional magnetic resonance imaging data that allows for the characterisation of regionally specific effects using Posterior Probability Maps (PPMs). In this paper we show how it also provides an approximation to the model evidence. This is important as it is the basis of Bayesian model comparison and provides a unified framework for Bayesian Analysis of Variance, Cluster of Interest analyses and the principled selection of signal and noise models. We also provide extensions that implement spatial and anatomical regularisation of noise process parameters. © 2006 Wiley-Liss, Inc.

205. Pastor, M.A., M. Valencia, J. Artieda, M. Alegre, and J.C. Masdeu, *Topography of cortical activation differs for fundamental and harmonic frequencies of the steady-state visual-evoked responses. An EEG and PET H 215O study*. Cerebral Cortex, 2007. **17**(8): p. 1899-1905.

Summary: In humans, visual flicker stimuli of graded frequency (2-90 Hz) elicit an electroencephalographic (EEG) steady-state visual-evoked response (SSVER) with the same fundamental frequency as the stimulus and, in addition, a series of harmonic responses. The fundamental component of the SSVER is generated by increased synaptic activity in primary visual cortex (V1). We set out to determine the cortical origin of the harmonic responses in humans. For this purpose, we recorded the SSVERs at 5 different frequencies (5, 10, 15, 25, and 40 Hz) and measured regional cerebral blood flow (rCBF) with positron emission tomography-H215O at rest and during visual stimulation at the same frequencies. The rCBF contrast weighted by the amplitude of the SSVERs first harmonics showed activation of a swath of cortex perpendicular to V1, including mostly the inferior half of the parieto-occipital sulcus. This area overlapped minimally with the primary visual cortex activated by the fundamental frequency. A different method, estimating EEG cortical source current density with low-resolution brain electromagnetic tomography, gave the same results. Our finding suggests that the inferior portion of the banks of the parieto-occipital sulci contains association visual cortex involved in the processing of stimuli that can be as simple as a flickering light source. © The Author 2006. Published by Oxford University Press. All rights reserved.

206. Papageorgiou, C.C., C. Sfagos, K.K. Kosma, K.A. Kontoangelos, N. Triantafyllou, D. Vassilopoulos, A.D. Rabavilas, and C.R. Soldatos, *Changes in LORETA and conventional patterns of P600 after steroid treatment in multiple sclerosis patients*. Progress in Neuro-Psychopharmacology and Biological Psychiatry, 2007. **31**(1): p. 234-241.

Summary: Objective: The P600 component of event-related potentials (ERPs) reflecting the 'rule-governed sequence of information processing', has been associated with multiple sclerosis (MS)-related cognition. The present study aimed at examining the effects of methylprednisolone treatment in MS patients on cognition as reflected by the low-resolution brain electromagnetic tomography (LORETA) of the P600 as well as its conventional constituents (amplitudes and latencies) recorded during a working memory (WM) test. Method: A paired LORETA comparison was performed in the P600 component of ERPs elicited during a (WM) test in 18 MS patients suffering from the relapsing-remitting form, before and after 1 week treatment with methylprednisolone. The P600 component was also evaluated in 16 healthy controls matched to the patients on age and educational level. Results: When pre- and post-treatment recordings of LORETA were compared all patients as a group showed significantly different patterns of current density activation located at right frontal lobe. The treatment was accompanied by an increase of the amplitude of P600 at the right frontoparietal area. In the post-treatment phase the patients exhibited significant improvement of the memory performance as compared to themselves before treatment. As a result both the P600 amplitudes and memory performance at post-treatment were closer to those exhibited by normal controls. Conclusion: These findings support the notion that steroid treatment in relapsing-remitting MS patients, may exert a beneficial effect in 'rule-governed sequence of information processing'. © 2006.

207. Palmero-Soler, E., K. Dolan, V. Hadamschek, and P.A. Tass, *swLORETA: A novel approach to robust source localization and synchronization tomography*. Physics in Medicine and Biology, 2007. **52**(7): p. 1783-1800.

Summary: Standardized low-resolution brain electromagnetic tomography (sLORETA) is a widely used technique for source localization. However, this technique still has some limitations, especially under realistic noisy conditions and in the case of deep sources. To overcome these problems, we present here swLORETA, an improved version of sLORETA, obtained by incorporating a singular value decomposition-based lead field weighting. We show that the precision of the source localization can further be improved by a tomographic phase synchronization analysis based on swLORETA. The phase synchronization analysis turns out to be superior to a standard linear coherence analysis, since the latter cannot distinguish between real phase locking and signal mixing. © 2007 IOP Publishing Ltd.

208. Neuhaus, A.H., S. Koehler, C. Opgen-Rhein, C. Urbanek, E. Hahn, and M. Dettling, *Selective anterior cingulate cortex deficit during conflict solution in schizophrenia: An event-related potential study*. Journal of Psychiatric Research, 2007. **41**(8): p. 635-644.

Summary: Background: Schizophrenia research has gained a new focus on identification and further characterization of neurocognitive deficits in the search for behavioural endophenotypes of this disorder. The objective of this study was to explore differential cortical processing during executive control in schizophrenia as assessed with the attention network test (ANT). Methods: Sixteen schizophrenic patients and sixteen healthy controls matched for gender, age, education, and nicotine consumption were tested with the ANT while recording 29-channel-electroencephalogram (EEG). Visual event-related potentials (ERP) N200 and P300 were topographically analyzed and cortical mapping using low resolution brain electromagnetic tomography (LORETA) was applied to localize neuroelectric generators of ERP. Results: Behaviourally, significant differences between schizophrenic patients and controls were found only for the conflict condition ($p < 0.05$) and for conflict adjusted by mean reaction time ($p < 0.01$). Examining ERP of control subjects, N200 failed to show robust flanker congruency effects. P300 amplitude was reduced at Pz ($p < 0.05$) and P300 latency was increased at Cz ($p < 0.005$) for the conflict condition. Schizophrenic patients differed significantly in P300 latency at Cz during late conflict processing ($p < 0.005$). Source analysis revealed a deficit in anterior cingulate cortex ($p < 0.05$). Conclusion: Our results are in line with previous reports about dysfunctional ACC activation in schizophrenia and argue in favour of a selective deficit of cortical conflict resolution. It is further proposed that dysfunctional ACC activation during executive processing may be a neurophysiologic endophenotype candidate of schizophrenia. © 2006 Elsevier Ltd. All rights reserved.

209. Mulert, C., G. Leicht, O. Pogarell, R. Mergl, S. Karch, G. Juckel, H.J. Möller, and U. Hegerl, *Auditory cortex and anterior cingulate cortex sources of the early evoked gamma-band response: Relationship to task difficulty and mental effort*. Neuropsychologia, 2007. **45**(10): p. 2294-2306.

Summary: High frequency oscillations in the 40 Hz (gamma-band)-range are involved in the synchronization of brain regions, e.g., in cognitive functions. It has been suggested that the auditory evoked gamma-band response (GBR) is affected by attention and apart from auditory cortex activity a frontal or anterior cingulate cortex (ACC) generator could be involved. It was the aim of the present study to address three questions: (1) is there a neural generator of the early evoked GBR in the dorsal (d)ACC? (2) Are there different activation patterns in the dACC and the auditory cortex areas in response to task difficulty? (3) Is it possible to detect an influence of early ACC-gamma-band activity (GBR timeframe) to later auditory information processing (N1 timeframe)? In the present EEG/ERP-study we have investigated 30 healthy subjects using six auditory reaction tasks with increasing difficulty and mental effort demands. In the MANOVA analysis we found a significant main effect of task difficulty on both the GBR amplitude ($F = 7.75$; $p < 0.001$) and the auditory evoked N1 potential ($F = 7.00$; $p < 0.001$) with higher amplitudes in the more difficult tasks. In the LORETA region of interest (ROI) analysis, this effect was only due to increased dACC-activity during the GBR-timeframe. For the ROI analysis during the N1 timeframe, in addition to a strong effect of task difficulty in the dACC a similar main effect was found in the auditory association area 22. These findings are in

line with a top-down influence of dACC-activity to the auditory association area 22 during the early evoked GBR. © 2007 Elsevier Ltd. All rights reserved.

210. Mulert, C., G. Juckel, M. Brunnmeier, S. Karch, G. Leicht, R. Mergl, H.J. Möller, U. Hegerl, and O. Pogarell, *Prediction of treatment response in major depression: Integration of concepts*. Journal of Affective Disorders, 2007. **98**(3): p. 215-225.

Summary: Background: Two promising approaches have been introduced for the prediction of treatment response in major depression: one concept is based on the activity in the rostral anterior cingulate cortex (rACC). Subjects with higher metabolic rates respond better to sleep deprivation or antidepressive medication. Another approach is the investigation of the loudness dependence of the auditory evoked potential (LDAEP). Here, a high LDAEP is supposed to reflect low central serotonergic activity. We present the first study comparing both approaches in the same group of patients. Methods: Patients with major depression ($n = 20$) were investigated using both resting EEG and LDAEP before treatment with either citalopram or reboxetine. Results: We found significant differences between responders and non-responders in the rACC in the theta-frequency range (6.5-8 Hz, $p < 0.05$). In the subgroup of patients, treated with citalopram we found higher LDAEP-values in responders versus non-responders ($p < 0.05$) and a significant correlation between pre-treatment-LDAEP and improvement in the Hamilton score after treatment ($r = 0.71$, $p < 0.05$). Conclusions: In combining both methods a prediction whether a patient with major depression might be at risk for non-response to a standard therapy as well as a suggestion for a pharmacological approach of choice seems to be possible. © 2006 Elsevier B.V. All rights reserved.

211. Mulert, C., G. Juckel, M. Brunnmeier, S. Karch, G. Leicht, R. Mergl, H.J. Möller, U. Hegerl, and O. Pogarell, *Rostral anterior cingulate cortex activity in the theta band predicts response to antidepressive medication*. Clinical EEG and Neuroscience, 2007. **38**(2): p. 78-81.

Summary: During the last 10 years the knowledge about rostral anterior cingulate cortex (ACC) activity in major depression has substantially increased. Several groups have independently described a relationship between resting activity in this area and response to antidepressant treatment. We have recently confirmed a relationship between resting activity of rostral ACC activity and response in a group of 20 patients with major depression using resting theta activity. In this earlier study regions of interest (ROI) were defined in order to establish regional specificity. Differences between responders and nonresponders were only found in the ACC-ROI, but not in the posterior cingulate region. We have now reanalyzed our data using a whole brain voxelwise approach, in order not to miss any other relevant functional differences. In addition to major differences between responders and nonresponders in the rostral ACC, we have identified a nearby region in the midline orbito-frontal region.

212. Mucci, A., S. Galderisi, B. Kirkpatrick, P. Bucci, U. Volpe, E. Merlotti, F. Centanaro, F. Catapano, and M. Maj, *Double dissociation of N1 and P3 abnormalities in deficit and nondeficit schizophrenia*. Schizophrenia Research, 2007. **92**(1-3): p. 252-261.

Summary: It has been proposed that the presence of enduring, idiopathic negative symptoms define a group of patients with a disease (deficit schizophrenia, DS) that is separate from other forms of schizophrenia (nondeficit schizophrenia, NDS). Although several findings support this hypothesis, the possibility that DS represents the severe end of a single schizophrenia continuum cannot be excluded yet. We tested the hypothesis that DS and NDS differ relative to event-related potentials (ERPs). Amplitude, scalp topography and cortical sources of the ERP components were assessed in clinically stable DS and NDS outpatients and in matched healthy subjects (HCS). Twenty subjects per group were recruited. Among the subjects who completed the target detection task, there were no group difference in accuracy. For N1, only patients with DS, as compared with HCS, showed an amplitude reduction over the scalp central leads and a reduced current source density in cingulate and parahippocampal gyrus. For P3, only patients with NDS, as compared with HCS, showed a lateralized amplitude reduction over the left posterior regions and reduced current source density in left temporal and bilateral frontal, cingulate and parietal areas. The DS and NDS groups differed significantly from each other with regard to N1 amplitude and topography, as well as P3 amplitude and cortical sources. The N1 was affected in DS but not in NDS patients, whereas P3 was affected in NDS only. This double dissociation is consistent with the hypothesis that DS represents a separate disease entity within schizophrenia. © 2007 Elsevier B.V. All rights reserved.

213. Mössner, R., O. Mikova, E. Koutsilieri, M. Saoud, A.C. Ehlis, N. Müller, A.J. Fallgatter, and P. Riederer, *Consensus paper of the WFSBP task force on biological markers: Biological markers in depression*. World Journal of Biological Psychiatry, 2007. **8**(3): p. 141-174.

Summary: Biological markers for depression are of great interest to aid in elucidating the causes of major depression. We assess currently available biological markers to query their validity for aiding in the diagnosis of major depression. We specifically focus on neurotrophic factors, serotonergic markers, biochemical markers, immunological markers, neuroimaging, neurophysiological findings, and neuropsychological markers. We delineate the most robust biological markers of major depression. These include decreased platelet imipramine binding, decreased 5-HT1A receptor expression, increase of soluble interleukin-2 receptor and interleukin-6 in serum, decreased brain-derived neurotrophic factor in serum, hypocholesterolemia, low blood folate levels, and impaired suppression of the dexamethasone suppression test. To date, however, none of these markers are sufficiently specific to contribute to the diagnosis of major depression. Thus, with regard to new diagnostic manuals such as DSM-V and ICD-11 which are currently assessing whether biological markers may be

included in diagnostic criteria, no biological markers for major depression are currently available for inclusion in the diagnostic criteria.

214. Möller, J., B.M. Jansma, A. Rodriguez-Fornells, and T.F. Münte, *What the brain does before the tongue slips*, in *Cerebral Cortex*. 2007. p. 1173-1178.

215. Minsley, B.J., J. Sogade, and F.D. Morgan, *Three-dimensional source inversion of self-potential data*. Journal of Geophysical Research B: Solid Earth, 2007. **112**(2).

Summary: The self-potential (SP) method has long been used for a variety of geophysical applications because of its ease of acquisition, but has suffered from difficulty in interpretation of the data. Self-potential signals result from a source term that is coupled with the earth resistivity and appropriate boundary conditions. This work describes an inversion methodology for determining the self-potential sources from measured SP and resistivity data. The SP source inversion is a linear problem, though it is complicated by nonuniqueness that is common to potential-field problems. The linear operator is also poorly conditioned because of the limited set of measurements, which are often constrained to the earth's surface. Our approach utilizes model regularization that selects a class of solutions which fit the data with sources that are spatially compact. Large variations in sensitivity due to distance and resistivity structure throughout the model are addressed through the use of a scaling term derived from the Green's functions that define the linear operator. A significant benefit of these methods is the resolution of targets at depth from surface measurements alone. This inversion technique is first illustrated with a simple synthetic data set. In a second example we apply this approach to a field data set taken from previously published literature and investigate the effects of different resistivity structure assumptions on the inversion results. The spatial distribution of sources provides useful information that can subsequently be interpreted in terms of physical processes that generate the SP data. Copyright 2007 by the American Geophysical Union.

216. Meyer, M., S. Elmer, S. Baumann, and L. Jancke, *Short-term plasticity in the auditory system: Differential neural responses to perception and imagery of speech and music*. Restorative Neurology and Neuroscience, 2007. **25**(3-4): p. 411-431.

Summary: Purpose: In this EEG study we sought to examine the neuronal underpinnings of short-term plasticity as a top-down guided auditory learning process. We hypothesized, that (i) auditory imagery should elicit proper auditory evoked effects (N1/P2 complex) and a late positive component (LPC). Generally, based on recent human brain mapping studies we expected (ii) to observe the involvement of different temporal and parietal lobe areas in imagery and in perception of acoustic stimuli. Furthermore we predicted (iii) that temporal regions show an asymmetric trend due to the different specialization of the temporal lobes in processing speech and non-speech sounds. Finally we sought evidence supporting the notion that short-term training is sufficient to drive top-down activity in brain regions that are not normally recruited by sensory induced bottom up processing. Methods: 18 non-musicians partook in a 30 channels based EEG session that investigated spatio-temporal dynamics of auditory imagery of "consonant-vowel" (CV) syllables and piano triads. To control for conditioning effects, we split the volunteers in two matched groups comprising the same conditions (visual, auditory or bimodal stimulation) presented in a slightly different serial order. Furthermore the study presents electromagnetic source localization (LORETA) of perception and imagery of CV- and piano stimuli. Results: Our results imply that auditory imagery elicited similar electrophysiological effects at an early stage (N1/P2) as auditory stimulation. However, we found an additional LPC following the N1/P2 for auditory imagery only. Source estimation evinced bilateral engagement of anterior temporal cortex, which was generally stronger for imagery of music relative to imagery of speech. While we did not observe lateralized activity for the imagery of syllables we noted significantly increased rightward activation over the anterior supratemporal plane for musical imagery. Conclusion: Thus, we conclude that short-term top-down training based auditory imagery of music and speech prompts involvement of distinct neural circuits residing in the perisylvian cortex. © 2007 - IOS Press and the authors. All rights reserved.

217. Meltzer, J.A., M. Negishi, L.C. Mayes, and R.T. Constable, *Individual differences in EEG theta and alpha dynamics during working memory correlate with fMRI responses across subjects*. Clinical Neurophysiology, 2007. **118**(11): p. 2419-2436.

Summary: Objective: Theta and alpha range EEG oscillations are commonly induced in cognitive tasks, but their possible relationship to the BOLD signal of fMRI is not well understood, and individual variability is high. We explored individual differences in EEG reactivity to determine whether it is positively or negatively correlated with BOLD across subjects. Methods: A Sternberg working memory task with 2, 4, or 6 digits was administered to 18 subjects in separate fMRI and EEG sessions. Memory load-dependent theta and alpha reactivity was quantified and used as a regressor to reveal brain areas exhibiting EEG-fMRI correlation across subjects. Results: Theta increases localized to medial prefrontal cortex, and correlated negatively with BOLD in that region and in other "default mode" areas. Alpha modulation localized to parietal-occipital midline cortex and also correlated negatively with BOLD. Conclusions: Individual tendencies to exhibit memory load-dependent oscillations are associated with negative BOLD responses in certain brain regions. Significance: Positive BOLD responses and increased EEG oscillations do not necessarily arise in the same regions. Negative BOLD responses may also relate to cognitive activity, as traditionally indexed by increased EEG power in the theta band. © 2007 International Federation of Clinical Neurophysiology.

218. Mazerolle, E.L., R.C.N. D'Arcy, Y. Marchand, and R.B. Bolster, *ERP assessment of functional status in the temporal lobe: Examining spatiotemporal*

correlates of object recognition, in *International Journal of Psychophysiology*. 2007. p. 81-92.

219. Maurer, U., S. Brem, K. Bucher, F. Kranz, R. Benz, H.C. Steinhausen, and D. Brandeis, *Impaired tuning of a fast occipito-temporal response for print in dyslexic children learning to read*. Brain, 2007. **130**(12): p. 3200-3210.

Summary: Developmental dyslexia is defined as a disorder of learning to read. It is thus critical to examine the neural processes that impair learning to read during the early phase of reading acquisition, before compensatory mechanisms are adapted by older readers with dyslexia. Using electroencephalography-based event-related imaging, we investigated how tuning of visual activity for print advances in the same children before and after initial reading training in school. The focus was on a fast, coarse form of visual tuning for print, measured as an increase of the occipito-temporal N1 response at 150-270 ms in the event-related potential (ERP) to words compared to symbol strings. The results demonstrate that the initial development of reading skills and visual tuning for print progressed more slowly in those children who became dyslexic than in their control peers. Print-specific tuning in 2nd grade strongly distinguished dyslexic children from controls. It was maximal in the inferior occipito-temporal cortex, left-lateralized in controls, and reduced in dyslexic children. The results suggest that delayed initial visual tuning for print critically contributes to the development of dyslexia. © The Author (2007). Published by Oxford University Press on behalf of the Guarantors of Brain. All rights reserved.

220. Litvak, V., S. Komssi, M. Scherg, K. Hoechstetter, J. Classen, M. Zaaroor, H. Pratt, and S. Kahkonen, *Artifact correction and source analysis of early electroencephalographic responses evoked by transcranial magnetic stimulation over primary motor cortex*. NeuroImage, 2007. **37**(1): p. 56-70.

Summary: Analyzing the brain responses to transcranial magnetic stimulation (TMS) using electroencephalography (EEG) is a promising method for the assessment of functional cortical connectivity and excitability of areas accessible to this stimulation. However, until now it has been difficult to analyze the EEG responses during the several tens of milliseconds immediately following the stimulus due to TMS-induced artifacts. In the present study we show that by combining a specially adapted recording system with software artifact correction it is possible to remove a major part of the artifact and analyze the cortical responses as early as 10 ms after TMS. We used this methodology to examine responses of left and right primary motor cortex (M1) to TMS at different intensities. Based on the artifact-corrected data we propose a model for the cortical activation following M1 stimulation. The model revealed the same basic response sequence for both hemispheres. A large part of the response could be accounted for by two sources: a source close to the stimulation site (peaking ~ 15 ms after the stimulus) and a midline frontal source ipsilateral to the stimulus (peaking ~ 25 ms). In addition the model suggests responses in ipsilateral temporo-parietal junction areas (~ 35 ms) and ipsilateral (~ 30 ms) and middle (~ 50 ms) cerebellum. Statistical analysis revealed significant dependence on stimulation intensity for the ipsilateral midline frontal source. The methodology developed in the present study paves the way for the detailed study of early responses to TMS in a wide variety of brain areas. © 2007 Elsevier Inc. All rights reserved.

221. Li, Y.O., T. Adali, and V.D. Calhoun, *Estimating the number of independent components for functional magnetic resonance imaging data*. Human Brain Mapping, 2007. **28**(11): p. 1251-1266.

Summary: Multivariate analysis methods such as independent component analysis (ICA) have been applied to the analysis of functional magnetic resonance imaging (fMRI) data to study brain function. Because of the high dimensionality and high noise level of the fMRI data, order selection, i.e., estimation of the number of informative components, is critical to reduce over/underfitting in such methods. Dependence among fMRI data samples in the spatial and temporal domain limits the usefulness of the practical formulations of information-theoretic criteria (ITC) for order selection, since they are based on likelihood of independent and identically distributed (i.i.d.) data samples. To address this issue, we propose a subsampling scheme to obtain a set of effectively i.i.d. samples from the dependent data samples and apply the ITC formulas to the effectively i.i.d. sample set for order selection. We apply the proposed method on the simulated data and show that it significantly improves the accuracy of order selection from dependent data. We also perform order selection on fMRI data from a visuomotor task and show that the proposed method alleviates the over-estimation on the number of brain sources due to the intrinsic smoothness and the smooth preprocessing of fMRI data. We use the software package ICASSO (Himberg et al. [2004]: Neuroimage 22:1214-1222) to analyze the independent component (IC) estimates at different orders and show that, when ICA is performed at overestimated orders, the stability of the IC estimates decreases and the estimation of task related brain activations show degradation. © 2007 Wiley-Liss, Inc.

222. Li, Y.O., T. Adali, and V.D. Calhoun, *A feature-selective independent component analysis method for functional MRI*. International Journal of Biomedical Imaging, 2007. **2007**.

Summary: In this work, we propose a simple and effective scheme to incorporate prior knowledge about thesources of interest (SOIs) in independent component analysis (ICA) and apply the method to estimatebrain activations from functional magnetic resonance imaging (fMRI) data. We name the proposedmethod as feature-selective ICA since it incorporates the features in the sample space of the independentcomponents during ICA estimation. The feature-selective scheme is achieved through a filtering operationin the source sample space followed by a projection onto the demixing vector space by a least squaresprojection in an iterative ICA process. We perform ICA estimation of artificial activations superimposedinto a resting state fMRI dataset to show that the feature-selective scheme improves the detection ofinjected activation from the independent component estimated by ICA. We also compare the task-relatedsources estimated from true fMRI data by a feature-selective ICA algorithm versus an ICA algorithmand show evidence that the feature-selective scheme helps improve the estimation of the sources in bothspatial activation patterns and the time courses.

223. Li, L. and D. Yao, *A new method of spatio-temporal topographic mapping by correlation coefficient of k-means cluster*. Brain Topography, 2007. **19**(4): p. 161-176.

Summary: It would be of the utmost interest to map correlated sources in the working human brain by Event-Related Potentials (ERPs). This work is to develop a new method to map correlated neural sources based on the time courses of the scalp ERPs waveforms. The ERP data are classified first by k-means cluster analysis, and then the Correlation Coefficients (CC) between the original data of each electrode channel and the time course of each cluster centroid are calculated and utilized as the mapping variable on the scalp surface. With a normalized 4-concentric-sphere head model with radius 1, the performance of the method is evaluated by simulated data. CC, between simulated four sources (s 1-s4) and the estimated cluster centroids (c 1-c4), and the distances (Ds), between the scalp projection points of the s1-s4 and that of the c 1-c4, are utilized as the evaluation indexes. Applied to four sources with two of them partially correlated (with maximum mutual CC = 0.4892), CC (Ds) between s 1-s4 and c1-c 4 are larger (smaller) than 0.893 (0.108) for noise levels NSR ≤ 0.2; Applied to four sources with two of them completely correlated, CC (Ds) between s1-s4 and c1-c4 are larger (smaller) than 0.97367 (0.1898) for a random noise level NSR ≤ 0.2; Applied to 128, 64 and 32 recording electrodes, CC (Ds) between s1-s 4 and c1-c4 are larger (smaller) than 0.9557 (0.4251) for a random noise level NSR = 0.15; And applied to the cases of spatially overlapped scalp activities, CC (Ds) between s 1-s 4 and c1-c4 are larger (smaller) than 0.9083 (0.4329) for a random noise level NSR = 0.15. Finally, the method successfully decomposed the ERPs collected in a spatial selective attention experiment into three clusters located at left, right occipital and frontal. The estimated vectors of the contra-occipital area demonstrate that attention to the stimulus location produces increased amplitude of the P1 and N1 components over the contra-occipital scalp. The estimated vector in the frontal area displays two large processing negativity waves around 100 ms and 250 ms when subjects are attentive, and there is a small negative wave around 140 ms and a P300 when subjects are unattentive. The results of simulations and real Visual Evoked Potentials (VEPs) data demonstrate the validity of the method in mapping correlated sources. This method may be an objective, heuristic and important tool to study the properties of cerebral, neural networks in cognitive and clinical neurosciences. © 2007 Springer Science+Business Media, LLC.

224. Lengger, P.G., F.P.S. Fischmeister, H. Leder, and H. Bauer, *Functional neuroanatomy of the perception of modern art: A DC-EEG study on the*

influence of stylistic information on aesthetic experience, in *Brain Research*. 2007. p. 93-102.

225. Kopřivová, J., J. Praško, M. Brunovský, M. Raszka, T. Novák, and J. Horáček, *Functional connectivity in obsessive-compulsive disorder: A correlation analysis of low-resolution brain electromagnetic tomography (LORETA)*. Funkční konektivita u obsedantně-kompulzivní poruchy: Korelační analýza elektromagnetické mozkové tomografie (LORETA), 2007. **11**(SUPPL. 3): p. 99-104.

Summary: This study compared cortical functional connectivity between patients with obsessive-compulsive disorder (OCD) and healthy controls using voxel-wise electrical activity (current density) correlations estimated by LORETA (low-resolution brain electromagnetic tomography). 16 OCD patients (10 men and 6 women) on stable, benzodiazepine-free medication participated in the study. The mean current density in three a priori selected homologous cortical regions (anterior cingulate, superior temporal cortex and orbitofrontal cortex) was correlated in time with current density in the remaining of 2394 cortical voxels. The individual z-scores obtained by normative database comparisons were analyzed with randomization-permutation statistics. In OCD patients, anterior cingulate and orbitofrontal cortex showed significantly lower correlations with a large frontotemporal region of the right hemisphere, mainly in the low-frequency band. Disconnection of the superior temporal cortex was less pronounced and showed a lateralized, slightly different frequency and topographic pattern. Our findings suggest that deficient right-hemispheric functional connections in inhibitory activities might be involved in the pathophysiology of OCD.

226. Kopřivová, J., J. Praško, M. Brunovský, and J. Horáček, *Independent component analysis of the EEG signal and its application in a patient with obsessive-compulsive disorder*. Využití analýzy nezávislých komponent EEG signálu u nemocného s obsedantně-kompulzivní poruchou, 2007. **11**(4): p. 240-243.

Summary: We demonstrate the potential diagnostic and therapeutic use of electrical brain activity information decomposed via independent component analysis (ICA) in an obsessive-compulsive patient. The resting EEG was analyzed by sLORETA (standardized low-resolution electromagnetic tomography) and by the ICA using the Independent Component Neurofeedback software (ICoN, Nova Tech EEG, Inc). The sLORETA normative database comparison (Nova Tech EEG, Inc) revealed increase of absolute power in the theta frequency band, especially in the anterior cingulate and orbitofrontal gyrus whose involvement in OCD pathophysiology has been previously reported. Abnormal theta waves were also detectable by visual EEG inspection. The ICA identified their main source, localized in the affective part of the anterior cingulate and in the medial orbitofrontal cortex. With respect to out findings we hypothesize that neurofeedback aimed at decreasing theta activity of this source might lead to the normalization of dysfunctional neural network and thus improve clinical symptoms.

227. Kleinlogel, H., W. Strik, and S. Begré, *Increased NoGo-anteriorisation in first-episode schizophrenia patients during Continuous Performance Test*. Clinical Neurophysiology, 2007. **118**(12): p. 2683-2691.

Summary: Objective: NoGo-stimuli during a Continuous Performance Test (CPT) activate prefrontal brain structures such as the anterior cingulate gyrus and lead to an anteriorisation of the positive electrical field of the NoGo-P300 relative to the Go-P300, so-called NoGo-anteriorisation (NGA). NGA during CPT is regarded as a neurophysiological standard index for cognitive response control. While it is known that patients with chronic schizophrenia exhibit a significant reduction in NGA, it is unclear whether this also occurs in patients undergoing their first-episode. Thus, the aim of the present study was to determine NGA in a group of patients with first-episode schizophrenia by utilizing a CPT paradigm. Methods: Eighteen patients with first-episode schizophrenia and 18 matched healthy subjects were investigated electrophysiologically during a cued CPT, and the parameters of the Go- and NoGo-P300 were determined using microstate analysis. Low resolution tomography analysis (LORETA) was used for source determination. Results: Due to a more posterior Go- and a more anterior NoGo-centroid, NGA was greater in patients than in healthy controls. LORETA indicated the same sources for both groups after Go-stimuli, but a more anterior source in patients after NoGo-stimuli. In patients P300-amplitude responses to both Go- and NoGo-stimuli were decreased, and P300-latency to NoGo-stimuli was increased. After the Go-stimuli false reactions and reaction times were increased in patients. Conclusions: Attention was reduced in patients with first-episode schizophrenia, as indicated by more false reactions, prolongation of reaction time, P300-latencies and by a decrease in P300-amplitude. Significantly however, the NGA and prefrontal LORETA-sources indicate intact prefrontal brain structures in first-episode schizophrenia patients. Previously described changes in this indicator of prefrontal function may be related to a progressive decay in chronic schizophrenia. Significance: The results support the idea of a possible new biological marker of first episode psychosis, which may be a useful parameter for the longitudinal measurement of changing prefrontal brain function in a single schizophrenia patient. © 2007 International Federation of Clinical Neurophysiology.

228. Kawasaki, Y., T. Sumiyoshi, Y. Higuchi, T. Ito, M. Takeuchi, and M. Kurachi, *Voxel-based analysis of P300 electrophysiological topography associated with positive and negative symptoms of schizophrenia*. Schizophrenia Research, 2007. **94**(1-3): p. 164-171.

Summary: Abnormal P300 waveforms of the event-related potentials during the auditory oddball task are one of the most consistent findings in patients with schizophrenia. In the present study, we sought to test the hypothesis that the abnormal P300 waveform results from composite representation of neural activity in anatomically distinct brain regions responsible for the manifestation of positive and negative symptoms. We used the low-resolution brain electromagnetic tomography (LORETA) to obtain current density images of the P300 component from 26 patients with schizophrenia. The statistical parametric mapping (SPM) was applied to the LORETA images in order to identify brain regions that are related with the severity of psychotic symptoms as evaluated by the Brief Psychiatric Rating Scale (BPRS). The BPRS Total score was negatively correlated with the P300 current density in the left superior temporal gyrus ($r = -0.615$, corrected $p = 0.009$) and that in the right medial frontal region ($r = -0.571$, corrected $p = 0.019$) by means of SPM single-subject covariates model. These brain regions were included in the region-specific P300 sources as represented by the current density maxima (corrected $p < 0.05$) using SPM one-sample t-test. A subsequent region-of-interest analysis of Pearson correlations revealed specific relationships between the Positive subscale score and the mean current density in the left superior temporal gyrus ($r = -0.528$, $p = 0.005$) and between the Negative subscale score and the mean current densities in the medial frontal region ($r = -0.551$, $p = 0.003$) and left superior temporal gyrus ($r = -0.499$, $p = 0.009$). These results indicate that functional disturbances of neural networks involving the medial prefrontal and superior temporal regions may be responsible for the generation of positive and the negative psychotic symptoms of schizophrenia. © 2007 Elsevier B.V. All rights reserved.

229. Kam, S.C., O.Y. Kwon, and J.S. Hyun, *Location of brain electrical source activation by visually stimulated sexual arousal in young men and women: A cross spectral analysis using low resolution brain electromagnetic tomography (LORETA)*. Korean Journal of Urology, 2007. **48**(3): p. 333-343.

Summary: Purpose: To investigate the locations of the cerebral cortex activated by visually stimulated sexual arousal, and to discriminate the gender differences between the cortical activation patterns in response to sexual stimuli. Materials and Methods: Thirty-two male and the twenty-one female volunteers from right-handed medical students were enrolled in this study. The electroencephatography (EEGs) included the segments recorded during resting, watching a music-video, intermission and watching a pornographic video. The low-resolution brain electromagnetic tomography (LORETA) images of cross-spectral analysis were obtained from the segments using the LORETA-KEY software. Results: The beta 1, 2 and 3 activities of males showed the point of maximal current densities in both the uncus and parahippocampal gyrus of the left limbic lobe, the anterior cingulate of the right limbic lobe, the superior temporal gyrus of both temporal lobes, the precuneus of the right parietal lobe, the medial frontal gyrus and superior frontal gyrus of the right frontal lobe, the superior parietal lobule of the right parietal lobe, and the middle occipital gyrus of both occipital lobes. The delta, theta, alpha and beta 1 activities of females showed the point of maximal current densities in the postcentral gyrus and inferior parietal lobule of the left parietal lobe, the middle frontal gyrus of the left frontal lobe, the middle occipital gyrus of the left occipital lobe, the left cuneus, the superior temporal gyrus of both temporal lobes and the left parahippocampal

gyrus. Conclusions: There was a difference in the visually stimulated sexual arousal-associated with the cerebral neuroanatomical areas between men and women, as estimated using the LORETA software. These areas; therefore, were thought to play important roles in the sexual arousal of males and females in response to audiovisual sexual stimulation.

230. Jiangang, L. and T. Jie, *Spatiotemporal analysis of single-trial EEG of emotional pictures based on Independent Component Analysis and source location*. Progress in Biomedical Optics and Imaging - Proceedings of SPIE, 2007. **6511**(PART 2).

Summary: The present study combined the Independent Component Analysis (ICA) and low-resolution brain electromagnetic tomography (LORETA) algorithms to identify the spatial distribution and time course of single-trial EEG record differences between neural responses to emotional stimuli vs. the neutral. Single-trial multichannel (129-sensor) EEG records were collected from 21 healthy, right-handed subjects viewing the emotion emotional (pleasant/unpleasant) and neutral pictures selected from International Affective Picture System (IAPS). For each subject, the single-trial EEG records of each emotional pictures were concatenated with the neutral, and a three-step analysis was applied to each of them in the same way. First, the ICA was performed to decompose each concatenated single-trial EEG records into temporally independent and spatially fixed components, namely independent components (ICs). The IC associated with artifacts were isolated. Second, the clustering analysis classified, across subjects, the temporally and spatially similar ICs into the same clusters, in which nonparametric permutation test for Global Field Power (GFP) of IC projection scalp maps identified significantly different temporal segments of each emotional condition vs. neutral. Third, the brain regions accounted for those significant segments were localized spatially with LORETA analysis. In each cluster, a voxel-by-voxel randomization test identified significantly different brain regions between each emotional condition vs. the neutral. Compared to the neutral, both emotional pictures elicited activation in the visual, temporal, ventromedial and dorsomedial prefrontal cortex and anterior cingulated gyrus. In addition, the pleasant pictures activated the left middle prefrontal cortex and the posterior precuneus, while the unpleasant pictures activated the right orbitofrontal cortex, posterior cingulated gyrus and somatosensory region. Our results were well consistent with other functional imaging studies, while revealed temporal dynamics of emotional processing of specific brain structure with high temporal resolution.

231. Jaušovec, N. and K. Jaušovec, *Personality, gender and brain oscillations*. International Journal of Psychophysiology, 2007. **66**(3): p. 215-224.

Summary: The aim of the study was to investigate the relationship between personality structure and brain activity of individuals while resting with eyes closed. In the experiment 110 individuals participated (55 males and 55 females). They were clustered into 5 personality types according to the dimensions of general and emotional intelligence, and the five-factor personality model (FFM) - extraversion (E), neuroticism (N), openness (O), conscientiousness (C) and agreeableness (A). The resting EEG of individuals was analyzed using three methods: a Fast Fourier Transformation (FFT); Approximated entropy (ApEn), and a low resolution brain electromagnetic tomography (LORETA). The results show that most robust differences between personality types were observed in the gamma band, between types with extreme constellations of dimensions (neurotic type - low emotional intelligence and A; high N), or between types with specific combinations of dimensions (introverts with high IQ, versus extraverts with low to average IQ). These differences were also gender specific. In the gamma band females with different personality structures differed much more than did males, whereas in the lower-1 alpha band a reverse pattern was observed. It was further shown that the differences were much more pronounced in the parieto-occipital brain areas than in the frontal areas. © 2007 Elsevier B.V. All rights reserved.

232. Im, C.H., H.K. Jung, K.Y. Jung, and S.Y. Lee, *Reconstruction of continuous and focalized brain functional source images from electroencephalography*. IEEE Transactions on Magnetics, 2007. **43**(4): p. 1709-1712.

Summary: In this paper, a new hybrid approach to reconstruct more accurate brain functional source images from electroencephalography is proposed. The proposed approach combines extended source model and focal underdetermined system solution algorithm. Feasibility studies with realistic simulation data and the epilepsy patient's data demonstrate that continuous, as well as focalized, brain electrical source images can be reconstructed utilizing the proposed approach. © 2007 IEEE.

233. Im, C.H., *Dealing with mismatched fMRI activations in fMRI constrained EEG cortical source imaging: A simulation study assuming various mismatch types*. Medical and Biological Engineering and Computing, 2007. **45**(1): p. 79-90.

Summary: Although fMRI constrained EEG source imaging could be a promising approach to enhancing both spatial and temporal resolutions of independent fMRI and EEG analyses, it has been frequently reported that a hard fMRI constraint may cause severe distortion or elimination of significant EEG sources when there are distinct mismatches between fMRI activations and EEG sources. If estimating actual EEG source locations is important and fMRI prior information is used as an auxiliary tool to enhance the concentration of widespread EEG source distributions, it is reasonable to weaken the fMRI constraint when significantly mismatched sources exist. The present study demonstrates that the mismatch problem may be partially solved by extending the prior fMRI activation regions based on the conventional source imaging results. A hard fMRI constraint is then applied when there is no distinct mismatch, while a weakened fMRI constraint is applied when there are significant mismatches. A preliminary simulation study assuming different types of mismatches such as fMRI invisible, extra, and discrepancy sources demonstrated that this approach can be a promising option to treat mismatched fMRI activations in fMRI constrained EEG source imaging. © International Federation for Medical and Biological Engineering 2006.

234. Hsiao, J.H.w., R. Shillcock, and C.y. Lee, *Neural correlates of foveal splitting in reading: Evidence from an ERP study of Chinese character recognition*. Neuropsychologia, 2007. **45**(6): p. 1280-1292.

Summary: Recent research on foveal structure and reading suggests that the two halves of a centrally fixated word seem to be initially projected to, and processed in, different hemispheres. In the current study, we utilize two contrasting structures in Chinese orthography, "SP" (the semantic radical on the left and the phonetic radical on the right) and "PS" characters (the opposite structure), to examine foveal splitting effects in event-related potential (ERP) recordings. We showed that when participants silently named centrally presented characters, there was a significant interaction between character type and hemisphere in N1 amplitude: SP characters elicited larger N1 compared with PS characters in the left hemisphere, whereas the right hemisphere had the opposite pattern. This effect is consistent with the split fovea claim, suggesting that the two halves of a character may be initially projected to and processed in different hemispheres. There was no such interaction observed in an earlier component P1. Also, there was an interaction between character type and sex of the reader in N350 amplitude. This result is consistent with Hsiao and Shillcock's [Hsiao, J. H., & Shillcock, R. (2005b). Foveal splitting causes differential processing of Chinese orthography in the male and female brain. Cognitive Brain Research, 25, 531-536] behavioural study, which showed a similar interaction in naming response time. They argued that this effect was due to a more left-lateralized network for phonological processing in the male brain compared with the female brain. The results hence showed that foveal splitting effects in visual word recognition were observed in N1 the earliest, and could extend far enough to interact with the sex of the reader as revealed in N350. © 2006 Elsevier Ltd. All rights reserved.

235. Horev, N., T. Most, and H. Pratt, *Categorical perception of speech (VOT) and analogous non-speech (FOT) signals: Behavioral and electrophysiological correlates*. Ear and Hearing, 2007. **28**(1): p. 111-128.

Summary: OBJECTIVE: To determine whether voicing perception is influenced primarily by linguistic experience or if it is due to innate temporal sensitivity to voicing boundaries, by examining behavioral and electrophysiological correlates of speech Voice-Onset-Time (VOT) and nonspeech Formant-Onset-Time (FOT) categorical perception. DESIGN: Behavioral measures and auditory event-related potentials (ERPs) were obtained from 14 normal-hearing Hebrew speakers, whose voicing distinction is different than English, during identification and discrimination of two sets of stimuli: a VOT continuum, created by editing natural productions of /ba/ and /pa/, and an analogous nonspeech continuum, composed of two synthesized formants, varying in their onset time-FOT. RESULTS: VOT and FOT continua yielded similar behavioral identification curves. Differences between the two stimulus types were found in discrimination

of within-category differences and in reaction time effects. During identification and discrimination tasks, ERPs were differently affected by the VOT or FOT value of the stimulus: VOT value had a significant effect on N1 latency and on N1 and P2 amplitudes whereas FOT value had a significant effect on P2 amplitude. Additionally, during identification tasks, whereas all speech signals evoked a P3, regardless of overt categorization, only the perceptually "rare" nonspeech stimulus (+15 msec FOT) evoked a P3. CONCLUSIONS: Voicing boundaries corresponded to Hebrew VOT values of production, suggesting that voicing perception in Hebrew is mediated mainly by linguistic experience rather than by innate temporal sensitivity. ERP data differed to VOT versus FOT stimuli as early as N1, indicating that brain processing of the temporal aspects of speech and nonspeech signals differ from their early stages. Further studies to establish the neural response patterns to voicing in speakers of languages that use different voicing categories than English are warranted. © 2007 Lippincott Williams & Wilkins, Inc.

236. Horacek, J., M. Brunovsky, T. Novak, L. Skrdlantova, M. Klirova, V. Bubenikova-Valesova, V. Krajca, B. Tislerova, M. Kopecek, F. Spaniel, P. Mohr, and C. Höschl, *Effect of low-frequency rTMS on electromagnetic tomography (LORETA) and regional brain metabolism (PET) in schizophrenia patients with auditory hallucinations*. Neuropsychobiology, 2007. **55**(3-4): p. 132-142.

Summary: Background: Auditory hallucinations are characteristic symptoms of schizophrenia with high clinical importance. It was repeatedly reported that low frequency (≤1Hz) repetitive transcranial magnetic stimulation (rTMS) diminishes treatment-resistant auditory hallucinations. A neuroimaging study elucidating the effect of rTMS in auditory hallucinations has yet to be published. Objective: To evaluate the distribution of neuronal electrical activity and the brain metabolism changes after low-frequency rTMS in patients with auditory hallucinations. Methods: Low-frequency rTMS (0.9 Hz, 100% of motor threshold, 20 min) applied to the left temporoparietal cortex was used for 10 days in the treatment of medication-resistant auditory hallucinations in schizophrenia (n = 12). The effect of rTMS on the low-resolution brain electromagnetic tomography (LORETA) and brain metabolism (18FDG PET) was measured before and after 2 weeks of treatment. Results: We found a significant improvement in the total and positive symptoms (PANSS), and on the hallucination scales (HCS, AHRS). The rTMS decreased the brain metabolism in the left superior temporal gyrus and in interconnected regions, and effected increases in the contralateral cortex and in the frontal lobes. We detected a decrease in current densities (LORETA) for the beta-1 and beta-3 bands in the left temporal lobe whereas an increase was found for beta-2 band contralaterally. Conclusion: Our findings implicate that the effect is connected with decreased metabolism in the cortex underlying the rTMS site, while facilitation of metabolism is propagated by transcallosal and intrahemispheric connections. The LORETA indicates that the neuroplastic changes affect the functional laterality and provide the substrate for a metabolic effect. Copyright © 2007 S. Karger AG.

237. Henson, R.N., J. Mattout, K.D. Singh, G.R. Barnes, A. Hillebrand, and K. Friston, *Population-level inferences for distributed MEG source localization under multiple constraints: Application to face-evoked fields*. NeuroImage, 2007. **38**(3): p. 422-438.

Summary: We address some key issues entailed by population inference about responses evoked in distributed brain systems using magnetoencephalography (MEG). In particular, we look at model selection issues at the within-subject level and feature selection issues at the between-subject level, using responses evoked by intact and scrambled faces around 170 ms (M170). We compared the face validity of subject-specific forward models and their summary statistics in terms of how estimated responses reproduced over subjects. At the within-subject level, we focused on the use of multiple constraints, or priors, for inverting distributed source models. We used restricted maximum likelihood (ReML) estimates of prior covariance components (in both sensor and source space) and show that their relative importance is conserved over subjects. At the between-subject level, we used standard anatomical normalization methods to create posterior probability maps that furnish inference about regionally specific population responses. We used these to compare different summary statistics, namely; (i) whether to test for differences between condition-specific source estimates, or whether to test the source estimate of differences between conditions, and (ii) whether to accommodate differences in source orientation by using signed or unsigned (absolute) estimates of source activity. Crown Copyright © 2007.

238. Hanslmayr, S., W. Klimesch, P. Sauseng, W. Gruber, M. Doppelmayr, R. Freunberger, T. Pecherstorfer, and N. Birbaumer, *Alpha phase reset contributes to the generation of ERPs*. Cerebral Cortex, 2007. **17**(1): p. 1-8.

Summary: An unresolved question in electroencephalogram (EEG) research is whether event-related potentials (ERPs) are generated by phase-reset or evoked response. We analyzed data of a visual feature detection task and will show 1) phase concentration in the alpha frequency range, 2) ongoing alpha activity prior to stimulus onset, 3) evoked alpha oscillation in the ERP, 4) lack of power increase during phase concentration, 5) decrease in amplitude variance during early evoked components preceding a decrease in power, and 6) the same cortical sources for induced prestimulus power and evoked poststimulus power. Because none of these data provide unequivocal evidence for phase reset, we additionally tested the basic assumption of the evoked model, which is the additivity of the evoked response on the basis of a simulation approach. Our findings suggest that nonadditive processes - typical for a phase reset - are involved in the generation of the ERP. Thus, together with the other findings this study provides unequivocal evidence for phase resetting in the human EEG. © The Author 2006. Published by Oxford University Press. All rights reserved.

239. Halder, P., S. Brem, K. Bucher, S. Boujraf, P. Summers, T. Dietrich, S. Kollias, E. Martin, and D. Brandeis, *Electrophysiological and hemodynamic*

evidence for late maturation of hand power grip and force control under visual feedback. Human Brain Mapping, 2007. **28**(1): p. 69-84.

Summary: Several human imaging studies have described the neural network involved in power grip under visual control and the subset of cortical areas within this network that are sensitive to force modulation. As there is behavioral evidence for late maturation in even simple hand motor tasks involving visual feedback, we aimed at identifying the neural correlates of these developmental changes. Subjects from three developmental age groups (9-11, 15-17, and adults) performed the same power grip task in both a functional magnetic resonance imaging and an event-related potential (ERP) session. Trials started with a visual target indicating whether to squeeze at 20%, 40%, or 75% of their maximum and online visual feedback on the actual amount of force was provided. Longer reaction times and more shallow slopes of the force curve characterized the behavior of the younger age groups, especially the children. Both neurophysiological methods detected both general as well as force modulation-specific maturational changes. General development was characterized by decreasing ERP amplitudes and increasing deactivation of an extended network, closely resembling the so-called "default" network. The most pronounced developmental changes specific for force control were observed in an ERP component and brain regions involved in feedback processing. In contrast to adult subjects, we found evidence for a stronger dependency on visual feedback information in the younger age groups. Our results also suggest that the ability to deactivate task-irrelevant networks might be a late developmental achievement. © 2006 Wiley-Liss, Inc.

240. Grau, C., L. Fuentemilla, and J. Marco-Pallarés, *Functional neural dynamics underlying auditory event-related N1 and N1 suppression response*. NeuroImage, 2007. **36**(3): p. 522-531.

Summary: Presenting tone triplets of identical stimuli preceded by silent intervals of 30 s produces a series of three N1 averaged event-related potentials (ERPs), the first being of greater amplitude (non-suppressed N1) than the second and third ones (suppressed N1). Maximal statistically independent components (ICs) of single-trial multi-electrode scalp EEG responses to triplets were obtained by ICA algorithm, and then each IC was searched for underlying brain structures by LORETA inverse solution, and for oscillatory contributions by time-frequency analysis. Non-suppressed N1 cortical mechanisms were broken down into five ICs, grouped in two time-windows (early-onset and late-onset) involving the participation of temporal, frontal and parietal structures, and sub-serving EEG oscillatory contributions of power enhancement and putative phase concentration of mainly theta, alpha and low beta bands. Suppressed N1 was due to the modulation of two above-mentioned early-onset ICs, involving temporal structures only, and mainly sub-serving oscillatory contributions of phase concentration of theta and alpha. Present results, showing quantifiable changes of IC descriptors - i.e. time window of activation, implied structures and oscillatory contributions - extracted from two distinct brain functional situations

(non-suppressed versus suppressed N1), give support to the view that ICA is not merely a statistical "latent variables" model when applied to ERPs, but could help to capture underlying specific function subunits of brain dynamics. © 2007 Elsevier Inc. All rights reserved.

241. Gómez, C.M., A. Flores, and A. Ledesma, *Fronto-parietal networks activation during the contingent negative variation period*. Brain Research Bulletin, 2007. **73**(1-3): p. 40-47.

Summary: The preparation for stimuli and responses in which the position and required finger to respond are cued, produces the preparatory activation of the specific neural resources that are going to be needed for the completion of the task. The focus of the present report is to evaluate if the fronto-parietal networks activated in fMRI studies during endogenous attention are also activated during the CNV period using EEG recording. The behavioural responses and 64 EEG channels were recorded during an S1-S2 paradigm similar to Posner central cue paradigms. The LORETA analysis based in the averaging of the z-LORETA values showed that the Brodmann's areas with the highest activation during the CNV period were in the medial and superior frontal areas, fronto-parietal lateral areas (including the premotor cortex) and extrastriate visual cortex. These results suggest that in addition to the previously described activation in premotor-motor, posterior sensory and superior and medial frontal areas, the activation of fronto-parietal networks is a main contributor to the CNV, indicating the endogenous attentional effort during the CNV period. © 2007 Elsevier Inc. All rights reserved.

242. Gianotti, L.R.R., G. Künig, D. Lehmann, P.L. Faber, R.D. Pascual-Marqui, K. Kochi, and U. Schreiter-Gasser, *Correlation between disease severity and brain electric LORETA tomography in Alzheimer's disease*. Clinical Neurophysiology, 2007. **118**(1): p. 186-196.

Summary: Objective: To compare EEG power spectra and LORETA-computed intracortical activity between Alzheimer's disease (AD) patients and healthy controls, and to correlate the results with cognitive performance in the AD group. Methods: Nineteen channel resting EEG was recorded in 21 mild to moderate AD patients and in 23 controls. Power spectra and intracortical LORETA tomography were computed in seven frequency bands and compared between groups. In the AD patients, the EEG results were correlated with cognitive performance (Mini Mental State Examination, MMSE). Results: AD patients showed increased power in EEG delta and theta frequency bands, and decreased power in alpha2, beta1, beta2 and beta3. LORETA specified that increases and decreases of power affected different cortical areas while largely sparing prefrontal cortex. Delta power correlated negatively and alpha1 power positively with the AD patients' MMSE scores; LORETA tomography localized these correlations in left temporo-parietal cortex. Conclusions: The non-invasive EEG method of LORETA localized pathological cortical activity in our mild to moderate AD patients in agreement with the literature, and yielded striking correlations between EEG delta and

alpha1 activity and MMSE scores in left temporo-parietal cortex. Significance: The present data support the hypothesis of an asymmetrical progression of the Alzheimer's disease. © 2006 International Federation of Clinical Neurophysiology.

243. Giabbiconi, C.M., N.J. Trujillo-Barreto, T. Gruber, and M.M. Müller, *Sustained spatial attention to vibration is mediated in primary somatosensory cortex*. NeuroImage, 2007. **35**(1): p. 255-262.

Summary: Focusing attention to a specific body location has been shown to improve processing of events presented at this body location. One important debate concerns the stage in the somatosensory pathway at which the neural response is modulated when one attends to a tactile stimulus. Previous studies focused on components of the somatosensory evoked potential to transient stimuli, and demonstrated an early cortical attentional modulation. The neural basis of sustained spatial stimulus processing with continuous stimulation remains, however, largely unexplored. A way to approach this topic is to present vibrating stimuli with different frequencies for several seconds simultaneously to different body locations while subjects have to attend to the one or the other location. The amplitude of the somatosensory steady-state evoked potential (SSSEP) elicited by these vibrating stimuli increases with attention. On the basis of 128 electrode recordings, we investigated the topographical distribution and the underlying cortical sources by means of a VARETA approach of this attentional amplitude modulation of the SSSEP. Sustained spatial attention was found to be mediated in primary somatosensory cortex with no differences in SSSEP amplitude topographies between attended and unattended body locations. These result patterns were seen as evidence for a low-level sensory gain control mechanism in tactile spatial attention. © 2006 Elsevier Inc. All rights reserved.

244. Gallinat, J., T. Götz, P. Kalus, M. Bajbouj, T. Sander, and G. Winterer, *Genetic variations of the NR3A subunit of the NMDA receptor modulate prefrontal cerebral activity in humans*. Journal of Cognitive Neuroscience, 2007. **19**(1): p. 59-68.

Summary: Introduction: Recently, a novel N-methyl-D-aspartate (NMDA) receptor subunit, NR3A, has been discovered in the brain. This subunit decreases NMDA receptor activity by modulating the calcium permeability of the receptor channel and current density in cortical cells. Because the NR3A is expressed in the human prefrontal cortex, we hypothesized that genetic variations of the NR3A subunit modulate prefrontal activation. Methods: Electromagnetic activity during selective attention (auditory odd-ball task with target processing) was measured in 281 healthy subjects. Genotyping of a missense variation (rs10989591, Val362Met) of the NR3A gene was performed. Results: Individuals carrying Val/Val genotype showed significantly reduced frontal P300 amplitudes compared with Met/Met subjects. Subsequent low-resolution electromagnetic source analysis revealed that this group difference is likely caused by reduced activation in the inferior frontal gyrus. Conclusions: It was shown for the first time that the genetic constitution of the subunit composition of NMDA receptor regulation might be relevant for prefrontal information processing in humans. The results underline the pivotal role of glutamate in frontal lobe function and indicate that the NR3A subunit could be a plausible candidate gene for diseases with prefrontal dysfunctions. © 2007 Massachusetts Institute of Technology.

245. Freunberger, R., W. Klimesch, P. Sauseng, B. Griesmayr, Y. Höller, T. Pecherstorfer, and S. Hanslmayr, *Gamma oscillatory activity in a visual discrimination task*. Brain Research Bulletin, 2007. **71**(6): p. 593-600.

Summary: We tested the hypothesis whether images of real objects elicit stronger gamma (>25 Hz) synchronization, when compared with scrambled objects. The background of this study is a recent debate about the functional meaning of evoked and induced gamma oscillations. Brain electrical source analysis (BESA) and low resolution electromagnetic tomography analysis (LORETA) was performed on the basis of the event-related potential (ERP) data. A component at around 230 ms (termed C230) showed strongest differences between objects and scrambled objects. Time-frequency analyses were run across electrodes and within the dipole sources. We found increased gamma event-related synchronization (ERS) between 200 and 300 ms for real objects. This effect was strongest in a fronto-medial source. Induced gamma, as also shown in previous studies, reflects the more task-relevant mechanism where object representations become activated. © 2006 Elsevier Inc. All rights reserved.

246. Ferri, R., F. Rundo, O. Bruni, M.G. Terzano, and C.J. Stam, *Small-world network organization of functional connectivity of EEG slow-wave activity during sleep*. Clinical Neurophysiology, 2007. **118**(2): p. 449-456.

Summary: Objective: To analyze the functional connectivity patterns of the EEG slow-wave activity during the different sleep stages and Cyclic Alternating Pattern (CAP) conditions, using concepts derived from Graph Theory. Methods: We evaluated spatial patterns of EEG slow-wave synchronization between all possible pairs of electrodes (19) placed over the scalp of 10 sleeping healthy young normal subjects using two graph theoretical measures: the clustering coefficient (Cp) and the characteristic path length (Lp). The measures were obtained during the different sleep stages and CAP conditions from the real EEG connectivity networks and randomized control (surrogate) networks (Cp-s and Lp-s). Results: Cp and Cp/Cp-s increased significantly from wakefulness to sleep while Lp and Lp/Lp-s did not show changes. Cp/Cp-s was higher for A1 phases, compared to B phases of CAP. Conclusions: The network organization of the EEG slow-wave synchronization during sleep shows features characteristic of small-world networks (high Cp combined with low Lp); this type of organization is slightly but significantly more evident during the CAP A1 subtypes. Significance: Our results show feasibility of using graph theoretical measures to characterize the complexity of brain networks during sleep and might indicate sleep, and the A1 phases of CAP in particular, as a period during which slow-wave synchronization

shows optimal network organization for information processing. © 2006 International Federation of Clinical Neurophysiology.

247. Fehmi, L.G. and T. Collura, *Effects of electrode placement upon EEG biofeedback training: The monopolar-bipolar controversy*. Journal of Neurotherapy, 2007. **11**(2): p. 45-63.

Summary: Roles of tradition, convenience, and noise or artifact rejection are discussed with regard to the referential versus bipolar electrode placement controversy in electroencephalography (EEG). Particular emphasis is placed on the relevance to neurofeedback. The crucial interactions between the differential amplifier, brain waves, and referential/bipolar placements are discussed. Through logical analysis and empirical observation, it is demonstrated how the very nature of the EEG differential amplifier must destroy those elements of brain activity which are common (synchronous) to the recording electrodes. Controlled experiments further illustrate the critical importance of electrode placements. Various methods, including preferred electrode placements, are presented to help resolve recording problems that frequently arise. It is concluded that there are serious implications for researchers, EEG clinicians, neurofeedback providers, and their clients in preferring one type of electrode placement technique over another. EEG recording information is affected by this choice. © 2007 by The Haworth Press, Inc. All rights reserved.

248. Ehlis, A.C., A. Reif, M.J. Herrmann, K.P. Lesch, and A.J. Fallgatter, *Impact of catechol-O-methyltransferase on prefrontal brain functioning in schizophrenia spectrum disorders*. Neuropsychopharmacology, 2007. **32**(1): p. 162-170.

Summary: The enzyme catechol-O-methyltransferase (COMT) has attracted increasing interest regarding a genetic disposition towards schizophrenias and as a modulator of prefrontal brain function. A common SNP in the COMT gene causes a Val to Met transition at AA158/AA108 (Val158Met), resulting in reduced COMT activity in Met allele carriers. An impact of COMT genotype on cognition has been well established; however, the exact nature of this influence has yet to be elucidated. The aim of this study was to determine whether COMT genotype affects an electrophysiological marker of prefrontal activation and neuropsychological frontal lobe measures in schizophrenia. To this end, 56 acutely psychotic in-patients with schizophrenia spectrum disorders were investigated. Patients with the COMT 1947AA (Met/Met) genotype (n=13) were compared to a carefully matched sample of patients with a G1947A (Val/Met) genotype (n=15); matching criteria included patients' age, handedness, gender distribution, diagnosis, and medication status. A small group of six homozygous Val allele carriers was additionally included to allow an assessment of possible gene-dosage effects. P300 amplitudes and latencies, as well as an electrophysiological marker of prefrontal brain function (NoGo-Anteriorization/ NGA) and neuropsychological measures (Stroop Test, Verbal Fluency, Trail Making Test) were regarded. Homozygous Met allele carriers had significantly increased NGA values and fronto-central Nogo amplitudes compared to patients with at least one Val allele. They also tended to perform better in the Stroop task, as compared to the matched group of Val/Met patients. These results indicate that COMT genotype exerts a strong impact on prefrontal functioning and executive control in schizophrenia spectrum disorders. © 2007 Nature Publishing Group All rights reserved.

249. Ehlis, A.C., M.J. Herrmann, P. Pauli, G. Stoeber, B. Pfuhlmann, and A.J. Fallgatter, *Improvement of prefrontal brain function in endogenous psychoses under atypical antipsychotic treatment*. Neuropsychopharmacology, 2007. **32**(8): p. 1669-1677.

Summary: Typical and atypical antipsychotics are thought to exert their effects on different neurotransmitter pathways with specific action of atypical compounds on the prefrontal cortex, but studies directly investigating the effect of those drugs on neurophysiological measures of prefrontal brain function are sparse. We therefore investigated the influence of different antipsychotics on an electrophysiological marker of prefrontal brain function (NoGo anteriorization, NGA) and neuropsychological test scores. For this purpose, 38 patients with endogenous psychoses were investigated at the beginning of a stationary psychiatric treatment and at a 6-week-follow-up. Patients were treated with typical or atypical antipsychotics, or a combination of both. They underwent psychopathological diagnostic and neuropsychological testing, as well as electrophysiological investigations during a Continuous Performance Test. The results indicate that typical and atypical antipsychotics differentially affected the development of the NGA over the course of the treatment, typical antipsychotics tending to result in decreased values at follow-up, and atypical antipsychotics stabilizing, or increasing this parameter. Performance in tests of frontal lobe function generally declined under typical antipsychotics and improved with atypical compounds, changes in Stroop interference correlated with changes in the NGA. We conclude that typical and atypical antipsychotics differ regarding their effect on prefrontal brain function in schizophrenia, atypical neuroleptics often showing a more favorable impact than conventional antipsychotics on respective parameters. © 2007 Nature Publishing Group All rights reserved.

250. Duregger, C., H. Bauer, R. Cunnington, G. Lindinger, L. Deecke, W. Lang, G. Dirnberger, and P. Walla, *EEG evidence of gender differences in a motor related CNV study*. Journal of Neural Transmission, 2007. **114**(3): p. 359-366.

Summary: In the present study gender differences related to the contingent negative variation (CNV) were investigated. A series of two acoustic stimuli was presented to participants across a wide age range. The first stimulus was consistent throughout the experiment whereas the second one was either a high frequency or a low frequency tone. One of them had to be answered by a button press (go condition) the other did not require any response (nogo condition). Between the first and the second tone there was a time period of two seconds in which the CNV appeared as a slow negative potential shift. Within this episode

data were analysed with respect to gender differences. Statistical analysis revealed topographical differences between men and women in go conditions for both left and right index finger movements. Differences were found over frontal regions where women showed higher brain activity than men and over temporo-parietal regions where men produced higher brain activity than women. In order to explain the fact that only in "go" conditions significant gender differences occurred we introduce the phenomenon of implicit learning. Due to implicit learning assumed predictions related to S2 might have occurred from time to time. This is so, because a 50% chance for one of two different stimuli to occur leads to reasonable assumed predictions after two or more stimuli of a kind occurring in a series. The present data now provide evidence that if such assumed prediction or expectancy is directed towards an upcoming demand to act then brain activity is subject to gender differences. Further studies providing controlled sequences of "go" conditions versus "nogo" conditions have to be done to prove this idea true. © 2006 Springer-Verlag.

251. Ding, L., G.A. Worrell, T.D. Lagerlund, and B. He, *Ictal source analysis: Localization and imaging of causal interactions in humans*. NeuroImage, 2007. **34**(2): p. 575-586.

Summary: We propose a new integrative approach to characterize the structure of seizures in the space, time, and frequency domains. Such characterization leads to a new technical development of ictal source analysis for the presurgical evaluation of epilepsy patients. The present new ictal source analysis method consists of three parts. First, a three-dimensional source scanning procedure is performed by a spatio-temporal FINE source localization method to locate the multiple sources responsible for the time evolving ictal rhythms at their onsets. Next, the dynamic behavior of the sources is modeled by a multivariate autoregressive process (MVAR). Lastly, the causal interaction patterns among the sources as a function of frequency are estimated from the MVAR modeling of the source temporal dynamics. The causal interaction patterns indicate the dynamic communications between sources, which are useful in distinguishing the primary sources responsible for the ictal onset from the secondary sources caused by the ictal propagation. The present ictal analysis strategy has been applied to a number of seizures from five epilepsy patients, and their results are consistent with observations from either MRI lesions or SPECT scans, which indicate its effectiveness. Each step of the ictal source analysis is statistically evaluated in order to guarantee the confidence in the results. © 2006 Elsevier Inc. All rights reserved.

252. Ding, L., C. Wilke, B. Xu, X. Xu, W. Van Drongelen, M. Kohrman, and B. He, *EEG source imaging: Correlating source locations and extents with electrocorticography and surgical resections in epilepsy patients*. Journal of Clinical Neurophysiology, 2007. **24**(2): p. 130-136.

Summary: It is desirable to estimate epileptogenic zones with both location and extent information from noninvasive EEG. In the present study, the authors use a subspace source localization method (FINE), combined with a local thresholding technique, to achieve such tasks. The performance of this method was evaluated in interictal spikes from three pediatric patients with medically intractable partial epilepsy. The thresholded subspace correlation, which is obtained from FINE scanning, is a favorable marker, which implies the extents of current sources associated with epileptic activities. The findings were validated by comparing the results with invasive electrocorticographic (ECoG) recordings of interictal spike activity. The surgical resections in these three patients correlated well with the epileptogenic zones identified from both EEG sources and ECoG potential distributions. The value of the proposed noninvasive technique for estimating epileptiform activity was supported by satisfactory surgery outcomes. Copyright © 2007 American Clinical Neurophysiology Society.

253. Ding, L. and B. He, *Sparse source imaging in EEG.* Proc. of 2007 Joint Meet. of the 6th Int. Symp. on Noninvasive Functional Source Imaging of the Brain and Heart and the Int. Conf. on Functional Biomedical Imaging, NFSI and ICFBI 2007, 2007: p. 20-23.

Summary: We have developed a new L1-norm based minimum norm estimate (MNE), which is termed as sparse source imaging (SSI). The new SSI algorithm corrects inaccurate orientation discrepancy in previously reported L1-norm MNEs. A new solver to the newly developed SSI has been adopted and known as the second order cone programming (SOCP). The new SSI is assessed by a series of computer simulations. The performance of SSI is compared with other L1-norm MNEs by evaluating the localization error and orientation error. The present simulation results indicate that the new SSI has significantly improved performance, especially in the metric of orientation error. The previously reported L1-norm MNEs show large orientation errors due to the orientation discrepancy. The new SSI algorithm is also applicable to MEG source imaging. © 2007 IEEE.

254. Deouell, L.Y., *The frontal generator of the mismatch negativity revisited.* Journal of Psychophysiology, 2007. **21**(3-4): p. 188-203.

Summary: The mismatch negativity (MMN) is an event-related brain potential elicited by the occurrence of a rare event (deviance) in an otherwise regular acoustic environment, and is assumed to reflect apreattentive mechanism for change detection. A widely adopted model holds that MMN has main generators in the superior temporal planes bilaterally, which are responsible for the sensory memory part of change detection, as well as frontal lobe sources responsible for triggering an attention shift upon change detection. Whereas the temporal sources have been documented in numerous studies across species and methodologies, much less is known about the frontal sources. The present review examines the current state of the evidence for their existence, location, and possible function. It confirms that the frontal generator is still a less consistent finding in MMN research than the temporal generator. There is clear evidence from scalp EEG and, especially, current source density studies for the existence of an MMN generator that is functionally distinct from the main supratemporal generator of the MMN. Evidence from fMRI, PET, optical imaging, EEG source imaging, and lesion studies implicates mainly the inferior frontal and possibly also the medial frontal cortex. However, these results should be taken with caution because of the paucity of support from more direct measures like intracranial recordings and MEG, and the negative findings from several fMRI and PET, as well as EEG source imaging studies. Recent studies also raise questions about the exact role of the frontal generator in triggering an attention shift. Delineating the exact cortical locations of frontal MMN generators, the conditions under which they are activated and. consequently, their function, remains an acute challenge. © 2007 Federation of European Psychophysiology Societies.

255. Delorme, A., M. Westerfield, and S. Makeig, *Medial prefrontal theta bursts precede rapid motor responses during visual selective attention*. Journal of Neuroscience, 2007. **27**(44): p. 11949-11959.

Summary: After visual target stimuli presented infrequently at a covertly attended location, quicker speeded button presses immediately followed a larger positive (P3f) ramp in averaged electroencephalographic (EEG) recordings from the forehead. We show this peak in the mean response time locked to the button press to be principally composed of triphasic, primarily low-theta band (4.5 Hz) complexes preceding but only partially phase-locked to the button press, with larger complexes preceding quicker motor responses. For 10 of 15 subjects, independent component analysis of the unaveraged 31-channel data identified a temporally independent medial frontal EEG process contributing to these phenomena. Low-resolution tomographic modeling localized related components of two 253-channel data sets to medial frontal polar cortex (BA32/10). The far-frontal low-theta complexes and concomitant mean P3f positivity may index cortical activity induced by paralimbic processes involved in disinhibiting impulsive motor responses to rewarding or goal-fulfilling stimuli or events. Copyright © 2007 Society for Neuroscience.

256. Deboer, T., *Technologies of sleep research*. Cellular and Molecular Life Sciences, 2007. **64**(10): p. 1227-1235.

Summary: Sleep is investigated in many different ways, many different species and under many different circumstances. Modern sleep research is a multidisciplinary venture. Therefore, this review cannot give a complete overview of all techniques used in sleep research and sleep medicine. What it will try to do is to give an overview of widely applied techniques and exciting new developments. Electroencephalography has been the backbone of sleep research and sleep medicine since its first application in the 1930s. The electroencephalogram is still used but now combined with many different techniques monitoring body and brain temperature, changes in brain and blood chemistry, or changes in brain functioning. Animal research has been very important for progress in sleep research and sleep medicine. It provides opportunities to investigate the sleeping brain in ways not possible in healthy volunteers. Progress in genomics has brought new insights in sleep regulation, the best example being the discovery of hypocretin/orexin deficiency as the cause of narcolepsy. Gene manipulation holds great promise for the future since it is possible not only to investigate the functions of different genes under normal conditions, but also to mimic human pathology in much greater detail. © 2007 Birkhäuser Verlag.

257. De Vos, M., L. De Lathauwer, B. Vanrumste, S. Van Huffel, and W. Van Paesschen, *Canonical decomposition of ictal scalp EEG and accurate source localisation: Principles and simulation study*. Computational Intelligence and Neuroscience, 2007. **2007**.

Summary: Long-term electroencephalographic (EEG) recordings are important in the presurgical evaluationof refractory partial epilepsy for the delineation of the ictal onset zones. In this paper, we introduce a new concept for an automatic, fast, and objective localisation of the ictal onset zone in ictal EEG recordings. Canonical decomposition of ictal EEG decomposes the EEG in atoms. One or more atoms are related to the seizure activity. A single dipole was then fitted to model the potential distribution of each epileptic atom. In this study, we performed a simulation study in order to estimate the dipole localisation error. Ictal dipole localisation was very accurate, even at low signal-to-noise ratios, was not affected by seizure activity frequency or frequency changes, and was minimally affected by the waveform and depth of the ictal onset zone location. Ictal dipole localisation error using 21 electrodes was around 10.0 mm andimproved more than tenfold in the range of 0.5-1.0 mm using 148 channels. In conclusion, oursimulation study of canonical decomposition of ictal scalp EEG allowed a robust and accuratelocalisation of the ictal onset zone.

258. de Tommaso, M., O. Difruscolo, V. Sciruicchio, N. Specchio, and P. Livrea, *Abnormalities of the contingent negative variation in Huntington's disease: Correlations with clinical features*. Journal of the Neurological Sciences, 2007. **254**(1-2): p. 84-89.

Summary: The contingent negative variation (CNV) is a neurophysiological pattern related to planning of external - paced, voluntary movements. The aim of the study, was to examine the CNV in a cohort of mild demented and non-medicated HD patients, evaluating the CNV amplitude modifications in the light of clinical features and performing Low Resolution Brain Electromagnetic Tomography (LORETA) analysis in order to show the CNV multiple generators. Fourteen HD patients and 25 sex and age-matched controls were studied. All subjects were evaluated by the motor section of UHDRS, MMSE and WAIS. The CNV was recorded by 19 scalp electrodes, with a red light flash as visual warning stimulus (S1), followed by a blue light flash (S2) after a fixed interval of 3 s. The amplitude of early CNV was significantly reduced in HD, compared to controls: the amplitude reduction was significantly correlated with the bradikinesia score. LORETA analysis of early CNV significantly discriminated patients from controls,

for a prevalent activation of the posterior part of anterior cingulate cortex in HD. An abnormal activation of the associative cortex devoted to the processing of attention preceding voluntary movement may be supposed in HD, probably mediated by the altered basal ganglia modulation. © 2007 Elsevier B.V. All rights reserved.

259. Daunizeau, J., C. Grova, G. Marrelec, J. Mattout, S. Jbabdi, M. Pélégrini-Issac, J.M. Lina, and H. Benali, *Symmetrical event-related EEG/fMRI information fusion in a variational Bayesian framework*. NeuroImage, 2007. **36**(1): p. 69-87.

Summary: In this work, we propose a symmetrical multimodal EEG/fMRI information fusion approach dedicated to the identification of event-related bioelectric and hemodynamic responses. Unlike existing, asymmetrical EEG/fMRI data fusion algorithms, we build a joint EEG/fMRI generative model that explicitly accounts for local coupling/uncoupling of bioelectric and hemodynamic activities, which are supposed to share a common substrate. Under a dedicated assumption of spatio-temporal separability, the spatial profile of the common EEG/fMRI sources is introduced as an unknown hierarchical prior on both markers of cerebral activity. Thereby, a devoted Variational Bayesian (VB) learning scheme is derived to infer common EEG/fMRI sources from a joint EEG/fMRI dataset. This yields an estimate of the common spatial profile, which is built as a trade-off between information extracted from EEG and fMRI datasets. Furthermore, the spatial structure of the EEG/fMRI coupling/uncoupling is learned exclusively from the data. The proposed data generative model and devoted VBEM learning scheme thus provide an un-supervised well-balanced approach for the fusion of EEG/fMRI information. We first demonstrate our approach on synthetic data. Results show that, in contrast to classical EEG/fMRI fusion approach, the method proved efficient and robust regardless of the EEG/fMRI discordance level. We apply the method on EEG/fMRI recordings from a patient with epilepsy, in order to identify brain areas involved during the generation of epileptic spikes. The results are validated using intracranial EEG measurements. © 2007 Elsevier Inc. All rights reserved.

260. Daunizeau, J. and K.J. Friston, *A mesostate-space model for EEG and MEG*. NeuroImage, 2007. **38**(1): p. 67-81.

Summary: We present a multi-scale generative model for EEG, that entails a minimum number of assumptions about evoked brain responses, namely: (1) bioelectric activity is generated by a set of distributed sources, (2) the dynamics of these sources can be modelled as random fluctuations about a small number of mesostates, (3) mesostates evolve in a temporal structured way and are functionally connected (i.e. influence each other), and (4) the number of mesostates engaged by a cognitive task is small (e.g. between one and a few). A Variational Bayesian learning scheme is described that furnishes the posterior density on the models parameters and its evidence. Since the number of meso-sources specifies the model, the model evidence can be used to compare models and find the optimum number of meso-sources. In addition to estimating the dynamics at each cortical dipole, the mesostate-space model and its inversion provide a description of brain activity at the level of the mesostates (i.e. in terms of the dynamics of meso-sources that are distributed over dipoles). The inclusion of a mesostate level allows one to compute posterior probability maps of each dipole being active (i.e. belonging to an active mesostate). Critically, this model accommodates constraints on the number of meso-sources, while retaining the flexibility of distributed source models in explaining data. In short, it bridges the gap between standard distributed and equivalent current dipole models. Furthermore, because it is explicitly spatiotemporal, the model can embed any stochastic dynamical causal model (e.g. a neural mass model) as a Markov process prior on the mesostate dynamics. The approach is evaluated and compared to standard inverse EEG techniques, using synthetic data and real data. The results demonstrate the added-value of the mesostate-space model and its variational inversion. © 2007 Elsevier Inc. All rights reserved.

261. Darvas, F. and R.M. Leahy, *Functional imaging of brain activity and connectivity with MEG.* Understanding Complex Systems, 2007. **2007**: p. 201-219.

Summary: We present a survey of imaging and signal processing methods that use data from magnetoencephalographic (MEG) or electroencephalographic (EEG) measurements to produce spatiotemporal maps of neuronal activity as well as measures of functional connectivity between active brain regions. During the course of the chapter, we give a short introduction to the basic bioelectromagnetic inverse problem and present a number of methods that have been developed to solve this problem. We discuss methods to address the statistical relevance of inverse solutions, which is especially important if imaging methods are used to compute the inverse. For such solutions, permutation methods can be used to identify regions of interest, which can subsequently be used for the analysis of functional connectivity. The third section of the chapter reviews a collection of methods commonly used in EEG and MEG connectivity analysis, emphasizing their restrictions and advantages and their applicability to time series extracted from inverse solutions.

262. Cottereau, B., K. Jerbi, and S. Baillet, *Multiresolution imaging of MEG cortical sources using an explicit piecewise model.* NeuroImage, 2007. **38**(3): p. 439-451.

Summary: Imaging neural generators from MEG magnetic fields is often considered as a compromise between computationally-reasonable methodology that usually yields poor spatial resolution on the one hand, and more sophisticated approaches on the other hand, potentially leading to intractable computational costs. We approach the problem of obtaining well-resolved source images with unexcessive computation load with a multiresolution image model selection (MiMS) technique. The building blocks of the MiMS source model are parcels of the cortical surface which can be designed at multiple spatial resolutions with the combination of anatomical and functional priors. Computation charge is reduced owing to 1) compact parametric models of the activation of extended brain parcels using current multipole expansions and 2) the optimization of the generalized cross-validation error on image models, which is closed-form for the broad class of linear estimators of neural currents. Model selection can be complemented by any conventional imaging approach of neural currents restricted to the optimal image support obtained from MiMS. The estimation of the location and spatial extent of brain activations is discussed and evaluated using extensive Monte-Carlo simulations. An experimental evaluation was conducted with MEG data from a somatotopic paradigm. Results show that MiMS is an efficient image model selection technique with robust performances at realistic noise levels. © 2007 Elsevier Inc. All rights reserved.

263. Cohen, M.X. and C. Ranganath, *Reinforcement learning signals predict future decisions*. Journal of Neuroscience, 2007. **27**(2): p. 371-378.

Summary: Optimal behavior in a competitive world requires the flexibility to adapt decision strategies based on recent outcomes. In the present study, we tested the hypothesis that this flexibility emerges through a reinforcement learning process, in which reward prediction errors are used dynamically to adjust representations of decision options. We recorded event-related brain potentials (ERPs) while subjects played a strategic economic game against a computer opponent to evaluate how neural responses to outcomes related to subsequent decision-making. Analyses of ERP data focused on the feedback-related negativity (FRN), an outcome-locked potential thought to reflect a neural prediction error signal. Consistent with predictions of a computational reinforcement learning model, we found that the magnitude of ERPs after losing to the computer opponent predicted whether subjects would change decision behavior on the subsequent trial. Furthermore, FRNs to decision outcomes were disproportionately larger over the motor cortex contralateral to the response hand that was used to make the decision. These findings provide novel evidence that humans engage a reinforcement learning process to adjust representations of competing decision options. Copyright © 2007 Society for Neuroscience.

264. Clemens, B., M. Bessenyei, P. Piros, M. Tóth, L. Seress, and I. Kondákor, *Characteristic distribution of interictal brain electrical activity in idiopathic generalized epilepsy*. Epilepsia, 2007. **48**(5): p. 941-949.

Summary: Purpose: To demonstrate the anatomic localization of the cortical sources of the interictal EEG activity in human idiopathic generalized epilepsy (IGE). Methods: Multiple cortical and hippocampal sources of the interictal spontaneous EEG activity were investigated by low-resolution electromagnetic tomography in 15 untreated IGE patients and in 15 healthy controls. EEG activity (current density) in four frequency bands (delta: 1.5-3.5 Hz, theta: 3.5-7.5 Hz, alpha: 7.5-12.5 Hz, beta: 12.5-25.0 Hz) was computed for 2,397 voxels. Voxel-by-voxel group comparison was done between the patient and the control group. Voxels with $p < 0.01$ differences (between the two groups) were correlated with

cortical anatomy. Results: Areas of significantly increased or decreased activity were characterized by their anatomical extension and the frequency bands involved. Five areas of bilaterally increased activity were found: rostral part of the prefrontal cortex (delta, theta); posterior part of the insula (delta); hippocampus and mediobasal temporal cortex (all frequency bands); medial parietooccipital cortex (theta, alpha, beta); dorsal and polar parts of the occipital cortex (alpha). Bilaterally decreased delta, theta, alpha activity was found in the majority of the frontal and anterior parietal cortex on the lateral surface, and in parts of the medial surface of the hemispheres. The area of decreased beta activity was less extensive. The right lateral and laterobasal temporal cortex showed decreased delta, theta, alpha, and beta activity, while its left counterpart only showed decreased delta and alpha activity in a limited part of this area. Conclusions: (1) Pathological interictal EEG activity is not evenly distributed across the cortex in IGE. The prefrontal area of increased activity corresponds to the area that is essential in the buildup of the ictal spike-wave paroxysms (absence seizures). The existence of the posterior "center of gravity" of increased EEG activity in IGE was confirmed. The frontal area of decreased activity might be related to the cognitive deficit described in IGE patients. (2) Increased activity in a lot of ontogenetically older areas (including the hippocampi) and decreased activity in the majority of the isocortex is a peculiar pattern that argues for a developmental hypothesis for IGE. © 2007 International League Against Epilepsy.

265. Chen, A., J. Yao, and J.P.A. Dewald, *A novel experimental setup combining EEG and robotics to investigate brain activity driving controlled reaching movements in chronic stroke survivors*. 2007 IEEE 10th International Conference on Rehabilitation Robotics, ICORR'07, 2007: p. 876-882.

Summary: When chronic, hemiparetic stroke survivors make reaching movements while lifting the paretic arm against gravity, their ability to generate the necessary independent joint movements for reaching degrades dramatically due to abnormal muscle coactivation patterns that couple shoulder abduction with elbow flexion. The neural mechanisms behind the appearance of abnormal coordination patterns during post-stroke recovery are largely unknown, but they are possibly related to a loss in cortical resolution and an increased usage of undamaged, indirect descending motor pathways via the brainstem. In order to investigate the underlying mechanisms for this behavior in chronic stroke survivors, we have developed a novel experimental setup that simultaneously records electroencephalographs (EEG) signals while the test subject makes different reaching movements with an ACT3D robot. This method allows us to map brain activity during controlled reaching movements with different levels of robot-mediated limb support for the first time. Our results provide evidence for changes in cortical activity driving realistic upperextremity reaching movements as independent joint control becomes compromised in stroke survivors. © 2007 IEEE.

266. Carretié, L., J.A. Hinojosa, S. López-Martín, and M. Tapia, *An electrophysiological study on the interaction between emotional content and spatial frequency of visual stimuli*. Neuropsychologia, 2007. **45**(6): p. 1187-1195.

Summary: Previous studies suggest that the magnocellular pathway, a visual processing system that rapidly provides low spatial frequency information to fast-responding structures such as the amygdala, is more involved in the processing of emotional facial expressions than the parvocellular pathway (which conveys all spatial frequencies). The present experiment explored the spatio-temporal characteristics of the spatial frequency modulation of affect-related neural processing, as well as its generalizability to non-facial stimuli. To that aim, the event-related potentials (ERPs) elicited by low-pass filtered (i.e., high spatial frequencies are eliminated) and intact non-facial emotional images were recorded from 31 participants using a 60-electrode array. The earliest significant effect of spatial frequency was observed at 135 ms from stimulus onset: N135 component of the ERPs. In line with previous studies, the origin of N135 was localized at secondary visual areas for low-pass filtered stimuli and at primary areas for intact stimuli. Importantly, this component showed an interaction between spatial frequency and emotional content: within low-pass filtered pictures, negative stimuli elicited the highest N135 amplitudes. By contrast, within intact stimuli, neutral pictures were those eliciting the highest amplitudes. These results suggest that high spatial frequencies are not essential for the initial affect-related processing of visual stimuli, which would mainly rely on low spatial frequency visual information. According to present data, high spatial frequencies would come into play later on. © 2006 Elsevier Ltd. All rights reserved.

267. Cao, N., I.S. Yetik, A. Nehorai, C.H. Muravchik, and J. Haueisen, *Parametric surface-source modeling and estimation with electroencephalography*. International Congress Series, 2007. **1300**: p. 117-120.

Summary: We develop four parametric EEG models to estimate current sources that are spatially distributed on a surface. Such sources exist for example in studies of epilepsy or induced spreading depression. We provide forward and inverse solutions and compute the Cramér-Rao bounds on the unknown source parameters. We validate our solutions using electric measurements from a body phantom. © 2007 Elsevier B.V. All rights reserved.

268. Cannon, R., J. Lubar, M. Congedo, K. Thornton, K. Towler, and T. Hutchens, *The effects of neurofeedback training in the cognitive division of the anterior cingulate gyrus*. International Journal of Neuroscience, 2007. **117**(3): p. 337-357.

Summary: This study examines the efficacy of neurofeedback training in the cognitive division of the anterior cingulate gyrus and describes its relationship with cortical regions known to be involved in executive functions. This study was conducted with eight non-clinical students, four male and four female, with a mean age of twenty-two. Learning occurred in the ACcd at significant levels over sessions and in the anterior regions that receive projections from the AC. There appears to be a multidimensional executive circuit that increases in the same frequency in apparent synchrony with the AC and it may be possible to train this sub-cortical region using LNFB. Copyright © 2007 Informa Healthcare.

269. Brookes, M.J., C.M. Stevenson, G.R. Barnes, A. Hillebrand, M.I.G. Simpson, S.T. Francis, and P.G. Morris, *Beamformer reconstruction of correlated sources using a modified source model*. NeuroImage, 2007. **34**(4): p. 1454-1465.

Summary: This paper introduces a lead field formulation for use in beamformer analysis of MEG data. This 'dual source beamformer' is a technique to image two temporally correlated sources using beamformer methodology. We show that while the standard, single source beamformer suppresses the reconstructed power of two spatially separate but temporally correlated sources, the dual source beamformer allows for their accurate reconstruction. The technique is proven to be accurate using simulations. We also show that it can be used to image accurately the auditory steady state response, which is correlated between the left and right auditory cortices. We suggest that this technique represents a useful way of locating correlated sources, particularly if a seed location can be defined a priori for one of the two sources. Such a priori information could be based on previous studies using similar paradigms, or from other functional neuroimaging techniques. © 2006 Elsevier Inc. All rights reserved.

270. Bolstad, A.K., B.D. Van Veen, and R.D. Nowak, *Space-time sparsity regularisation for the magnetoencephalography inverse problem*. 2007 4th IEEE International Symposium on Biomedical Imaging: From Nano to Macro - Proceedings, 2007: p. 984-987.

Summary: The concept of "Space-Time Sparsity" (STS) penalization is introduced for solving the magnetoencephalography (MEG) inverse problem. The STS approach assumes that events of interest occur on localized areas of the cortex over a limited time duration, and that only a few events of interest occur during a measurement period (or epoch). Cortical activity is reconstructed by minimizing a cost function which fits the data with a sparse set of space-time events using a novel expectation-maximization (EM) algorithm. We employ spatial and temporal basis functions to reduce the dimension of the data fitting problem and combat noise. Simulations suggest that our approach could be useful for identifying sequential relationships in the brain. © 2007 IEEE.

271. Blum, J., K. Lutz, and L. Jäncke, *Coherence and phase locking of intracerebral activation during visuo- and audio-motor learning of continuous tracking movements*. Experimental Brain Research, 2007. **182**(1): p. 59-69.

Summary: The aim of the present study was to assess changes in EEG coherence and phase locking between fronto-parietal areas, including the frontal and parietal motor areas, during early audio- and visuo-motor learning of continuous tracking movements. Subjects learned to turn a steering-wheel according to a

given trajectory in order to minimise the discrepancy between a changing foreground stimulus (controllable by the subjects) and a constant background stimulus (uncontrollable) for both the auditory and the visual modality. In the auditory condition, we uncovered a learning-related increase in inter-hemispheric phase locking between inferior parietal regions, suggesting that coupling between areas involved in audiomotor integration is augmented during early learning stages. Intra-hemispheric phase locking between motor and superior parietal areas increased in the left hemisphere as learning progressed, indicative of integrative processes of spatial information and movement execution. Further tests show a significant correlation of intra-hemispheric phase locking between the motor and the parietal area bilaterally and movement performance in the visual condition. These results suggest that the motor-parietal network is operative in the auditory and in the visual condition. This study confirms that a complex fronto-parietal network subserves learning of a new movement that requires sensorimotor transformation and demonstrates the importance of interregional coupling as a neural correlate for successful acquisition and implementation of externally guided behaviour. © 2007 Springer-Verlag.

272. Béla, C., B. Mónika, T. Márton, and K. István, *Valproate selectively reduces EEG activity in anterior parts of the cortex in patients with idiopathic generalized epilepsy. A low resolution electromagnetic tomography (LORETA) study*. Epilepsy Research, 2007. **75**(2-3): p. 186-191.

Summary: Purpose: To localize the cortical area where the anticonvulsive drug valproate (VPA) exerts its effect in patients with idiopathic generalized epilepsy (IGE). Methods: In a prior study we investigated 15 IGE patients in the untreated condition and compared their low resolution electromagnetic tomography (LORETA) results to a normal control group. The investigation of these patients was continued in the present study. All the 15 patients were treated with VPA and were followed by the authors. EEG was recorded after 3 months of VPA treatment in the seizure-free patients. A total of 2 min of 19-channels, common reference-recorded, waking-relaxed background activity (without paroxysmal and other, non-stationary elements) was analyzed. "Activity" (current density, amper/meters squared) was given in four frequency bands (delta, theta, alpha, beta). Band-related group differences between the present LORETA results (treated condition) and the prior LORETA results (untreated condition) were computed for all the 2394 voxels by t-tests for interdependent datasets. The statistically significant ($p < 0.01$, uncorrected) differences of activity were projected to real cortical anatomy using the Talairach Brain Atlas. Results: Statistically significant differences between the untreated and treated condition emerged in the delta and theta bands. VPA decreased delta and theta activity in the entire frontal cortex, insula, anterior temporal cortex and hippocampus, and in the anterior part of the parietal cortex. Conclusions: VPA decreased activity in parts of the cortex that display ictogenic properties and contribute to seizure generation in IGE. Furthermore, the anatomical distribution of the drug effect exactly corresponded to the VPA-related accumulation of neuroprotective proteins reported in experimental papers. © 2007 Elsevier B.V. All rights reserved.

273. Banaschewski, T. and D. Brandeis, *Annotation: What electrical brain activity tells us about brain function that other techniques cannot tell us - A child psychiatric perspective*. Journal of Child Psychology and Psychiatry and Allied Disciplines, 2007. **48**(5): p. 415-435.

Summary: Background: Monitoring brain processes in real time requires genuine subsecond resolution to follow the typical timing and frequency of neural events. Non-invasive recordings of electric (EEG/ERP) and magnetic (MEG) fields provide this time resolution. They directly measure neural activations associated with a wide variety of brain states and processes, even during sleep or in infants. Mapping and source estimation can localise these time-varying activation patterns inside the brain. Methods: Recent EEG/ERP research on brain functions in the domains of attention and executive functioning, perception, memory, language, emotion and motor processing in ADHD, autism, childhood-onset schizophrenia, Tourette syndrome, specific language disorder and developmental dyslexia, anxiety, obsessive-compulsive disorder, and depression is reviewed. Results: Over the past two decades, electrophysiology has substantially contributed to the understanding of brain functions during normal development, and psychiatric conditions of children and adolescents. Its time resolution has been important to measure covert processes, and to distinguish cause and effect. Conclusion: In the future, EEG/ERP parameters will increasingly characterise the interplay of neural states and information processing. They are particularly promising tools for multilevel investigations of etiological pathways and potential predictors of clinical treatment response. © 2007 The Authors Journal compilation © 2007 Association for Child and Adolescent Mental Health.

274. Bai, X., V.L. Towle, E.J. He, and B. He, *Evaluation of cortical current density imaging methods using intracranial electrocorticograms and functional MRI*. NeuroImage, 2007. **35**(2): p. 598-608.

Summary: Objective: EEG source imaging provides important information regarding the underlying neural activity from noninvasive electrophysiological measurements. The aim of the present study was to evaluate source reconstruction techniques by means of the intracranial electrocorticograms (ECoGs) and functional MRI. Methods: Five source imaging algorithms, including the minimum norm least square (MNLS), LORETA with Lp-norm (p equal to 1, 1.5 and 2), sLORETA, the minimum Lp-norm (p equal to 1 and 1.5; when p = 2, the MNLS method is mathematically equivalent to the minimum Lp-norm) and L1-norm (the linear programming) methods, were evaluated in a group of 10 human subjects, in a paradigm with somatosensory stimulation. Cortical current density (CCD) distributions were estimated from the scalp somatosensory evoked potentials (SEPs), at approximately 30 ms following electrical stimulation of median nerve at the wrist. Realistic geometry boundary element head models were constructed from the MRIs of each subject and used in the CCD analysis. Functional MRI results obtained from a motor task and sensory stimulation in all subjects were used to identify the central sulcus, motor and sensory areas. In three patients undergoing neurosurgical evaluation, ECoGs were recorded in response to the somatosensory stimulation, and were used to help determine the central sulcus and the sensory cortex. Results: The CCD distributions estimated by the Lp-norm and LORETA-Lp methods were smoother when the p values were high. The LORETA based on the L1-norm performed better than the LORETA-L2 method for imaging well localized sources such as the P30 component of the SEP. The mean and standard deviation of the distance between the location of maximum CCD value and the central sulcus, estimated by the minimum Lp-norm (with p equal to 1), L1-norm (the Linear programming) and LORETA-Lp (with p equal to 1) methods, were 4, 7, 7 mm and 3, 4, 2 mm, respectively (after converting into Talairach coordinates). The mean and standard deviation of the aforementioned distance, estimated by the MNLS, LORETA with Lp-norm (p equal to 1.5 and 2.0), sLORETA and the minimum Lp-norm (p equal to 1.5) methods, were over 11 mm and 6 mm, respectively. Conclusions: The present experimental study suggests that L1-norm-based algorithms provide better performance than L2 and L1.5-norm-based algorithms, in the context of CCD imaging of well localized sources induced by somatosensory electrical stimulation of median nerve at the wrist. © 2006 Elsevier Inc. All rights reserved.

275. Astolfi, L., F. De Vico Fallani, F. Cincotti, D. Mattia, M.G. Marciani, S. Bufalari, S. Salinari, A. Colosimo, L. Ding, J.C. Edgar, W. Heller, G.A. Miller, B. He, and F. Babiloni, *Imaging functional brain connectivity patterns from high-resolution EEG and fMRI via graph theory*. Psychophysiology, 2007. **44**(6): p. 880-893.

Summary: We describe a set of computational tools able to estimate cortical activity and connectivity from high-resolution EEG and fMRI recordings in humans. These methods comprise the estimation of cortical activity using realistic geometry head volume conductor models and distributed cortical source models, followed by the evaluation of cortical connectivity between regions of interest coincident with the Brodmann areas via the use of Partial Directed Coherence. Connectivity patterns estimated on the cortical surface in different frequency bands are then imaged and interpreted with measures based on graph theory. These computational tools were applied on a set of EEG and fMRI data from a Stroop task to demonstrate the potential of the proposed approach. The present findings suggest that the methodology is able to identify differences in functional connectivity patterns elicited by different experimental tasks or conditions. Copyright © 2007 Society for Psychophysiological Research.

276. Arzouan, Y., A. Goldstein, and M. Faust, *Dynamics of hemispheric activity during metaphor comprehension: Electrophysiological measures*. NeuroImage, 2007. **36**(1): p. 222-231.

Summary: Brain imaging studies have lead to conflicting findings regarding the involvement of the right hemisphere (RH) in metaphor comprehension. Some report more relative RH activation when processing figurative expressions but others have shown just the opposite. The inconsistencies might be a result of the low temporal resolution related to current brain imaging techniques which is insufficient to uncover patterns of hemispheric interaction that change over time. Event-related potentials and a source estimation technique (LORETA) were used to investigate such temporal interactions when processing two-word expressions denoting literal, conventional metaphoric, and novel metaphoric meaning, as well as unrelated word pairs. Participants performed a semantic judgment task in which they decided whether each word pair conveyed a meaningful expression. Our findings indicate that during comprehension of novel metaphors there are some stages of considerable RH involvement, mainly of the temporal and superior frontal areas. Although the processing mechanisms used for all types of expressions were similar and require both hemispheres, the relative contribution of each hemisphere at specific processing stages depended on stimulus type. Those stages correspond roughly to the N400 and LPC components which reflect semantic and contextual integration, respectively. The present study demonstrates that RH mechanisms are necessary, but not sufficient, for understanding metaphoric expressions. Both hemispheres work in concert in a complex dynamical pattern during literal and figurative language comprehension. Electrophysiological recordings together with source localization algorithms such as LORETA are a viable tool for measuring this type of activity patterns. © 2007 Elsevier Inc. All rights reserved.

277. Zumsteg, D., A.M. Lozano, H.G. Wieser, and R.A. Wennberg, *Cortical activation with deep brain stimulation of the anterior thalamus for epilepsy.* Clinical Neurophysiology, 2006. **117**(1): p. 192-207.

Summary: Objective: We studied the relation between thalamic stimulation parameters and the morphology, topographic distribution and cortical sources of the cerebral responses in patients with intractable epilepsy undergoing deep brain stimulation (DBS) of the thalamus. Methods: Bipolar and monopolar stimuli were delivered at a rate of 2 Hz to the anterior (AN, four patients), the dorsomedian (DM, four patients), and the centromedian nucleus (CM, one patient) using the programmable stimulation device (Medtronic ITREL II). Source modeling was carried out by using statistical non-parametric mapping of low-resolution electromagnetic tomography (LORETA) values. Results: All patients demonstrated reproducible time-locked cortical responses (CRs) consisting of a sequence of components with latencies between 20 and 320 ms. The morphology of these CRs, however, was very heterogeneous, depending primarily on the site of stimulation. Following AN stimulation, cortical activation was most prominent in ipsilateral cingulate gyrus, insular cortex and lateral neocortical temporal structures. Stimulation of the DM mainly showed activation of the ipsilateral orbitofrontal and mesial and lateral frontal areas, but also involvement of mesial temporal structures. Stimulation of the CM showed a rather diffuse (though still mainly ipsilateral) increase of cortical activity. The magnitude of cortical activation was positively related to the strength of the stimulus and inversely related to the impedance of the electrode. Conclusions: The pattern of cortical activation corresponded with the hodology of the involved structures and may underscore the importance of optimal localization of DBS electrodes in patients with epilepsy. Significance: The method of analyzing sources of CRs could potentially be a useful tool for titration of DBS parameters in patients with electrode contacts in clinically silent areas. Furthermore, the inverse relation of the cortical activation and the impedance of the electrode contacts might suggest that these impedance measurements should be taken into consideration when adjusting DBS parameters in patients with epilepsy. © 2005 International Federation of Clinical Neurophysiology. Published by Elsevier Ireland Ltd. All rights reserved.

278. Zumsteg, D., A. Friedman, H.G. Wieser, and R.A. Wennberg, *Source localization of interictal epileptiform discharges: Comparison of three different techniques to improve signal to noise ratio*. Clinical Neurophysiology, 2006. **117**(3): p. 562-571.

Summary: Objective: To investigate the localization accuracy of low-resolution electromagnetic tomography (LORETA) for mesial temporal interictal epileptiform discharges (IED) using a new relative averaging (RELAVG) technique for noise reduction. Methods: We analyzed 19 patterns of mesial temporal IED recorded simultaneously with scalp and foramen ovale (FO) electrodes in 15 consecutive patients who underwent presurgical assessment for intractable temporal lobe epilepsy. The scalp signals were time-locked to the peak activity in the FO electrode recordings and source modeling was performed using the RELAVG technique. Random noise of various amounts was then applied. The results were compared to intracranial data obtained from the FO electrode recordings and to LORETA source solutions obtained using two other approaches to improve signal to noise ratio (SNR): statistical non-parametric mapping (SNPM) and the commonly applied averaging (AVG) technique. Results: The RELAVG technique allowed for reasonable mesial temporal localization in 52.6% (10/19) of IED patterns, compared with 73.7% (14/19) using SNPM. The AVG technique provided no strictly mesial temporal solutions. Nine of the IED patterns revealed relative current density quotient changes >10; all of these were accurately localized by RELAVG into mesial temporal structures. Increasing amounts of white and physiological noise had no influence on the accuracy of RELAVG and SNPM solutions, whereas AVG source reconstructions became progressively spurious. Conclusion: The RELAVG technique and SNPM, but not the commonly used AVG technique, allow for reasonable source localization of mesial temporal IED. SNPM is the most accurate but also the most time-consuming noise reduction technique. Significance: The RELAVG LORETA technique might provide a simple and fast semi-quantitative alternative for localizing IED with low single to noise ratio. © 2005 International Federation of Clinical Neurophysiology. Published by Elsevier Ireland Ltd. All rights reserved.

279. Zumsteg, D., A. Friedman, H.G. Wieser, and R.A. Wennberg, *Propagation of interictal discharges in temporal lobe epilepsy: Correlation of spatiotemporal mapping with intracranial foramen ovale electrode recordings*. Clinical Neurophysiology, 2006. **117**(12): p. 2615-2626.

Summary: Objective: We have investigated intracerebral propagation of interictal epileptiform discharges (IED) in patients with mesial temporal lobe epilepsy (MTLE) by using spatiotemporal source maps based on statistical nonparametric mapping (SNPM) of low resolution electromagnetic tomography (LORETA) values. Methods: We analyzed 30 patterns of IED recorded simultaneously with scalp and intracranial foramen ovale (FO) electrodes in 15 consecutive patients with intractable MTLE. The scalp EEG signals were averaged time-locked to the peak activity in bilateral 10-contact FO electrode recordings. SNPM was applied to LORETA values and spatiotemporal source maps were created by allocating the t-values over time to their corresponding Brodmann areas. Propagation was defined as secondary statistically significant involvement of distinct cortical areas separated by >15 ms. The results were correlated with intracranial data obtained from FO electrode recordings and with scalp EEG recordings. All patients underwent subsequent amygdalo-hippocampectomy and outcome was assessed one year after surgery. Results: We found mesial to lateral propagation in 6/30 IED patterns (20%, four patients), lateral to mesial propagation in 4/30 IED patterns (13.3%, four patients) and simultaneous (within 15 ms) activation of mesial and lateral temporal areas in 6/30 IED patterns (20%, five patients). Propagation generally occurred within 30 ms and was always limited to ipsilateral cortical regions. Nine/30 IED patterns (30%) showed restricted activation of mesial temporal structures and no significant solutions were found in 5/30 IED patterns (16.7%). There was no clear association between the number or characteristics of IED patterns and the postsurgical outcome. Conclusions: Spatiotemporal mapping of SNPM LORETA accurately describes mesial to lateral temporal propagation of IED, and vice versa, which commonly occur in patients with MTLE. Significance: Intracerebral propagation must be considered when using non-invasive source algorithms in patients with MTLE. Spatiotemporal mapping might be useful for visualizing this propagation. © 2006 International Federation of Clinical Neurophysiology.

280. Zumsteg, D., D.M. Andrade, and R.A. Wennberg, *Source localization of small sharp spikes: Low resolution electromagnetic tomography (LORETA) reveals two distinct cortical sources*. Clinical Neurophysiology, 2006. **117**(6): p. 1380-1387.

Summary: Objective: We have investigated the cortical sources and electroencephalographic (EEG) characteristics of small sharp spikes (SSS) by using statistical non-parametric mapping (SNPM) of low resolution electromagnetic tomography (LORETA). Methods: We analyzed 7 SSS patterns (501 individual SSS) in 6 patients who underwent sleep EEG studies with 29 or 23 scalp electrodes. The scalp signals were averaged time-locked to the SSS peak activity and subjected to SNPM of LORETA values. Results: All 7 SSS patterns (mean 72 individual SSS, range 11-200) revealed a very similar and highly characteristic transhemispheric oblique scalp voltage distribution comprising a first negative field maximum over ipsilateral lateral temporal areas, followed by a second negative field maximum over the contralateral subtemporal region approximately 30 ms later. SNPM-LORETA consistently localized the first component into the ipsilateral posterior insular region, and the second component into ipsilateral posterior mesial temporo-occipital structures. Conclusions: SSS comprise an amalgam of two sequential, distinct cortical components, showing a very uniform and peculiar EEG pattern and cortical source solutions. As such, they must be clearly distinguished from interictal epileptiform discharges in patients with epilepsy. Significance: The awareness of these peculiar EEG characteristics may increase our ability to differentiate SSS from interictal epileptiform activity. The finding of a posterior insular source might serve as an inspiration for new physiological considerations regarding these enigmatic waveforms. © 2006 International Federation of Clinical Neurophysiology.

281. Zumsteg, D., D.M. Andrade, J.M. Del Campo, and R. Wennberg, *Parietal lobe source localization and sensitivity to hyperventilation in a patient with subclinical rhythmic electrographic discharges of adults (SREDA).* Clinical Neurophysiology, 2006. **117**(10): p. 2257-2263.

Summary: Objective: Subclinical rhythmic electrographic discharges of adults (SREDA) is currently considered a benign EEG pattern of uncertain significance. The underlying cortical sources and generating mechanisms are unknown. We performed a source localization analysis of SREDA with the aim of better understanding this unusual EEG pattern. Methods: Multiple spontaneous episodes of typical SREDA were recorded in a patient during continuous EEG monitoring. Additional SREDA episodes were induced by hyperventilation. Source localization was carried out using statistical non-parametric mapping (SNPM) of low resolution electromagnetic tomography (LORETA). Results: SNPM of both time- and frequency-domain LORETA revealed a widespread biparietal cortical origin of SREDA, the anatomical distribution of which included the parietal operculum and the known vascular watershed areas between anterior, middle and posterior cerebral arteries. Vigorous deep hyperventilation induced SREDA on three of four attempts. Mean duration of the hyperventilation-induced SREDA was approximately three times longer than spontaneous events. Conclusions: Investigations in this patient with typical SREDA revealed hyperventilation sensitivity and a posterior hemispheric source localization maximal in the parietal cortex bilaterally, in large part overlying the anatomical distribution of the vascular watershed areas. Significance: The source localization results and sensitivity to hyperventilation suggest some sort of association between cerebral vascular supply and SREDA, as originally proposed by Naquet et al. [Naquet R, Louard C, Rhodes J, Vigouroux M. A propos de certaines décharges paroxystiques du carrefour temporo-pariéto-occipital. Leur activation par l'hypoxie. Rev Neurol 1961;105:203-207.]. © 2006 International Federation of Clinical Neurophysiology.

282. Zhang, Y., L. Ding, W. van Drongelen, K. Hecox, D.M. Frim, and B. He, *A cortical potential imaging study from simultaneous extra- and intracranial electrical recordings by means of the finite element method*. NeuroImage, 2006. **31**(4): p. 1513-1524.

Summary: In the present study, we have validated the cortical potential imaging (CPI) technique for estimating cortical potentials from scalp EEG using simultaneously recorded electrocorticogram (ECoG) in the presence of strong local inhomogeneity, i.e., Silastic ECoG grid(s). The finite element method (FEM) was used to model the realistic postoperative head volume conductor, which includes the scalp, skull, cerebrospinal fluid (CSF) and brain, as well as the Silastic ECoG grid(s) implanted during the surgical evaluation in epilepsy patients, from the co-registered magnetic resonance (MR) and computer tomography (CT) images. A series of computer simulations were conducted to evaluate the present FEM-based CPI technique and to assess the effect of the Silastic ECoG grid on the scalp EEG forward solutions. The present simulation results show that the Silastic ECoG grid has substantial influence on the scalp potential forward solution due to the distortion of current pathways in the presence of the extremely low conductive materials. On the other hand, its influence on the estimated cortical potential distribution is much less than that on the scalp potential distribution. With appropriate numerical modeling and inverse estimation techniques, we have demonstrated the feasibility of estimating the cortical potentials from the scalp EEG with the implanted Silastic ECoG gird(s), in both computer simulations and in human experimentation. In an epilepsy patient undergoing surgical evaluation, the cortical potentials were reconstructed from the simultaneously recorded scalp EEG, in which main features of spatial patterns during interictal spike were preserved and over 0.75 correlation coefficient value was obtained between the recorded and estimated cortical potentials. The FEM-based CPI technique provides a means of connecting the simultaneous recorded ECoG and the scalp EEG and promises to become an effective tool to evaluate and validate CPI techniques using clinic data. © 2006 Elsevier Inc. All rights reserved.

283. Wolter, S., C. Friedel, K. Böhler, U. Hartmann, W.J. Kox, and M. Hensel, *Presence of 14 Hz spindle oscillations in the human EEG during deep anesthesia*. Clinical Neurophysiology, 2006. **117**(1): p. 157-168.

Summary: Objective: To report on presence of human EEG spindle oscillations on the cortical level within flat periods of the burst-suppression pattern during propofol-induced anesthesia; to search for corresponding oscillations and possible functional connections. Methods: Artefact-free epochs of spindle activation were selected from the electroencephalograms of opiate-dependent patients undergoing rapid opiate detoxification. Power spectral analysis and source localization using low-resolution-brain-electromagnetic-tomography (LORETAKey) were performed. Results: Sinusoidal rhythms with waxing and waning amplitudes appeared after propofol-induced narcosis but no direct correlations could be determined between individual dosage and characteristic spindle attributes. The power maximum stood midline over the cortical areas, especially around Cz. We calculated a peak frequency of 14(±1.2) Hz. Motor fields, particularly in the frontal, parietal, and various cingulate areas, were found to be the primary sources of spindle oscillations in the cortex. Conclusions: The frequent occurrence of these localized spindle sources demonstrates the preference for motor fields. Spindle oscillations observed during propofol-induced narcosis were similar in frequency and shape to those observed in natural sleep. Significance: The results lend support to models that postulate a close link between the motor system and the organization of behavior. In addition, spindle rhythms under propofol bore some resemblance to spindle types which occur during sleep. © 2005 International Federation of Clinical Neurophysiology. Published by Elsevier Ireland Ltd. All rights reserved.

284. Waldorp, L.J., H.M. Huizenga, R.P.P.P. Grasman, K.B.E. Böcker, and P.C.M. Molenaar, *Hypothesis testing in distributed source models for EEG and MEG data*. Human Brain Mapping, 2006. **27**(2): p. 114-128.

Summary: Hypothesis testing in distributed source models for the electro- or magnetoencephalogram is generally performed for each voxel separately. Derived from the analysis of functional magnetic resonance imaging data, such a statistical parametric map (SPM) ignores the spatial smoothing in hypothesis testing with distributed source models. For example, when intending to test a single voxel, actually an entire region of voxels is tested simultaneously. Because there are more parameters than observations, typically constraints are employed to arrive at a solution which spatially smooths the solution. If ignored, it can be concluded from the hypothesis test that there is activity at some location where there is none. In addition, an SPM on distributed source models gives the illusion of very high resolution. As an alternative, a multivariate approach is suggested in which a region of interest is tested that is spatially smooth. In simulations with MEG and EEG it is shown that clear hypothesis testing in distributed source models is possible, provided that there is high correspondence between what is intended to be tested and what is actually tested. The approach is also illustrated by an application to data from an experiment measuring visual evoked fields when presenting checker-board patterns. © 2005 Wiley-Liss, Inc.

285. Van Leeuwen, T., P. Been, C. Kuijpers, F. Zwarts, B. Maassen, and A. Van Der Leij, *Mismatch response is absent in 2-month-old infants at risk for dyslexia*. NeuroReport, 2006. **17**(4): p. 351-355.

Summary: This study examined auditory processing in 2-month-old infants at genetic risk for dyslexia and in controls. Manipulated natural speech stimuli (/bAk/ and /dAk/), at either side of the phoneme boundary, were presented to these infants and their automatic cortical deviance responses were recorded. Control infants showed two distinct mismatch responses, thus extending similar findings reported with kindergartners in terms of topographical distribution and cortical sources. The absence of such mismatch responses in the infants at risk supports the hypothesis of basic auditory (temporal) processing impairments in the disorder. The results suggest that these early signs of deficient auditory processing may point to problematic categorical perception at a later age. © 2006 Lippincott Williams & Wilkins.

286. Tsai, A.C., M. Liou, T.P. Jung, J.A. Onton, P.E. Cheng, C.C. Huang, J.R. Duann, and S. Makeig, *Mapping single-trial EEG records on the cortical surface through a spatiotemporal modality*. NeuroImage, 2006. **32**(1): p. 195-207.

Summary: Event-related potentials (ERPs) induced by visual perception and cognitive tasks have been extensively studied in neuropsychological experiments. ERP activities time-locked to stimulus presentation and task performance are often observed separately at individual scalp channels based on averaged time series across epochs and experimental subjects. An analysis using averaged EEG dynamics could discount information regarding interdependency between ongoing EEG and salient ERP features. Advanced tools such as independent component analysis (ICA) have been developed for decomposing collections of single-trial EEG records into separate features. Those features (or independent components) can then be mapped onto the cortical surface using source localization algorithms to visualize brain activation maps and to study between-subject consistency. In this study, we propose a statistical framework for estimating the time course of spatiotemporally independent EEG components simultaneously with their cortical distributions. Within this framework, we implemented Bayesian spatiotemporal analysis for imaging the sources of EEG features on the cortical surface. The framework allows researchers to include prior knowledge regarding spatial locations as well as spatiotemporal independence of different EEG sources. The use of the Electromagnetic Spatiotemporal ICA (EMSICA) method is illustrated by mapping event-related EEG dynamics induced by events in a visual two-back continuous performance task. The proposed method successfully identified several interesting components with plausible corresponding cortical activation topographies, including processes contributing to the late positive complex (LPC) located in central parietal, frontal midline, and anterior cingulate cortex, to atypical mu rhythms associated with the precentral gyrus, and to the central posterior alpha activity in the precuneus. © 2006 Elsevier Inc. All rights reserved.

287. Stern, J., D. Jeanmonod, and J. Sarnthein, *Persistent EEG overactivation in the cortical pain matrix of neurogenic pain patients*. NeuroImage, 2006. **31**(2): p. 721-731.

Summary: Functional brain imaging of pain over the last years has provided insight into a distributed anatomical matrix involved in pain processing which includes multiple cortical areas. EEG/MEG-based imaging studies have mostly relied on settings of evoked nociception. We report here the spontaneous presence of enhanced activations in the pain matrix of the patient group on the basis of continuous EEG and functional Low Resolution Electromagnetic Tomography (LORETA) from 16 chronic neurogenic pain patients and 16 healthy controls. These overactivations occurred predominantly within the high theta (6-

9 Hz) and low beta frequency ranges (12-16 Hz). Theta and beta overactivations were localized to multiple pain-associated areas, primarily to insular (IC), anterior cingulate (ACC), prefrontal, and inferior posterior parietal cortices, as well as to primary (S1), secondary (S2), and supplementary somatosensory (SSA) cortices. After a therapeutic lesion in the thalamus (central lateral thalamotomy, CLT), we followed a subgroup of 6 patients. Twelve months after surgery, activation in cingulate and insular cortices was significantly reduced. The presence of rhythmic processes in multiple, partially overlapping areas of the cortical pain matrix concur with the concept of thalamocortical dysrhythmia (TCD) that predicts increased thalamocortical low and high frequency oscillations ensuing from thalamic desactivation. These spontaneous, ongoing, frequency-specific overactivations may therefore serve as an anatomo-physiological hallmark of the processes underlying chronic neurogenic pain. © 2006 Elsevier Inc. All rights reserved.

288. Stein, M., T. Dierks, D. Brandeis, M. Wirth, W. Strik, and T. Koenig, *Plasticity in the adult language system: A longitudinal electrophysiological study on second language learning*. NeuroImage, 2006. **33**(2): p. 774-783.

Summary: Event-related potentials (ERPs) were used to trace changes in brain activity related to progress in second language learning. Twelve English-speaking exchange students learning German in Switzerland were recruited. ERPs to visually presented single words from the subjects' native language (English), second language (German) and an unknown language (Romansh) were measured before (day 1) and after (day 2) 5 months of intense German language learning. When comparing ERPs to German words from day 1 and day 2, we found topographic differences between 396 and 540 ms. These differences could be interpreted as a latency shift indicating faster processing of German words on day 2. Source analysis indicated that the topographic differences were accounted for by shorter activation of left inferior frontal gyrus (IFG) on day 2. In ERPs to English words, we found Global Field Power differences between 472 and 644 ms. This may due to memory traces related to English words being less easily activated on day 2. Alternatively, it might reflect the fact that - with German words becoming familiar on day 2 - English words loose their oddball character and thus produce a weaker P300-like effect on day 2. In ERPs to Romansh words, no differences were observed. Our results reflect plasticity in the neuronal networks underlying second language acquisition. They indicate that with a higher level of second language proficiency, second language word processing is faster and requires shorter frontal activation. Thus, our results suggest that the reduced IFG activation found in previous fMRI studies might not reflect a generally lower activation but rather a shorter duration of activity. © 2006 Elsevier Inc. All rights reserved.

289. Stančák, A., J. Mlynář, H. Poláček, and J. Vrána, *Source imaging of the cortical 10 Hz oscillations during cooling and warming in humans*. NeuroImage, 2006. **33**(2): p. 660-671.

Summary: Primary cold and warm afferent fibers show a robust overshoot in their firing during periods of temperature change, which subsides during tonic thermal stimulation. Our objective was to analyze cortical activation, on a scale of hundreds of milliseconds, occurring during the process of dynamic cooling and warming, based on an evaluation of the amplitude changes seen in 10 Hz electroencephalographic oscillations. Eleven right-handed subjects were exposed to innocuous cold ramp stimuli (from 32°C to 22°C, 10°C/s) and warm ramp stimuli (32°C to 42°C, 10°C/s) on the thenar region of their right palm, using a contact thermode. EEG was recorded from 111 scalp sites, and the 10 Hz current source densities were modeled using low-resolution electromagnetic tomography. During cooling, the earliest amplitude decreases of 10 Hz oscillations were seen in the contralateral posterior insula and secondary somatosensory cortex (SII), and the premotor cortex (PMC). During warming, the earliest events were only observed in the PMC and occurred ≈ 0.7 s later than during cooling. Linear regression analysis between 10 Hz current source densities and temperature variations revealed cooling-sensitive activation in the bilateral posterior insula, PMC and the anterior cingulate cortex. During warming, the amplitude of 10 Hz oscillations in the PMC and posterior insula correlated with stimulus temperature. Dynamic thermal stimulation activates, in addition to the posterior insula and parietal operculum, the lateral PMC. The activation of the anterior cingulate cortex during cooling may aid in the anticipation of the cold temperature end-point and provide continuous evaluation of the thermal stimulus. © 2006 Elsevier Inc. All rights reserved.

290. Sittiprapaporn, W., C. Chindaduangratn, and N. Kotchabhakdi, *Pattern of language-related potential maps in cluster and noncluster initial consonants in consonant-vowel (CV) syllables*. Songklanakarin Journal of Science and Technology, 2006. **28**(5): p. 911-920.

Summary: Mismatch negativity (MMN) was used to investigate the processing of cluster and noncluster initial consonants in consonant-vowel syllables in the human brain. The MMN was elicited by either syllable with cluster or noncluster initial consonant, phonetic contrasts being identical in both syllables. Compared to the noncluster consonant, the cluster consonant elicited a more prominent MMN. The MMN to the cluster consonant occurred later than that of the noncluster consonant. The topography of the mismatch responses showed clear left-hemispheric laterality in both syllables. However, the syllable with an initial noncluster consonant stimulus produced MMN maximum over the middle temporal gyrus, whereas maximum of the MMN activated by the syllable with initial cluster consonant was observed over the superior temporal gyrus. We suggest that the MMN component in consonant-vowel syllables is more sensitive to cluster compared to noncluster initial consonants. Spatial and temporal features of the cluster consonant indicate delayed activation of left-lateralized perisylvian cell assemblies that function as cortical memory traces of cluster initial consonant in consonant-vowel syllables.

291. Séverac Cauquil, A., Y. Trotter, and M.J. Taylor, *At what stage of neural processing do perspective depth cues make a difference?* Experimental Brain Research, 2006. **170**(4): p. 457-463.

Summary: The present study investigated the cortical processing of three-dimensional (3D) perspective cues in humans, to determine how the brain computes depth from a bidimensional retinal image. We recorded visual evoked potentials in 12 subjects in response to flat and in-perspective stimuli, which evoked biphasic potentials over posterior electrodes. The first, positive component (P1, at 90 ms) was not sensitive to perspective, while the second, negative peak (N1 at ~150 ms) was significantly larger for 3D stimuli, regardless of attention. The amplitude increase due to perspective was seen on all posterior electrodes, but was largest over the right hemisphere, particularly at parietal sites. Source modeling low-resolution electromagnetic tomography (LORETA) confirmed that among the different areas participating in two- and three-dimensional stimuli processing, the right parietal source is the most enhanced by perspective depth cues. We conclude that the extraction of depth from perspective cues occurs at a second level of stimulus processing, by increasing the activity of the regions involved in 2D stimuli processing, particularly in the right hemisphere, possibly through feedback loops from higher cortical areas. These modulations would participate in the fine-tuned analysis of the 3D features of stimuli. © Springer-Verlag 2005.

292. Schicke, T., L. Muckli, A.L. Beer, M. Wibral, W. Singer, R. Goebel, F. Rösler, and B. Röder, *Tight covariation of BOLD signal changes and slow ERPs in the parietal cortex in a parametric spatial imagery task with haptic acquisition.* European Journal of Neuroscience, 2006. **23**(7): p. 1910-1918.

Summary: The present study investigated the relation of brain activity patterns measured with functional magnetic resonance imaging (fMRI) and slow event-related potentials (ERPs) associated with a complex cognitive task. A second goal was to examine the neural correlates of spatial imagery of haptically - instead of visually - acquired representations. Using a mental image scanning task, spatial imagery requirements were systematically manipulated by parametrically varying the distance between haptically acquired landmarks. Results showed a close relation between slow ERPs and the blood oxygenation level dependent (BOLD) signal in human parietal lobe. Reaction times of mental scanning correlated with the distances between landmarks on the learned display. In parallel, duration and amplitude of slow ERPs and duration of the haemodynamic response systematically varied as a function of mental scanning distance. Source analysis confirmed that the ERP imagery effect likely originated from the same cortical substrate as the corresponding BOLD effect. This covariation of the BOLD signal with slow ERPs is in line with recent findings in animals demonstrating a tight link between local field potentials and the BOLD signal. The parietal location of the imagery effect is consistent with the idea that externally triggered (perceptual) and mentally driven (imagery) spatial processes are both mediated by the same supramodal brain areas. © The Authors (2006).

293. Saletu, B., P. Anderer, and G.M. Saletu-Zyhlarz, *EEG topography and tomography (LORETA) in the classification and evaluation of the pharmacodynamics of psychotropic drugs*. Clinical EEG and Neuroscience, 2006. **37**(2): p. 66-80.

Summary: By multi-lead computer-assisted quantitative analyses of human scalp-recorded electroencephalogram (QEEG) in combination with certain statistical procedures (quantitative pharmaco-EEG) and mapping techniques (pharmaco-EEG mapping or topography), it is possible to classify psychotropic substances and objectively evaluate their bioavailability at the target organ, the human brain. Specifically, one may determine at an early stage of drug development whether a drug is effective on the central nervous system (CNS) compared with placebo, what its clinical efficacy will be like, at which dosage it acts, when it acts and the equipotent dosages of different galenic formulations. Pharmaco-EEG maps of neuroleptics, antidepressants, tranquilizers, hypnotics, psychostimulants and nootropics/cognition-enhancing drugs will be described. Methodological problems, as well as the relationships between acute and chronic drug effects, alterations in normal subjects and patients, CNS effects and therapeutic efficacy will be discussed. Imaging of drug effects on the regional brain electrical activity of healthy subjects by means of EEG tomography such as low-resolution electromagnetic tomography (LORETA) has been used for identifying brain areas predominantly involved in psychopharmacological action. This will be shown for the representative drugs of the four main psychopharmacological classes, such as 3 mg haloperidol for neuroleptics, 20 mg citalopram for antidepressants, 2 mg lorazepam for tranquilizers and 20 mg methylphenidate for psychostimulants. LORETA demonstrates that these psychopharmacological classes affect brain structures differently. By considering these differences between psychotropic drugs and placebo in normal subjects, as well as between mental disorder patients and normal controls, it may be possible to choose the optimum drug for a specific patient according to a key-lock principle, since the drug should normalize the deviant brain function. Thus, pharmaco-EEG topography and tomography are valuable methods in human neuropsychopharmacology, clinical psychiatry and neurology.

294. Rodríguez, V. and M. Valdés-Sosa, *Sensory suppression during shifts of attention between surfaces in transparent motion*. Brain Research, 2006. **1072**(1): p. 110-118.

Summary: During transparent motion, attention to changes in the direction of one illusory surface will impede recognition of a similar event affecting the other surface if both are close together in time. This is a form of object-based attentional blink (AB). Here, we show that this AB is related to a smaller N200 response to the change in direction and that the response is even smaller for trials on which the subject makes mistakes compared to those with correct responses consistent with signal detection theory models. The variation of N200 associated with the AB can be modeled by an attenuation of current sources estimated in visual extrastriate cortex. These results suggest that the AB in the

transparent motion paradigm is due to the suppression of sensory signals in early visual areas. © 2005 Elsevier B.V. All rights reserved.

295. Riera, J.J., P.A. Valdés, K. Tanabe, and R. Kawashima, *A theoretical formulation of the electrophysiological inverse problem on the sphere*. Physics in Medicine and Biology, 2006. **51**(7): p. 1737-1758.

Summary: The construction of three-dimensional images of the primary current density (PCD) produced by neuronal activity is a problem of great current interest in the neuroimaging community, though being initially formulated in the 1970s. There exist even now enthusiastic debates about the authenticity of most of the inverse solutions proposed in the literature, in which low resolution electrical tomography (LORETA) is a focus of attention. However, in our opinion, the capabilities and limitations of the electro and magneto encephalographic techniques to determine PCD configurations have not been extensively explored from a theoretical framework, even for simple volume conductor models of the head. In this paper, the electrophysiological inverse problem for the spherical head model is cast in terms of reproducing kernel Hilbert spaces (RKHS) formalism, which allows us to identify the null spaces of the implicated linear integral operators and also to define their representers. The PCD are described in terms of a continuous basis for the RKHS, which explicitly separates the harmonic and non-harmonic components. The RKHS concept permits us to bring LORETA into the scope of the general smoothing splines theory. A particular way of calculating the general smoothing splines is illustrated, avoiding a brute force discretization prematurely. The Bayes information criterion is used to handle dissimilarities in the signal/noise ratios and physical dimensions of the measurement modalities, which could affect the estimation of the amount of smoothness required for that class of inverse solution to be well specified. In order to validate the proposed method, we have estimated the 3D spherical smoothing splines from two data sets: electric potentials obtained from a skull phantom and magnetic fields recorded from subjects performing an experiment of human faces recognition. © 2006 IOP Publishing Ltd.

296. Pun, T., T.I. Alecu, G. Chanel, J. Kronegg, and S. Voloshynovskiy, *Brain-computer interaction research at the Computer Vision and Multimedia Laboratory, University of Geneva*. IEEE Transactions on Neural Systems and Rehabilitation Engineering, 2006. **14**(2): p. 210-213.

Summary: This paper describes the work being conducted in the domain of brain-computer interaction (BCI) at the Multimodal Interaction Group, Computer Vision and Multimedia Laboratory, University of Geneva, Geneva, Switzerland. The application focus of this work is on multimodal interaction rather than on rehabilitation, that is how to augment classical interaction by means of physiological measurements. Three main research topics are addressed. The first one concerns the more general problem of brain source activity recognition from EEGs. In contrast with classical deterministic approaches, we studied iterative robust stochastic based reconstruction procedures modeling

source and noise statistics, to overcome known limitations of current techniques. We also developed procedures for optimal electroencephalogram (EEG) sensor system design in terms of placement and number of electrodes. The second topic is the study of BCI protocols and performance from an information-theoretic point of view. Various information rate measurements have been compared for assessing BCI abilities. The third research topic concerns the use of EEG and other physiological signals for assessing a user's emotional status. © 2006 IEEE.

297. Pourtois, G. and P. Vuilleumier, *Chapter 4 Dynamics of emotional effects on spatial attention in the human visual cortex*. Progress in Brain Research, 2006. **156**: p. 67-91.

Summary: An efficient detection of threat is crucial for survival and requires an appropriate allocation of attentional resources toward the location of potential danger. Recent neuroimaging studies have begun to uncover the brain machinery underlying the reflexive prioritization of spatial attention to locations of threat-related stimuli. Here, we review functional brain imaging experiments using event-related potentials (ERPs) and functional magnetic resonance imaging (fMRI) in a dot-probe paradigm with emotional face cues, in which we investigated the spatio-temporal dynamics of attentional orienting to a visual target when the latter is preceded by either a fearful or happy face, at the same (valid) location or at a different (invalid) location in visual periphery. ERP results indicate that fearful faces can bias spatial attention toward threat-related location, and enhance the amplitude of the early exogenous visual P1 activity generated within the extrastriate cortex in response to a target following a valid rather than invalid fearful face. Furthermore, this gain control mechanism in extrastriate cortex (at 130-150 ms) is preceded by an earlier modulation of activity in posterior parietal regions (at 40-80 ms) that may provide a critical source of top-down signals on visual cortex. Happy faces produced no modulation of ERPs in extrastriate and parietal cortex. fMRI data also show increased responses in the occipital visual cortex for valid relative to invalid targets following fearful faces, but in addition reveal significant decreases in intraparietal cortex and increases in orbitofrontal cortex when targets are preceded by an invalid fearful face, suggesting that negative emotional stimuli may not only draw but also hold spatial attention more strongly than neutral or positive stimuli. These data confirm that threat may act as a powerful exogenous cue and trigger reflexive shifts in spatial attention toward its location, through a rapid temporal sequence of neural events in parietal and temporo-occipital areas, with dissociable neural substrates for engagement benefits in attention affecting activity in extrastriate occipital areas and increased disengagement costs affecting intraparietal cortex. These brain-imaging results reveal how emotional signals related to threat can play an important role in modulating spatial attention to afford flexible perception and action. © 2006 Elsevier B.V. All rights reserved.

298. Pourtois, G., M. De Pretto, C.A. Hauert, and P. Vuilleumier, *Time course of brain activity during change blindness and change awareness: Performance is*

predicted by neural events before change onset. Journal of Cognitive Neuroscience, 2006. **18**(12): p. 2108-2129.

Summary: People often remain "blind" to visual changes occurring during a brief interruption of the display. The processing stages responsible for such failure remain unresolved. We used event-related potentials to determine the time course of brain activity during conscious change detection versus change blindness. Participants saw two successive visual displays, each with two faces, and reported whether one of the faces changed between the first and second displays. Relative to blindness, change detection was associated with a distinct pattern of neural activity at several successive processing stages, including an enhanced occipital P1 response and a sustained frontal activity (CNV-like potential) after the first display, before the change itself. The amplitude of the N170 and P3 responses after the second visual display were also modulated by awareness of the face change. Furthermore, a unique topography of event-related potential activity was observed during correct change and correct nochange reports, but not during blindness, with a recurrent time course in the stimulus sequence and simultaneous sources in the parietal and temporo-occipital cortex. These results indicate that awareness of visual changes may depend on the attentional state subserved by coordinated neural activity in a distributed network, before the onset of the change itself. © 2006 Massachusetts Institute of Technology.

299. Pogarell, O., C. Mulert, and U. Hegerl, *Event related potentials and fMRI in neuropsychopharmacology*. Clinical EEG and Neuroscience, 2006. **37**(2): p. 99-107.

Summary: Event related potentials (ERP) are important clinical and research instruments in neuropsychiatry, particularly due to their strategic role for the investigation of brain function. These techniques are often underutilized in the evaluation of neurological and psychiatric disorders, but nevertheless they can be most useful and highly effective in the diagnostic workup of a wide range of neuropsychiatric disorders as well as in monitoring the course of the disorders and the prediction of treatment responses. ERP are noninvasive instruments that directly reflect cortical neuronal activity. Cortical neuronal dysfunction plays a major role in variable neuropsychiatric disorders, and a change in cortical activity under medication might reflect treatment response and could be useful for monitoring drug effects. ERP are the only methods with a sufficiently high time resolution for the analysis of the dynamic patterns of neuronal brain activity, e.g., synchronization and desynchronization, oscillations, coherence, gamma band activity, latency of event related activity, etc., which are crucial for a deeper understanding of functional (neurophysiological) correlates of cognitive, emotional and behavioral disturbances in neuropsychiatric patients. Methodological advances have further improved and strengthened the position of ERP concerning research and clinical application. The usefulness and applicability of ERP in determining and monitoring clinico-pharmacological effects will be summarized mainly by focussing on the auditory evoked P300 and the N1/P2 component of auditory evoked potentials. Owing to important recent developments in the field of brain functional diagnostics the combination of neurophysiological techniques and functional magnetic resonance imaging (fMRI) will be included.

300. Pizzagalli, D.A., L.A. Peccoralo, R.J. Davidson, and J.D. Cohen, *Resting anterior cingulate activity and abnormal responses to errors in subjects with elevated depressive symptoms: A 128-channel study*. Human Brain Mapping, 2006. **27**(3): p. 185-201.

Summary: Depression has been associated with dysfunctional executive functions and abnormal activity within the anterior cingulate cortex (ACC), a region critically involved in action regulation. Prior research invites the possibility that executive deficits in depression may arise from abnormal responses to negative feedback or errors, but the underlying neural substrates remain unknown. We hypothesized that abnormal reactions to error would be associated with dysfunctional rostral ACC activity, a region previously implicated in error detection and evaluation of the emotional significance of events. To test this hypothesis, subjects with low and high Beck Depression Inventory (BDI) scores performed an Eriksen Flanker task. To assess whether tonic activity within the rostral ACC predicted post-error adjustments, 128-channel resting EEG data were collected before the task and analyzed with low-resolution electromagnetic tomography (LORETA) using a region-of-interest approach. High BDI subjects were uniquely characterized by significantly lower accuracy after incorrect than correct trials. Mirroring the behavioral findings, high BDI subjects had significantly reduced pretask gamma (36.5-44 Hz) current density within the affective (rostral; BA24, BA25, BA32) but not cognitive (dorsal; BA24′, BA32′) ACC subdivision. For low, but not high, BDI subjects pretask gamma within the affective ACC subdivision predicted post-error adjustments even after controlling for activity within the cognitive ACC subdivision. Abnormal responses to errors may thus arise due to lower activity within regions subserving affective and/or motivational responses to salient cues. Because rostral ACC regions have been implicated in treatment response in depression, our findings provide initial insight into putative mechanisms fostering treatment response. © 2005 Wiley-Liss, Inc.

301. Pascual-Montano, A., J.M. Carazo, K. Kochi, D. Lehmann, and R.D. Pascual-Marqui, *Nonsmooth nonnegative matrix factorization (nsNMF)*. IEEE Transactions on Pattern Analysis and Machine Intelligence, 2006. **28**(3): p. 403-415.

Summary: We propose a novel nonnegative matrix factorization model that aims at finding localized, part-based, representations of nonnegative multivariate data items. Unlike the classical nonnegative matrix factorization (NMF) technique, this new model, denoted "nonsmooth nonnegative matrix factorization" (nsNMF), corresponds to the optimization of an unambiguous cost function designed to explicitly represent sparseness, in the form of nonsmoothness, which is controlled by a single parameter. In general, this method produces a set of basis and encoding vectors that are not only capable of representing the original data, but they also extract highly localized patterns, which generally lend themselves to improved interpretability. The properties of this new method are illustrated with several data sets. Comparisons to previously published methods show that the new nsNMF method has some advantages in keeping faithfulness to the data in the achieving a high degree of sparseness for both the estimated basis and the encoding vectors and in better interpretability of the factors. © 2006 IEEE.

302. Ogawa, K., H. Nittono, and T. Hori, *Cortical regions activated after rapid eye movements during REM sleep*. Sleep and Biological Rhythms, 2006. **4**(1): p. 63-71.

Summary: The present study investigated the cortical regions activated during rapid eye movement (REM) sleep by identifying the sources of electric currents of brain potentials related to rapid eye movements using low-resolution brain electromagnetic tomography (LORETA). The brain potentials measured were the lambda response (P1 and P2) during wakefulness and the lambda-like response (P1r and P2r) during REM sleep. Fifteen healthy university students participated in this study. During wakefulness, the sources of the electric current of the lambda response (P1 and P2) were estimated to be in the primary and secondary visual cortices (BA 17, 18). During REM sleep, the P1r has a source in a higher order visual area (precuneus; BA 7, 31) and P2r comes from the primary and secondary visual cortices (BA 17, 18). In addition, the density of electric current in the premotor and fronto-central regions including anterior cingulate gyrus was higher after rapid eye movements, which was a discriminative feature of REM sleep. The results of this study suggest that these activities that occur after rapid eye movements might underlie the generation of vivid visual images of dreaming. © 2006 The Author Journal compilation © 2006 Japanese Society of Sleep Research.

303. Neuhaus, A., M. Bajbouj, T. Kienast, P. Kalus, D. Von Haebler, G. Winterer, and J. Gallinat, *Persistent dysfunctional frontal lobe activation in former smokers*. Psychopharmacology, 2006. **186**(2): p. 191-200.

Summary: Objective: Chronic smoking and nicotine exposure are accompanied by impaired cognitive task performance, modulated cerebral activity in brain imaging studies, and neuritic damage in experimental animals. The profile of the described dysfunctions matches frontal lobe circuits which also play a role in reward processing and reinforcement behavior. However, it is largely unknown if cerebral dysfunctions are reversible or persist during long term abstinence. Materials and methods: Cortical activation during auditory target processing (oddball task, P300 component) was recorded with 32-channel EEG in 247 healthy subjects consisting of 84 smokers, 53 former smokers (mean time of abstinence 11.9 years), and 110 never smokers. Results: Both current smokers and former smokers exhibited significantly diminished P300 amplitudes (Cz, Pz) relative to never smokers. Neuroelectric source analysis (low resolution brain electromagnetic tomography) revealed a hypoactivation of the anterior cingulate, orbitofrontal, and prefrontal cortex in smokers compared to never smokers. A similar profile of hypoactivation was observed in former smokers. Conclusion: For the first time, evidence is provided that dysfunctional activation of frontal lobe networks in smokers is also present in long term abstainers. © Springer-Verlag 2006.

304. Nakamura, W., S. Koyama, S. Kuriki, and Y. Inouye, *Smoothness constraint for the estimation of current distribution from EEG/MEG data*. ICASSP, IEEE International Conference on Acoustics, Speech and Signal Processing - Proceedings, 2006. **2**.

Summary: Separation of EEG (Electroencephalography) or MEG (Magnetoencephalography) data into activations of small dipoles or current density distribution is an ill-posed problem in which the number of parameters to estimate is larger than the dimension of the data. Several constraints have been proposed and used to avoid this problem, such as minimization of the L1-norm of the current distribution or minimization of Laplacian of the distribution. In this paper, we propose another biologically plausible constraint, sparseness of spatial difference of the current distribution. By numerical experiments, we show that the proposed method estimates current distribution well from both data generated by strongly localized current distributions and data generated by currents broadly distributed. © 2006 IEEE.

305. Nakamura, W., S. Koyama, S. Kuriki, and Y. Inouye, *Estimation of current density distributions from EEG/MEG data by maximizing sparseness of spatial difference*. Proceedings - IEEE International Symposium on Circuits and Systems, 2006: p. 1071-1074.

Summary: Separation of EEG(Electroencephalography) or MEG(Magnetoencephalography) data into activations of small dipoles or current density distribution is an ill-posed problem in which the number of parameters to estimate is larger than the dimension of the data. Several constraints have been proposed and used to avoid this problem, such as minimization of the Linorm of the current distribution or minimization of Laplacian of the distribution. In this paper, we propose another constraint that the current density distribution changes at only a small number of areas and these changes can be large. By numerical experiments, we show that the proposed method estimates current distribution well from both data generated by strongly localized current distributions and data generated by currents broadly distributed. © 2006 IEEE.

306. Mulert, C., G. Juckel, I. Giegling, O. Pogarell, G. Leicht, S. Karch, P. Mavrogiorgou, H.J. Möller, U. Hegerl, and D. Rujescu, *A Ser9Gly polymorphism in the dopamine D3 receptor gene (DRD3) and event-related P300 potentials*. Neuropsychopharmacology, 2006. **31**(6): p. 1335-1344.

Summary: An important reason for the interest in P300 event-related potentials are findings in patients with psychiatric disorders like schizophrenia or alcoholism in which attenuations of the P300 amplitude are common findings. The P300 wave has been suggested to be a promising endophenotype for genetic research since attenuations of the amplitude and latency can be observed not only in patients but also in relatives. In parallel, the search for genes involved in the pathogenesis of psychiatric disorders has revealed for both, schizophrenia and alcoholism an association with a DRD3 Ser9Gly polymorphism in a number of studies. In the present study, we have investigated 124 unrelated healthy subjects of German descent and have found diminished parietal and increased frontal P300 amplitudes in Gly9 homozygotes in comparison to Ser9 carriers. This finding suggests a possible role of the DRD3 receptor gene in the interindividual variation of P300 amplitudes. Further studies should address the direct role of the DRD3 Ser9Gly polymorphism in attenuated P300 amplitudes in psychiatric disorders like schizophrenia or alcoholism. © 2006 Nature Publishing Group All rights reserved.

307. Meyer, M., S. Baumann, and L. Jancke, *Electrical brain imaging reveals spatio-temporal dynamics of timbre perception in humans*. NeuroImage, 2006. **32**(4): p. 1510-1523.

Summary: Timbre is a major attribute of sound perception and a key feature for the identification of sound quality. Here, we present event-related brain potentials (ERPs) obtained from sixteen healthy individuals while they discriminated complex instrumental tones (piano, trumpet, and violin) or simple sine wave tones that lack the principal features of timbre. Data analysis yielded enhanced N1 and P2 responses to instrumental tones relative to sine wave tones. Furthermore, we applied an electrical brain imaging approach using low-resolution electromagnetic tomography (LORETA) to estimate the neural sources of N1/P2 responses. Separate significance tests of instrumental vs. sine wave tones for N1 and P2 revealed distinct regions as principally governing timbre perception. In an initial stage (N1), timbre perception recruits left and right (peri-)auditory fields with an activity maximum over the right posterior Sylvian fissure (SF) and the posterior cingulate (PCC) territory. In the subsequent stage (P2), we uncovered enhanced activity in the vicinity of the entire cingulate gyrus. The involvement of extra-auditory areas in timbre perception may imply the presence of a highly associative processing level which might be generally related to musical sensations and integrates widespread medial areas of the human cortex. In summary, our results demonstrate spatio-temporally distinct stages in timbre perception which not only involve bilateral parts of the peri-auditory cortex but also medially situated regions of the human brain associated with emotional and auditory imagery functions. © 2006 Elsevier Inc. All rights reserved.

308. Merrin, E.L., T.C. Floyd, R.F. Deicken, and P.A. Lane, *The Wisconsin Card Sort Test and P300 responses to novel auditory stimuli in schizophrenic patients*. International Journal of Psychophysiology, 2006. **60**(3): p. 330-348.

Summary: The authors studied the relationship between performance on the Wisconsin Card Sort Test (WCST) and P300 activity in schizophrenics and normal controls. Fourteen male predominantly medicated schizophrenics and matched non-ill controls were administered the WCST and tests of temporal lobe (delayed verbal and spatial memory) and general intellectual functioning (Shipley). Patients were rated with negative and positive symptom scales extracted from the Brief Psychiatric Rating Scale. Subjects performed a tone discrimination task requiring identification of rare targets in both a standard oddball paradigm and a three-stimulus paradigm that included rare novel sounds. Reference independent data from 16 scalp electrodes yielded Global Field Power (GFP), from which P300 latency was determined. P300 amplitude measures included amplitude at this identified latency as well as amplitude integrated over a 100 ms time window centered over it. These amplitude measures were examined at six selected electrode locations. Schizophrenics produced smaller P300 responses that tended to be slower, but there were no group differences in the relationships between neuropsychological performance and P300 responses. Across diagnostic groups percent perseverative errors predicted lower integrated and peak P300 amplitude during the novel but not the standard oddball paradigm. The effect on integrated P300 amplitude was localized to anterior leads after novel stimuli. Negative symptoms predicted lower WCST performance, lower integrated P300 amplitude, and smaller GFP after novel stimuli. Positive symptoms predicted reduced overall GFP and specific but inconsistent reductions in parietal P300 amplitude. The results suggest relationships between dorsolateral prefrontal competence, P300 activity in response to stimulus novelty, and negative symptoms in schizophrenic patients, paralleling findings obtained from blood flow and other measures of brain activity. © 2005 Elsevier B.V. All rights reserved.

309. Lorig, T.S., M. Rigdon, and A. Poor, *Temporal pattern of odor administration alters hemispheric processing in humans*. NeuroReport, 2006. **17**(3): p. 231-234.

Summary: Evidence from a variety of sensory modalities has suggested that the left hemisphere may be 'tuned' to process more rapidly changing stimuli than the right and some have suggested that this difference forms the foundation of the functional dichotomy often drawn between the two hemispheres. Odors may be thought to engage these same temporally dependent processes as portions of an odor mixture may come to be transduced into a phasic series of neural events. Using brain electrical activity, we show that the temporal sequence of the odor alters the pattern of brain electrical activity. Estimates of the source localization for this activity indicate that rapidly changing odors, like sounds, visual and tactile stimuli, show increased activity in the left hemisphere. © 2006 Lippincott Williams & Wilkins.

310. Liu, Z., C. Liu, and B. He, *Noninvasive reconstruction of three-dimensional ventricular activation sequence from the inverse solution of distributed*

equivalent current density. IEEE Transactions on Medical Imaging, 2006. **25**(10): p. 1307-1318.

Summary: We propose a new electrocardiographic (ECG) inverse approach for imaging the three-dimensional (3-D) ventricular activation sequence based on the modeling and estimation of the equivalent current density throughout the entire volume of the ventricular myocardium. The spatio-temporal coherence of the ventricular excitation process has been utilized to derive the activation time from the estimated time course of the equivalent current density. In the present study, we explored four different linear inverse algorithms (the minimum norm and weighted minimum norm estimates in combination with two regularization schemes: the instant-by-instant regularization and the isotropy method) to estimate the current density at each time instant during the ventricular depolarization. The activation time at any given -location within the ventricular myocardium was determined as the time point with the occurrence of the maximum local current density estimate. Computer simulations were performed to evaluate this approach using single- and dual-site pacing protocols in a physiologically realistic cellular automaton heart model. The performance and stability of the proposed approach was evaluated with respect to the various levels of measurement noise (0, 5, 10, 20, 40, and 60 μV), the various numbers of ECG electrodes and the modeling errors on the torso geometry and heart position. The simulation results demonstrate that: 1) the single-site paced 3-D activation sequence can be well reconstructed from 200-channel body surface potential maps with additive Gaussian white noise of 20 μV (correlation coefficient = 0.90, relative error = 0.19, and localization error = 5.49 mm); 2) a higher imaging accuracy can be obtained when the activation is initiated from the left/right ventricle (LV/RV) compared to from the septum; 3) the isotropy method gives rise to a better performance than the conventional instant-by-instant regularization; 4) a decreased imaging accuracy results from a larger noise level, a fewer number of electrodes, or the volume conductor modeling errors; however, a reasonable imaging accuracy can still be obtained with a 60 /μV noise level, 64 electrodes, or mild errors on both the torso geometry and heart position, respectively; 5) the dual-site paced 3-D activation sequence can be imaged when the two sites are paced either simultaneously or with a time delay of 20 ms; 6) two pacing sites can be resolved and localized in the imaged 3-D activation sequence when they are located at the contralateral sides of ventricles or at the ventricular lateral wall and the apex, respectively. © 2006 IEEE.

311. Liu, Z., L. Ding, and B. He, *Integration of EEG/MEG with MRI and fMRI*. IEEE Engineering in Medicine and Biology Magazine, 2006. **25**(4): p. 46-53.

Summary:

312. Liu, H. and P.H. Schimpf, *Efficient localization of synchronous EEG source activities using a modified RAP-MUSIC algorithm*. IEEE Transactions on Biomedical Engineering, 2006. **53**(4): p. 652-661.

Summary: Synchronization across different brain regions is suggested to be a possible mechanism for functional integration. Noninvasive analysis of the synchronization among cortical areas is possible if the electrical sources can be estimated by solving the electroencephalography inverse problem. Among various inverse algorithms, spatio-temporal dipole fitting methods such as RAP-MUSIC and R-MUSIC have demonstrated superior ability in the localization of a restricted number of independent sources, and also have the ability to reliably reproduce temporal waveforms. However, these algorithms experience difficulty in reconstructing multiple correlated sources. Accurate reconstruction of correlated brain activities is critical in synchronization analysis. In this study, we modified the well-known inverse algorithm RAP-MUSIC to a multistage process which analyzes the correlation of candidate sources and searches for independent topographies (ITs) among precorrelated groups. Comparative studies were carried out on both simulated data and clinical seizure data. The results demonstrated superior performance with the modified algorithm compared to the original RAP-MUSIC in recovering synchronous sources and localizing the epileptiform activity. The modified RAP-MUSIC algorithm, thus, has potential in neurological applications involving significant synchronous brain activities. © 2006 IEEE.

313. Li, Z., X. Bai, Q. Zhang, M. Akutagawa, F. Shichijo, and Y. Kinouchi, *Accuracy of two-dipole source localization using a method combining BP neural network with NLS method from 32-channel EEGs*. IEICE Transactions on Information and Systems, 2006. **E89-D**(7): p. 2234-2242.

Summary: The electroencephalogram (EEG) has become a widely used tool for investigating brain function. Brain signal source localization is a process of inverse calculation from sensor information (electric potentials for EEG) to the identification of multiple brain sources to obtain the locations and orientation parameters. In this paper, we describe a combination of the backpropagation neural network (BPNN) with the nonlinear least-square (NLS) method to localize two dipoles with reasonable accuracy and speed from EEG data computerized by two dipoles randomly positioned in the brain. The trained BPNN, obtains the initial values for the two dipoles through fast calculation and also avoids the influence of noise. Then the NLS method (Powell algorithm) is used to accurately estimate the two dipole parameters. In this study, we also obtain the minimum distance between the assumed dipole pair, 0.8 cm, in order to localize two sources from a smaller limited distance between the dipole pair. The present simulation results demonstrate that the combined method can allow us to localize two dipoles with high speed and accuracy, that is, in 20 seconds and with the position error of around 6.5, and to reduce the influence of noise. Copyright © 2006 The Institute of Electronics, Information and Communication Engineers.

314. Li, N., C. Li, Y. Lai, G. Shi, and D. Yao, *Coherent sources mapping by K-means cluster and correlation coefficient*. Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics), 2006. **4221 LNCS - I**: p. 237-240.

Summary: A new equivalent representation of the neural electric activities in the brain is presented here, which images the time courses of neural sources within several seconds by the methods of k-means cluster and correlation coefficient on the scalp EEG waveforms. The simulation results demonstrate the validity of this method: The correlation coefficients between time courses of simulation sources and those of estimated sources are higher than 0.974 for random noise with NSR≤0.2. The distances between the normalized locations of simulation sources and those of estimated sources are shorter than 0.108 for random noise with NSR≤0.2. The proposed approach has also been applied to a human study related to spatial selective attention. The results of real VEPs data show that three correlative sources can be located and time courses of those can describe the attention cognitive process correctly. © Springer-Verlag Berlin Heidelberg 2006.

315. Lehmann, D., P.L. Faber, L.R.R. Gianotti, K. Kochi, and R.D. Pascual-Marqui, *Coherence and phase locking in the scalp EEG and between LORETA model sources, and microstates as putative mechanisms of brain temporo-spatial functional organization*, in *Journal of Physiology Paris*. 2006. p. 29-36.

316. Lee, S.H., J.K. Wynn, M.F. Green, H. Kim, K.J. Lee, M. Nam, J.K. Park, and Y.C. Chung, *Quantitative EEG and low resolution electromagnetic tomography (LORETA) imaging of patients with persistent auditory hallucinations*. Schizophrenia Research, 2006. **83**(2-3): p. 111-119.

Summary: Electrophysiological studies have demonstrated gamma and beta frequency oscillations in response to auditory stimuli. The purpose of this study was to test whether auditory hallucinations (AH) in schizophrenia patients reflect abnormalities in gamma and beta frequency oscillations and to investigate source generators of these abnormalities. This theory was tested using quantitative electroencephalography (qEEG) and low-resolution electromagnetic tomography (LORETA) source imaging. Twenty-five schizophrenia patients with treatment refractory AH, lasting for at least 2 years, and 23 schizophrenia patients with non-AH (N-AH) in the past 2 years were recruited for the study. Spectral analysis of the qEEG and source imaging of frequency bands of artifact-free 30 s epochs were examined during rest. AH patients showed significantly increased beta 1 and beta 2 frequency amplitude compared with N-AH patients. Gamma and beta (2 and 3) frequencies were significantly correlated in AH but not in N-AH patients. Source imaging revealed significantly increased beta (1 and 2) activity in the left inferior parietal lobule and the left medial frontal gyrus in AH versus N-AH patients. These results imply that AH is reflecting increased beta frequency oscillations with neural generators localized in speech-related areas. © 2006 Elsevier B.V. All rights reserved.

317. Latif, M.A., S. Sanei, J. Chambers, and L. Shoker, *Localization of abnormal EEG sources using blind source separation partially constrained by the locations of known sources*. IEEE Signal Processing Letters, 2006. **13**(3): p. 117-120.

Summary: Electroencephalogram (EEG) source localization requires a solution to an ill-posed inverse problem. The additional challenge is to solve this problem in the context of multiple moving sources. An effective and simple technique for both separation and localization of EEG sources is therefore proposed by incorporating an algorithmically coupled blind source separation (BSS) approach. The method relies upon having a priori knowledge of the locations of a subset of the sources. The cost function of the BSS algorithm is constrained by this information, and the unknown sources are iteratively calculated. An important application of this method is to localize abnormal sources, which, for example, cause changes in attention, movement, and behavior. In this application, the Alpha rhythm was considered as the known sources. Simulation studies are presented to support the potential of the approach in terms of source localization. © 2006 IEEE.

318. Lapalme, E., J.M. Lina, and J. Mattout, *Data-driven parceling and entropic inference in MEG*. NeuroImage, 2006. **30**(1): p. 160-171.

Summary: In Amblard et al. [Amblard, C., Lapalme, E., Lina, J.M. 2004. Biomagnetic source detection by maximum entropy and graphical models. IEEE Trans. Biomed. Eng. 55 (3) 427-442], the authors introduced the maximum entropy on the mean (MEM) as a methodological framework for solving the magnetoencephalography (MEG) inverse problem. The main component of the MEM is a reference probability density that enables one to include all kind of prior information on the source intensity distribution to be estimated. This reference law also encompasses the definition of a model. We consider a distributed source model together with a clustering hypothesis that assumes functionally coherent dipoles. The reference probability distribution is defined as a prior parceling of the cortical surface. In this paper, we present a data-driven approach for parceling out the cortex into regions that are functionally coherent. Based on the recently developed multivariate source prelocalization (MSP) principle [Mattout, J., Pelegrini-Issac, M., Garnero, L., Benali, H. 2005. Multivariate source prelocalization (MSP): Use of functionally informed basis functions for better conditioning the MEG inverse problem. NeuroImage 26 (2) 356-373], the data-driven clustering (DDC) of the dipoles provides an efficient parceling of the sources as well as an estimate of parameters of the initial reference probability distribution. On MEG simulated data, the DDC is shown to further improve the MEM inverse approach, as evaluated considering two different iterative algorithms and using classical error metrics as well as ROC (receiver operating characteristic) curve analysis. The MEM solution is also compared to a LORETA-like inverse approach. The data-driven clustering allows to take most advantage of the MEM formalism. Its main trumps lie in the flexible probabilistic way of introducing priors and in the notion of spatial coherent regions of activation. The latter reduces the dimensionality of the problem. In so doing, it narrows down the gap between the two types of inverse methods, the popular dipolar approaches and the distributed ones. © 2005 Elsevier Inc. All rights reserved.

319. Kopeček, M., M. Brunovský, T. Novák, B. Tišlerová, J. Horáček, and C. Höschl, *The effect of cerebellar repetitive transcranial magnetic stimulation on electrical brain activity detected by low resolution electromagnetic tomography*. Psychiatrie, 2006. **10**(SUPPL. 3): p. 54-58.

Summary: Background: Previous studies have detected EEG, cognitive and motor cortex modulation after cerebellar repetitive Transcranial Magnetic Stimulation (rTMS). The aim of our study was to determine a) if these findings actually reflect cerebellar rTMS or rather neck muscle magnetic stimulation (MMS), and b) if cerebellar rTMS modulates frontal cortex activity. Methods: EEG recordings were obtained from 6 right-handed healthy volunteers before and after 1) rTMS applied over the right cerebellar hemisphere and 2) MMS applied over the right muscle trapezius. We used 20 minutes of 10 Hz rTMS and MMS with 1200 impulses. The spatial distribution of the rTMS and MMS-induced changes in the electrical brain activity were assessed using low-resolution electromagnetic tomography (LORETA). Results: Right cerebellar rTMS increased the power density in the delta, theta, alpha-1 and beta-2 frequency bands. Power increments in the delta, theta and beta-2 bands were found predominantly over the frontal and parietal lobes, whereas the alpha-1 power was increased bilaterally in the medial cingulate. No significant changes were detected after MMS applied over the trapezius muscle. Conclusions: Our results suggest the feasibility to modulate frontal cortical activity by means of cerebellar rTMS. This could support the use of the cerebellar rTMS in patients with neuropsychiatric disorders where cortico-subcortico-cerebellar abnormalities have been detected.

320. Klimesch, W., S. Hanslmayr, P. Sauseng, W. Gruber, C.J. Brozinsky, N.E.A. Kroll, A.P. Yonelinas, and M. Doppelmayr, *Oscillatory EEG correlates of episodic trace decay*. Cerebral Cortex, 2006. **16**(2): p. 280-290.

Summary: Recent studies suggest that human theta oscillations appear to be functionally associated with memory processes. It is less clear, however, to what type of memory sub-processes theta is related. Using a continuous word recognition task with different repetition lags, we investigate whether theta reflects the strength of an episodic memory trace or general processing demands, such as task difficulty. The results favor the episodic trace decay hypothesis and show that during the access of an episodic trace in a time window of ~200-400 ms, theta power decreases with increasing lag (between the first and second presentation of an item). LORETA source localization of this early theta lag effect indicates that parietal regions are involved in episodic trace processing, whereas right frontal regions may guide the process of retrieval. We conclude that episodic encoding can be characterized by two different stages: traces are first processed at parietal sites at ~300 ms, then further processing takes place in regions of the medial temporal lobe at ~500 ms. Only the first stage is related to theta, whereas the second is reflected by a slow wave with a frequency of ~2.5 Hz.
© The Author 2005. Published by Oxford University Press. All rights reserved.

321. Kim, Y.Y., B. Lee, Y.W. Shin, J.S. Kwon, and M.S. Kim, *Activity of left inferior frontal gyrus related to word repetition effects: LORETA imaging with 128-channel EEG and individual MRI*. NeuroImage, 2006. **29**(3): p. 712-720.

Summary: We investigated the brain substrate of word repetition effects on the implicit memory task using low-resolution electromagnetic tomography (LORETA) with high-density 128-channel EEG and individual MRI as a realistic head model. Thirteen right-handed, healthy subjects performed a word/non-word discrimination task, in which the words and non-words were presented visually, and some of the words appeared twice with a lag of one or five items. All of the subjects exhibited word repetition effects with respect to the behavioral data, in which a faster reaction time was observed to the repeated word (old word) than to the first presentation of the word (new word). The old words elicited more positive-going potentials than the new words, beginning at 200 ms and lasting until 500 ms post-stimulus. We conducted source reconstruction using LORETA at a latency of 400 ms with the peak mean global field potentials and used statistical parametric mapping for the statistical analysis. We found that the source elicited by the old words exhibited a statistically significant current density reduction in the left inferior frontal gyrus. This is the first study to investigate the generators of word repetition effects using voxel-by-voxel statistical mapping of the current density with individual MRI and high-density EEG. © 2005 Elsevier Inc. All rights reserved.

322. Kayser, J. and C.E. Tenke, *Principal components analysis of Laplacian waveforms as a generic method for identifying ERP generator patterns: II. Adequacy of low-density estimates*. Clinical Neurophysiology, 2006. **117**(2): p. 369-380.

Summary: Objective: To evaluate the comparability of high- and low-density surface Laplacian estimates for determining ERP generator patterns of group data derived from a typical ERP sample size and paradigm. Methods: High-density ERP data (129 sites) recorded from 17 adults during tonal and phonetic oddball tasks were converted to a 10-20-system EEG montage (31 sites) using spherical spline interpolations. Current source density (CSD) waveforms were computed from the high- and low-density, but otherwise identical, ERPs, and correlated at corresponding locations. CSD data were submitted to separate covariance-based, unrestricted temporal PCAs (Varimax of covariance loadings) to identify and effectively summarize temporally and spatially overlapping CSD components. Solutions were compared by correlating factor loadings and scores, and by plotting ANOVA F statistics derived from corresponding high- and low-resolution factor scores using representative sites. Results: High- and low-density CSD waveforms, PCA solutions, and F statistics were remarkably similar, yielding correlations of $.9 \leq r \leq .999$ between waveforms, loadings, and scores for almost all comparisons at low-density locations except for low-signal CSD waveforms at occipital sites. Each of the first 10 high-density factors corresponded precisely to one factor of the first 10 low-density factors, with each 10-factor set accounting for the meaningful CSD variance (>91.6%). Conclusions: Low-density surface

Laplacian estimates were shown to be accurate approximations of high-density CSDs at these locations, which adequately and quite sufficiently summarized group data. Moreover, reasonable approximations of many high-density scalp locations were obtained for group data from interpolations of low-density data. If group findings are the primary objective, as typical for cognitive ERP research, low-resolution CSD topographies may be as efficient, given the effective spatial smoothing when averaging across subjects and/or conditions. Significance: Conservative recommendations for restricting surface Laplacians to high-density recordings may not be appropriate for all ERP research applications, and should be re-evaluated considering objective, costs and benefits. © 2005 International Federation of Clinical Neurophysiology. Published by Elsevier Ireland Ltd. All rights reserved.

323. Kam, S.C., S.M. Choi, S.U. Jeh, J.S. Hwa, K.H. Jung, S.W. Jeong, O.Y. Kwon, and J.S. Hyun, *Location of brain electrical source activation according to visually stimulated sexual arousal: A cross spectral analysis using low resolution brain electromagnetic tomography (LORETA)*. Korean Journal of Urology, 2006. **47**(7): p. 779-785.

Summary: Purpose: Low resolution brain electromagnetic tomography (LORETA) is a kind of functional imaging technique and it is also an up-to-date technique for conducting electroencephalography (EEC) analysis. We tried to investigate the locations on the cerebral cortex that are activated by visually stimulated sexual arousal. Materials and Methods: Thirty-three male volunteers (age range: 24.7±1.7 years) among all the right-handed medical students at our university were enrolled in this study. The EEGs included the segments recorded during resting, watching a music-video, intermission and watching a porno-video. The LORETA images of the cross-spectral analysis were obtained with using segments of LORETA-KEY (KEY Institute for Brain-Mind Research, Switzerland) software. Results: In the statistical nonparametric maps (SnPM) of each spectrum and the delta, theta and alpha waves did not show the increased current density. The beta 1, 2 and 3 activity showed the point of maximal current densities in the anterior parahippocampal gyrus of the left limbic lobe and the superior temporal gyrus of both temporal lobes, the superior temporal gyrus of the right temporal lobe, the precuneus of the right parietal lobe, the medial frontal gyrus of the left frontal lobe, the middle occipital gyrus of the right occipital lobe, the superior temporal gyrus of both temporal lobes and the superior frontal gyrus of the right frontal lobe. Conclusions: The sexual arousal by visual stimulation may activate the anterior parahippocampal gyrus of the left limbic lobe, the superior temporal gyrus of both temporal lobes, the precuneus of the right parietal lobe, the medial frontal gyrus of the left frontal gyrus, and the middle occipital gyrus of the right occipital lobe.

324. Junghöfer, M., P. Peyk, T. Flaisch, and H.T. Schupp, *Chapter 7 Neuroimaging methods in affective neuroscience: Selected methodological issues*. Progress in Brain Research, 2006. **156**: p. 123-143.

Summary: A current goal of affective neuroscience is to reveal the relationship between emotion and dynamic brain activity in specific neural circuits. In humans, noninvasive neuroimaging measures are of primary interest in this endeavor. However, methodological issues, unique to each neuroimaging method, have important implications for the design of studies, interpretation of findings, and comparison across studies. With regard to event-related brain potentials, we discuss the need for dense sensor arrays to achieve reference-independent characterization of field potentials and improved estimate of cortical brain sources. Furthermore, limitations and caveats regarding sparse sensor sampling are discussed. With regard to event-related magnetic field (ERF) recordings, we outline a method to achieve magnetoencephalography (MEG) sensor standardization, which improves effects' sizes in typical neuroscientific investigations, avoids the finding of ghost effects, and facilitates comparison of MEG waveforms across studies. Focusing on functional magnetic resonance imaging (fMRI), we question the unjustified application of proportional global signal scaling in emotion research, which can greatly distort statistical findings in key structures implicated in emotional processing and possibly contributing to conflicting results in affective neuroscience fMRI studies, in particular with respect to limbic and paralimbic structures. Finally, a distributed EEG/MEG source analysis with statistical parametric mapping is outlined providing a common software platform for hemodynamic and electromagnetic neuroimaging measures. Taken together, to achieve consistent and replicable patterns of the relationship between emotion and neuroimaging measures, methodological aspects associated with the various neuroimaging techniques may be of similar importance as the definition of emotional cues and task context used to study emotion. © 2006 Elsevier B.V. All rights reserved.

325. John, E.R. and L.S. Prichep, *The relevance of QEEG to the evaluation of behavioral disorders and pharmacological interventions*. Clinical EEG and Neuroscience, 2006. **37**(2): p. 135-143.

Summary: It has become apparent that the electrical signals recorded from the scalp of healthy individuals under standardized conditions are predictable, and that patients with a wide variety of brain disorders display activity with unusual features. It also early became apparent that centrally active medications produced striking changes in this activity. The application of computerized signal analysis to EEG recordings collected using standardized procedures has made it possible to obtain quantitative descriptions of brain electrical activity (QEEG) in normal individuals and patients with disorders of brain function or structure, as well as quantitative description of the ways in which centrally active medications alter this activity (Pharmaco-EEG or "PEEG"). With the emergence of three-dimensional EEG source localization techniques, it has recently become possible to visualize the mathematically most probable generators of QEEG abnormalities within the brain as well as the neuroanatomical regions where abnormal activity is most altered by efficacious medication. As QEEG and PEEG have evolved, a vast body of facts has been accumulated, describing changes in the EEG or event-related potentials (ERPs) observed in a variety of brain disorders or after

administration of a variety of medications. With some notable exceptions, these studies have tended to be phenomenological rather than analytic. There has not been a systematic attempt to integrate these phenomena in order to build better understanding of how the abnormal behaviors of a particular psychiatric patient might be related to the specific pattern of the deviant electrical activity, nor just how pharmacological reduction of that deviant activity may have resulted in more normal behavior. This article is an endeavor to provide a more specific theoretical framework for understanding the relationships between the neuroanatomy and neurochemistry of the homeostatic system underlying the regulation of the QEEG, and the mechanisms revealed by Pharmaco-EEG that aid in correcting these illnesses.

326. Jäncke, L., K. Lutz, and S. Koeneke, *Chapter 18 Converging evidence of ERD/ERS and BOLD responses in motor control research.* Progress in Brain Research, 2006. **159**: p. 261-271.

Summary: In this chapter we summarize findings of our group in which we studied the neural underpinnings of finger tapping control using different methods (functional magnetic resonance imaging: fMRI, electroencephalography: EEG, transcranial magnetic stimulation: TMS, and behavioural experiments). First, we found that maximum finger tapping speed is a matter of training as shown for professional musicians. Secondly, we demonstrated that different finger tapping speeds are accompanied by different hemodynamic responses in the primary hand motor area (M1), the cerebellum and partly in pre-motor areas. With increasing tapping speed there is an increase of hemodynamic response in these areas (rate effect). Thirdly, the effect measured with fMRI is substantiated by rate effects measured by means of task-related power decreases in the upper α-band (10-12 Hz) over the primary motor cortex. In case of sequential finger movement learning, we observed decreases in task-related α-power in lateral PMC (event-related desynchronization: ERD) and simultaneous α-power increases in SMA (event-related synchronization: ERS) that came along with training-induced increases in movement rate. This pattern is discussed in relation to the "focal ERD/surround ERS" phenomenon suggested by Pfurtscheller and Lopes da Silva. Finally, we demonstrated that finger tapping speed was slowed by selectively inhibiting the primary hand motor area using TMS. Taken together, these studies demonstrate on the basis of converging evidence that the primary hand motor area is the basic control centre for controlling the movement parameter tapping speed. However, the neural efficiency to control finger tapping speed (as measured with hemodynamic responses or ERD/ERS patterns) is a matter of training. © 2006 Elsevier B.V. All rights reserved.

327. Im, C.H. and S.Y. Lee, *A technique to consider mismatches between fMRI and EEG/MEG sources for fMRI-constrained EEG/MEG source imaging: A preliminary simulation study.* Physics in Medicine and Biology, 2006. **51**(23): p. 6005-6021.

Summary: fMRI-constrained EEG/MEG source imaging can be a powerful tool in studying human brain functions with enhanced spatial and temporal resolutions. Recent studies on the combination of fMRI and EEG/MEG have suggested that fMRI prior information could be readily implemented by simply imposing different weighting factors to cortical sources overlapping with the fMRI activations. It has been also reported, however, that such a hard constraint may cause severe distortions or elimination of meaningful EEG/MEG sources when there are distinct mismatches between the fMRI activations and the EEG/MEG sources. If one wants to obtain the actual EEG/MEG source locations and uses the fMRI prior information as just an auxiliary tool to enhance focality of the distributed EEG/MEG sources, it is reasonable to weaken the strength of fMRI constraint when severe mismatches between fMRI and EEG/MEG sources are observed. The present study suggests an efficient technique to automatically adjust the strength of fMRI constraint according to the mismatch level. The use of the proposed technique rarely affects the results of conventional fMRI-constrained EEG/MEG source imaging if no major mismatch between the two modalities is detected; while the new results become similar to those of typical EEG/MEG source imaging without fMRI constraint if the mismatch level is significant. A preliminary simulation study using realistic EEG signals demonstrated that the proposed technique can be a promising tool to selectively apply fMRI prior information to EEG/MEG source imaging. © 2006 IOP Publishing Ltd.

328. Hu, J., J. Tian, L. Yang, X. Pan, and J. Liu, *Combination of PCA and LORETA for sources analysis of ERP data: An emotional processing study*. Progress in Biomedical Optics and Imaging - Proceedings of SPIE, 2006. **6143 II**.

Summary: The purpose of this paper is to study spatiotemporal patterns of neuronal activity in emotional processing by analysis of ERP data. 108 pictures (categorized as positive, negative and neutral) were presented to 24 healthy, right-handed subjects while 128-channel EEG data were recorded. An analysis of two steps was applied to the ERP data. First, principal component analysis was performed to obtain significant ERP components. Then LORETA was applied to each component to localize their brain sources. The first six principal components were extracted, each of which showed different spatiotemporal patterns of neuronal activity. The results agree with other emotional study by fMRI or PET. The combination of PCA and LORETA can be used to analyze spatiotemporal patterns of ERP data in emotional processing.

329. Hoffman, D.A., *LORETA: An attempt at a simple answer to a complex controversy*. Journal of Neurotherapy, 2006. **10**(1): p. 57-72.

Summary: QEEG and LORETA have been applied successfully to neuropsychiatric conditions for both diagnosis and treatment guidance using EEG neurotherapy. These techniques aid in providing localization of the sources of normal and abnormal EEG. However, there is confusion about which statistics

offer the more accurate data for source density localization. The average clinician is not able to assess the differences in the two most popular data processing programs currently on the market. This paper compares a side-by-side evaluation of NeuroGuide™ and EureKa™ in order to help the reader visualize the differences between these two imaging programs, which have resulted in different maps. This study compares and contrasts both software programs using pathologies with confirmed spatial localization to assess and evaluate their differences and to understand how to use each program to obtain accurate information. © by The Haworth Press, Inc. All rights reserved.

330. Hill, H., F. Ott, C. Herbert, and M. Weisbrod, *Response execution in lexical decision tasks obscures sex-specific lateralization effects in language processing: Evidence from event-related potential measures during word reading*. Cerebral Cortex, 2006. **16**(7): p. 978-989.

Summary: A common hypothesis about sex differences in language processing attributes these differences to a bilateral contribution of language-related brain areas in females and a left-hemispheric dominated activation in males. However, most imaging studies failed to find such a generalized lateralization effect and reported a left-lateralized activation in both sexes instead. In a previous semantic priming study, we found a sustained (~190-640 ms) bilateral positivity in the ERP waveforms, which was larger for the female group. Word reading and lexical decision were confounded in that study. In the present study we used a delayed response to separate semantic processing from response selection and execution. The modification of the task design, together with a dense sensor array, showed that females developed a bilateral sustaining posterior positivity/frontal negativity during reading/semantic processing. In contrast, males showed an attenuated positivity at left posterior sites and an attenuated negativity at right frontal sites. This sex-specific lateralization effect disappeared during response processing, evoking a bilaterally distributed activation for both sexes (frontal negative and posterior positive), which was larger for the female subjects. We conclude that, at least under specific conditions, language processing evokes a bilateral activation in females and a lateralization effect in males. However, the processing of the response, which is dominated by a 'P300-like' component evoked by this process, evokes a larger activation in both sexes which obscures the sex-specific lateralization effect when semantic processing and response processing are not separated. © The Author 2005. Published by Oxford University Press. All rights reserved.

331. Henderson, J.A., A.J.K. Phillips, and P.A. Robinson, *Multielectrode electroencephalogram power spectra: Theory and application to approximate correction of volume conduction effects*. Physical Review E - Statistical, Nonlinear, and Soft Matter Physics, 2006. **73**(5).

Summary: Using a physiologically based model of brain activity, electroencephalogram (EEG) power spectra are calculated for signals derived from general linear combinations of voltages from multiple electrodes, with and

without filtering by volume conduction. Two simple methods of combining scalp measurements to estimate unfiltered EEG power spectra are then proposed and their accuracy and robustness are explored, using the model predictions as an illustration. It is found that these methods, including a case that uses just three electrodes, enable improved estimation of the underlying spectrum relative to each of several widely used combinations alone. © 2006 The American Physical Society.

332. Heine, A., S. Tamm, M. Hofmann, R.M. Bösel, and A.M. Jacobs, *Event-related theta activity reflects memory processes in pronoun resolution.* NeuroReport, 2006. **17**(18): p. 1835-1839.

Summary: A recent eye-tracking study reported a reverse effect of a noun's lexical frequency in the context of the resolution of coreferring pronouns. Investigating the neurophysiological basis of this effect, the present electroencephalographic study found differential patterns in theta activation when participants read pronouns referring to nouns of different frequency classes. Evoked theta power after pronoun onset increased with the frequency of the critical noun. This finding suggests differential load on memory resources depending on the nouns' frequency. Elevated attention promoting memory encoding for low-frequency words is assumed to facyilitate the resolution of pronouns. Location of sources of differential theta activity in the parahippocampal region is accounted for by its role in an association network that mediates memory processes. © 2006 Lippincott Williams & Wilkins, Inc.

333. Halder, P., A. Curt, S. Brem, A. Lang-Dullenkopf, K. Bucher, S. Kollias, and D. Brandeis, *Preserved aspects of cortical foot control in paraplegia.* NeuroImage, 2006. **31**(2): p. 692-698.

Summary: While several recent imaging studies confirm that motor foot areas can still be activated in complete and chronic paraplegia, it remains unclear whether their functionality is also maintained or declines after years of "non-use". Force control is one of the most important and best investigated functions within the motor cortex. It has been repeatedly reported that the motor cortex is more active when higher forces have to be applied. We thus addressed the question of preserved cortical functions by comparing motor force control patterns in the event-related potentials of 10 motor complete paraplegic subjects and 10 controls after attempted (paraplegic patients)/executed (healthy controls) ballistic foot movements with three different force levels. In addition to the peak amplitudes reflecting force levels, peak latencies were also investigated to elucidate timing as another functional aspect of motor control. No significant group difference was found for the peak latencies, indicating that the timing of motor cortical activation is preserved. Concerning amplitudes, we found preserved cortical modulation of higher forces but distorted low force modulation, especially early after injury. These findings thus suggest that important aspects of cortical control over paralyzed limbs are maintained despite years of "non-use". © 2005 Elsevier Inc. All rights reserved.

334. Hajós, M., *Targeting information-processing deficit in schizophrenia: a novel approach to psychotherapeutic drug discovery*. Trends in Pharmacological Sciences, 2006. **27**(7): p. 391-398.

Summary: Current observations indicate that dysfunction of neuronal circuitry dynamics contributes to the abnormal information processing in the brain in schizophrenia. It is presumed that disrupted auditory gating, abnormal P300-evoked potentials and deficits in mismatch negativity in schizophrenic patients indicate impaired processing of information. Recently, abnormalities in neuronal synchrony and oscillatory activity have been postulated as the mechanisms that underlie the distorted perception and cognitive dysfunction associated with schizophrenia. These novel observations might reveal the pathophysiology of the disorder, and indicate potential targets for antipsychotic drug therapy. Neuronal circuitry dynamics, such as network oscillations and sensory-gating processes, are conserved phylogenetically, which provides excellent opportunities for designing translational biomarkers. Whether preclinical, experimental compounds that impact on network oscillations and sensory processing (such as agonists and modulators of α7 nicotinic acetylcholine receptors) elicit the same neurophysiological events in schizophrenic patients and, subsequently, improve perception and cognitive functions will be determined when these drug candidates are available clinically. © 2006 Elsevier Ltd. All rights reserved.

335. Gruber, T., N.J. Trujillo-Barreto, C.M. Giabbiconi, P.A. Valdés-Sosa, and M.M. Müller, *Brain electrical tomography (BET) analysis of induced gamma band responses during a simple object recognition task*. NeuroImage, 2006. **29**(3): p. 888-900.

Summary: The formation of cortical object representations requires the activation of cell assemblies, correlated by induced oscillatory bursts above 20 Hz (gamma band), which are characterized by trial-by-trial latency fluctuations around a mean of approximately 300 ms after stimulus onset. The present electroencephalogram (EEG) study was intended to uncover to the generators of induced gamma band responses (GBRs) and to analyze phase-synchronization between these sources. A standard object recognition task was used to elicit gamma activity. At the scalp surface (electrode space), we found an augmentation of induced GBRs after the presentation of meaningful (familiar) as opposed to meaningless (unfamiliar) stimuli, which was accompanied by a dense pattern of significant phase-locking values between distant recording sites. Subsequently, intracranial current density distributions compatible with the observed scalp voltage topographies were estimated by means of VARETA (Variable Resolution Electromagnetic Tomography). In source space brain electrical tomographies (BETs) revealed widespread generators of induced GBRs at temporal, parietal, posterior, and frontal areas. Phase-locking analysis was calculated between re-constructed electrode signals based on separate forward solutions of the observed generators, thereby eliminating the possibly confounding influence of activity from areas not under observation. The results support the view that induced GBRs signify synchronous neuronal activity in a broadly distributed network

during object recognition. The localization of the generators of event-related potentials (ERPs), evoked gamma activity, and induced alpha activity revealed different sources as compared to the induced GBR and, thus, seem to mirror complementary functions during the present task as compared to induced high-frequency brain dynamics. © 2005 Elsevier Inc. All rights reserved.

336. Grova, C., J. Daunizeau, J.M. Lina, C.G. Bénar, H. Benali, and J. Gotman, *Evaluation of EEG localization methods using realistic simulations of interictal spikes*. NeuroImage, 2006. **29**(3): p. 734-753.

Summary: Performing an accurate localization of sources of interictal spikes from EEG scalp measurements is of particular interest during the presurgical investigation of epilepsy. The purpose of this paper is to study the ability of six distributed source localization methods to recover extended sources of activated cortex. Due to the frequent lack of a gold standard to evaluate source localization methods, our evaluation was performed in a controlled environment using realistic simulations of EEG interictal spikes, involving several anatomical locations with several spatial extents. Simulated data were corrupted by physiological EEG noise. Simulations involving pairs of sources with the same amplitude were also studied. In addition to standard validation criteria (e.g., geodesic distance or mean square error), we proposed an original criterion dedicated to assess detection accuracy, based on receiver operating characteristic (ROC) analysis. Six source localization methods were evaluated: the minimum norm, the minimum norm weighted by multivariate source prelocalization (MSP), cortical LORETA with or without additional minimum norm regularization, and two derivations of the maximum entropy on the mean (MEM) approach. Results showed that LORETA-based and MEM-based methods were able to accurately recover sources of different spatial extents, with the exception of sources in temporo-mesial and fronto-mesial regions. Several spurious sources were generated by those methods, however, whereas methods using the MSP always located very accurately the maximum of activity but not its spatial extent. These findings suggest that one should always take into account the results from different localization methods when analyzing real interictal spikes. © 2005 Elsevier Inc. All rights reserved.

337. Gómez, C.M., J. Marco-Pallarés, and C. Grau, *Location of brain rhythms and their modulation by preparatory attention estimated by current density*. Brain Research, 2006. **1107**(1): p. 151-160.

Summary: To test the hypothesis that there is a functional modulation of conventional EEG bands associated with preparatory attention, putative changes in the spontaneous brain rhythms and their associated cerebral sources were addressed. The goals of the present report were, first, to find the brain areas with maximal rhythmic activity before warning and imperative stimuli in a classic contingent negative variation (CNV) paradigm, and, second, to study the modulation of the EEG rhythms of these areas during the preparatory attention interval which precedes the S2 (imperative) stimulus. Trial by trial LORETA analysis found similar brain rhythm generators during both pre-S1 and pre-S2 intervals. Each theta, alpha and beta traditional EEG rhythm originates in several anatomically distinct brain structures. Preparatory attention is associated with a decrease in power in alpha (right and left occipital and temporal areas) and low-beta (left frontal, bilateral occipital and middle frontal areas) EEG bands. In these structures power changes associated with preparatory attention modulated either a dominant or a non-dominant oscillatory band, suggesting that non-dominant rhythms of a cerebral area have some functional relevance. Our results imply distributed regional sources for brain rhythms and support the view that during preparatory attention there is a modulation of the brain sources generating alpha and beta brain rhythms. Moreover, the proposed combined approach makes it possible to explore the definition of a given brain area not only anatomically, but also by the frequency content and the functional reactivity of the electrical rhythms that it generates. © 2006 Elsevier B.V. All rights reserved.

338. Godinho, F., M. Magnin, M. Frot, C. Perchet, and L. Garcia-Larrea, *Emotional modulation of pain: Is it the sensation or what we recall?* Journal of Neuroscience, 2006. **26**(44): p. 11454-11461.

Summary: Emotions modulate pain perception, although the mechanisms underlying this phenomenon remain unclear. In this study, we show that intensity reports significantly increased when painful stimuli were concomitant to images showing human pain, whereas pictures with identical emotional values but without somatic content failed to modulate pain. Early somatosensory responses (<200 ms) remained unmodified by emotions. Conversely, late responses showed a significant enhancement associated with increased pain ratings, localized to the right prefrontal, right temporo-occipital junction, and right temporal pole. In contrast to selective attention, which enhances pain ratings by increasing sensory gain, emotions triggered by seeing other people's pain did not alter processing in SI-SII (primary and second somatosensory areas), but may have biased the transfer to, and the representation of pain in short-term memory buffers (prefrontal), as well as the affective assignment to this representation (temporal pole). Memory encoding and recall, rather than sensory processing, appear to be modulated by empathy with others' physical suffering. Copyright © 2006 Society for Neuroscience.

339. Fischmeister, F.P.S. and H. Bauer, *Neural correlates of monocular and binocular depth cues based on natural images: A LORETA analysis*. Vision Research, 2006. **46**(20): p. 3373-3380.

Summary: Functional imaging studies investigating perception of depth rely solely on one type of depth cue based on non-natural stimulus material. To overcome these limitations and to provide a more realistic and complete set of depth cues natural stereoscopic images were used in this study. Using slow cortical potentials and source localization we aimed to identify the neural correlates of monocular and binocular depth cues. This study confirms and extends functional imaging studies, showing that natural images provide a good,

reliable, and more realistic alternative to artificial stimuli, and demonstrates the possibility to separate the processing of different depth cues. © 2006 Elsevier Ltd. All rights reserved.

340. Ferri, R., F. Rundo, O. Bruni, M.G. Terzano, and C.J. Stam, *Regional scalp EEG slow-wave synchronization during sleep cyclic alternating pattern A1 subtypes*. Neuroscience Letters, 2006. **404**(3): p. 352-357.

Summary: The levels of EEG synchronization, in the 0.25-2.5 Hz band, during the A1 subtypes of the sleep "cyclic alternating pattern" (CAP) were measured in five healthy subjects by means of the synchronization likelihood (SL) algorithm. SL was measured for seven electrode pairs (F4-F3, C4-C3, P4-P3 for the analysis of interhemispheric SL and F4-C4, C4-P4, F3-C3, and C3-P3, for the analysis of intrahemispheric SL). During the A1 CAP subtypes, SL tended to be highest between pairs of electrodes situated over different hemispheres; in particular, SL obtained from F4-F3 was the highest, followed by that of P4-P3. These results indicate that the transient high level of synchronization in the slow-wave EEG range, during the sleep A1 CAP subtypes, is a phenomenon involving mostly the anterior parts of the brain and is probably based on interhemispheric interactions, possibly mediated by transcallosal connections. © 2006 Elsevier Ireland Ltd. All rights reserved.

341. Fallgatter, A.J., M.J. Herrmann, C. Hohoff, A.C. Ehlis, T.A. Jarczok, C.M. Freitag, and J. Deckert, *DTNBP1 (dysbindin) gene variants modulate prefrontal brain function in healthy individuals*. Neuropsychopharmacology, 2006. **31**(9): p. 2002-2010.

Summary: DTNBP1 (dysbindin) is one of the several putative schizophrenia genes supported by association, neuroanatomical, and cellular studies. These suggest an involvement of DTNBP1 in the prefrontal cortex and cognitive functions mediated by interaction with neurotransmitter systems, in particular glutamate. The influence of DTNBP1 gene variation on prefrontal brain function at the systemic neurophysiological level, though, has not been characterized. The NoGo-anteriorization (NGA) as an event-related potential (ERP) measure elicited during the continuous performance test (CPT) has been established as a valid neurophysiological parameter for prefrontal brain function in healthy individuals and patients with schizophrenias. In the present study, we therefore investigated the influence of eight dysbindin gene variants on the NGA as a marker of prefrontal brain function in 48 healthy individuals. Two DTNBP1 polymorphisms previously linked to schizophrenia (P1765 and P1320) were found associated with changes in the NGA. Post hoc analysis showing an influence of genetic variation at these loci on the Go centroid and frontal amplitudes suggest that this might be due to modification of the execution of motor processes by the prefrontal cortex. This is the first report on a role of DTNBP1 gene variation for prefrontal brain function at a systemic neurophysiological level in healthy humans. Future studies will have to address the relevance of this observation for patients with schizophrenias. © 2006 Nature Publishing Group All rights reserved.

342. Ding, L., G.A. Worrell, T.D. Lagerlund, and B. He, *3D source localization of interictal spikes in epilepsy patients with MRI lesions*. Physics in Medicine and Biology, 2006. **51**(16): p. 4047-4062.

Summary: The present study aims to accurately localize epileptogenic regions which are responsible for epileptic activities in epilepsy patients by means of a new subspace source localization approach, i.e. first principle vectors (FINE), using scalp EEG recordings. Computer simulations were first performed to assess source localization accuracy of FINE in the clinical electrode set-up. The source localization results from FINE were compared with the results from a classic subspace source localization approach, i.e. MUSIC, and their differences were tested statistically using the paired t-test. Other factors influencing the source localization accuracy were assessed statistically by ANOVA. The interictal epileptiform spike data from three adult epilepsy patients with medically intractable partial epilepsy and well-defined symptomatic MRI lesions were then studied using both FINE and MUSIC. The comparison between the electrical sources estimated by the subspace source localization approaches and MRI lesions was made through the coregistration between the EEG recordings and MRI scans. The accuracy of estimations made by FINE and MUSIC was also evaluated and compared by R2 statistic, which was used to indicate the goodness-of-fit of the estimated sources to the scalp EEG recordings. The three-concentric-spheres head volume conductor model was built for each patient with three spheres of different radii which takes the individual head size and skull thickness into consideration. The results from computer simulations indicate that the improvement of source spatial resolvability and localization accuracy of FINE as compared with MUSIC is significant when simulated sources are closely spaced, deep, or signal-to-noise ratio is low in a clinical electrode set-up. The interictal electrical generators estimated by FINE and MUSIC are in concordance with the patients' structural abnormality, i.e. MRI lesions, in all three patients. The higher R2 values achieved by FINE than MUSIC indicate that FINE provides a more satisfactory fitting of the scalp potential measurements than MUSIC in all patients. The present results suggest that FINE provides a useful brain source imaging technique, from clinical EEG recordings, for identifying and localizing epileptogenic regions in epilepsy patients with focal partial seizures. The present study may lead to the establishment of a high-resolution source localization technique from scalp-recorded EEGs for aiding presurgical planning in epilepsy patients. © 2006 IOP Publishing Ltd.

343. Ding, L. and B. He, *Spatio-temporal EEG source localization using a three-dimensional subspace FINE approach in a realistic geometry inhomogeneous head model*. IEEE Transactions on Biomedical Engineering, 2006. **53**(9): p. 1732-1739.

Summary: The subspace source localization approach, i.e., first principle vectors (FINE), is able to enhance the spatial resolvability and localization accuracy for closely-spaced neural sources from EEG and MEG measurements. Computer simulations were conducted to evaluate the performance of the FINE algorithm in an inhomogeneous realistic geometry head model under a variety of conditions. The source localization abilities of FINE were examined at different cortical regions and at different depths. The present computer simulation results indicate that FINE has enhanced source localization capability, as compared with MUSIC and RAP-MUSIC, when sources are closely spaced, highly noise-contaminated, or inter-correlated. The source localization accuracy of FINE is better, for closely-spaced sources, than MUSIC at various noise levels, i.e., signal-to-noise ratio (SNR) from 6 dB to 16 dB, and RAP-MUSIC at relatively low noise levels, i.e., 6 dB to 12 dB. The FINE approach has been further applied to localize brain sources of motor potentials, obtained during the finger tapping tasks in a human subject. The experimental results suggest that the detailed neural activity distribution could be revealed by FINE. The present study suggests that FINE provides enhanced performance in localizing multiple closely spaced, and inter-correlated sources under low SNR, and may become an important alternative to brain source localization from EEG or MEG. © 2006 IEEE.

344. Deouell, L.Y., A. Parnes, N. Pickard, and R.T. Knight, *Spatial location is accurately tracked by human auditory sensory memory: Evidence from the mismatch negativity*. European Journal of Neuroscience, 2006. **24**(5): p. 1488-1494.

Summary: The nature of spatial representation in human auditory cortex remains elusive. In particular, although humans can discriminate the locations of sounds as close as 1-10 degrees apart, such resolution has not been shown in auditory cortex of humans or animals. We used the mismatch negativity (MMN) event related brain potential to measure the neural response to spatial change in humans in narrow 10 degree spatial steps. Twelve participants were tested using a dense array EEG setup while watching a silent movie and ignoring the sounds. The MMN was reliably elicited by infrequent changes of spatial location of sounds in free field. The MMN amplitude was linearly related to the degree of spatial change with a resolution of at least 10 degrees. These electrophysiological responses occurred within a window of 100-200 milliseconds from stimulus onset, and were localized to the posterior superior temporal gyrus. We conclude that azimuthal spatial displacement is rapidly, accurately and automatically represented in auditory sensory memory in humans, at the level of the auditory cortex. © The Authors (2006).

345. Daunizeau, J., J. Mattout, D. Clonda, B. Goulard, H. Benali, and J.M. Lina, *Bayesian spatio-temporal approach for EEG source reconstruction: Conciliating ECD and distributed models*. IEEE Transactions on Biomedical Engineering, 2006. **53**(3): p. 503-516.

Summary: Characterizing the cortical activity sources of electroencephalography (EEG)/magnetoencephalography data is a critical issue since it requires solving an ill-posed inverse problem that does not admit a unique solution. Two main different and complementary source models have emerged: equivalent current dipoles (ECD) and distributed linear (DL) models. While ECD models remain

highly popular since they provide an easy way to interpret the solutions, DL models (also referred to as imaging techniques) are known to be more realistic and flexible. In this paper, we show how those two representations of the brain electromagnetic activity can be cast into a common general framework yielding an optimal description and estimation of the EEG sources. From this extended source mixing modelw we derive a hybrid approach whose key aspect is the separation between temporal and spatial characteristics of brain activity, which allows to dramatically reduce the number of DL model parameters. Furthermore, the spatial profile of the sources, as a temporal invariant map, is estimated using the entire time window data, allowing to significantly enhance the information available about the spatial aspect of the EEG inverse problem. A Bayesian framework is introduced to incorporate distinct temporal and spatial constraints on the solution and to estimate both parameters and hyperparameters of the model. Using simulated EEG data, the proposed inverse approach is evaluated and compared with standard distributed methods using both classical criteria and ROC curves. © 2006 IEEE.

346. Czigler, I., L. Pató, E. Poszet, and L. Balázs, *Age and novelty: Event-related potentials to visual stimuli within an auditory oddball-visual detection task*. International Journal of Psychophysiology, 2006. **62**(2): p. 290-299.

Summary: Age-related change of event-related potentials to novel visual stimuli was investigated while participants attended to both auditory and visual stimulation. Meaningful but irrelevant pictures (novel stimuli) were presented to younger (mean = 21.8, range = 18-26 years) and older (mean = 70.0, range = 60-78) participants (10 in each group). The participants were performing an auditory oddball task and counting silently the changes of a visually presented letter. In the younger group novel stimuli elicited a posterior positivity in the 220-255 ms range. This component habituated to the repetition of the same picture. In the older group this component had longer latency, and did not habituate. A later positivity had shorter latency and larger amplitude in the younger group, but this positivity was preceded by a negative component (N2b) only in the elderly. Results show decreased sensitivity to the content of the visual stimuli in an earlier stage of novelty processing in the elderly, and the age-related slowing of both orientation-related and task-related processes. © 2006 Elsevier B.V. All rights reserved.

347. Casarotto, S., A.M. Bianchi, S. Cerutti, N. Vanello, E. Ricciardi, C. Gentili, L. Sani, D. Bonino, M. Guazzelli, P. Pietrini, L. Landini, and G.A. Chiarenza, *Combination of event-related potentials and functional magnetic resonance imaging during single-letter reading*. Annual International Conference of the IEEE Engineering in Medicine and Biology - Proceedings, 2006: p. 984-987.

Summary: This work proposes a mathematical approach for combining event-related potentials (ERPs) and functional magnetic resonance images (fMRI). Data were separately recorded during the same event-related experimental design, consisting of visually presented single letters and non-alphabetic symbols, that had to be either simply observed (passive condition) or read aloud (active condition). This protocol was useful for exploring the neural correlates of reading processes. Healthy adults participated in the experiment. Averaged ERPs were decomposed by Independent Component Analysis; Low Resolution Electromagnetic Tomography (LORETA) was applied to estimate the current density distribution maps of each independent component. fMRI images time series were analyzed by multiple linear regression. ERP-fMRI correspondence was quantified by computing the Euclidean distance between LORETA local maxima and clusters of significantly activated fMRI voxels. During reading aloud of letters, that is clearly the task most similar to natural reading conditions, significant electrical and hemodynamic response was observed in the left medial frontal gyrus (BA 6) and left middle temporal gyrus (BA 22/39) just before articulation and in the bilateral middle superior temporal gyrus (BA 22/37) during and after verbal-motor production. These results indicate that the middle-superior temporal gyrus plays a crucial and multifunctional role in grapheme-phoneme matching. ©2006 IEEE.

348. Carretié, L., J.A. Hinojosa, J. Albert, and F. Mercado, *Neural response to sustained affective visual stimulation using an indirect task*. Experimental Brain Research, 2006. **174**(4): p. 630-637.

Summary: Event-related potentials were recorded from 30 subjects using sustained stimulation and an indirect task, two strategies which facilitate affective responses that are complete and free of cognitive interference. Stimuli were of three types: pleasant, unpleasant and neutral. A three-phase pattern was found. The first phase, an amplitude increase in response to negative stimuli higher than to neutral and pleasant stimuli, was produced at 160 ms after stimulus onset, the prefrontal cortex being the origin of this phase. The second phase, characterized by maximal amplitudes in response to positive stimuli, was produced at 400 ms, originating in the visual cortex. Finally, the third phase, another amplitude increase in response to negative stimuli, was produced at 680 ms, and its source was located in the left precentral gyrus. Present data show that the cortical response to sustained emotional visual stimulation presented within indirect tasks provides information on attention-, motivation- and motor-related biases that complement information obtained under other experimental conditions. © 2006 Springer-Verlag.

349. Cao, N., I.Ş. Yetik, A. Nehorai, C.H. Muravchik, and J. Haueisen, *Estimating parametric line-source models with electroencephalography*. IEEE Transactions on Biomedical Engineering, 2006. **53**(11): p. 2156-2165.

Summary: We develop three parametric models for electroencephalography (EEG) to estimate current sources that are spatially distributed on a line. We assume a realistic head model and solve the EEG forward problem using the boundary element method (BEM). We present the models with increasing degrees of freedom, provide the forward solutions, and derive the maximum-likelihood estimates as well as Cramér-Rao bounds of the unknown source

parameters. A series of experiments are conducted to evaluate the applicability of the proposed models. We use numerical examples to demonstrate the usefulness of our line-source models in estimating extended sources. We also apply our models to the real EEG data of N20 response that is known to have an extended source. We observe that the line-source models explain the N20 measurements better than the dipole model. © 2006 IEEE.

350. Cao, N., I.Ş. Yetik, A. Nehorai, C.H. Muravchik, and J. Haueisen, *Parametric surface-source modeling and estimation with electroencephalography*. IEEE Transactions on Biomedical Engineering, 2006. **53**(12): p. 2414-2424.

Summary: Electroencephalography (EEG) is an important tool for studying the brain functions and is becoming popular in clinical practice. In this paper, we develop four parametric EEG models to estimate current sources that are spatially distributed on a surface. Our models approximate the source shape and extent explicitly and can be applied to localize extended sources which are often encountered, e.g., in epilepsy diagnosis. We assume a realistic head model and solve the EEG forward problem using the boundary element method. We present the source models with increasing degrees of freedom, provide the forward solutions, and derive the maximum-likelihood estimates as well as Cramér-Rao bounds of the unknown source parameters. In order to evaluate the applicability of the proposed models, we first compare their estimation performances with the dipole model's using several known source distributions. We then discuss the conditions under which we can distinguish between the proposed extended sources and the focal dipole using the generalized likelihood ratio test. We also apply our models to the electric measurements obtained from a phantom body in which an extended electric source is imbedded. We observe that the proposed model can capture the source extent information satisfactorily and the localization accuracy is better than the dipole model. © 2006 IEEE.

351. Cannon, R., J. Lubar, A. Gerke, K. Thornton, T.A. Hutchens, and V. McCammon, *EEG spectral-power and coherence: LORETA neurofeedback training in the anterior cingulate gyrus*. Journal of Neurotherapy, 2006. **10**(1): p. 5-31.

Summary: Introduction. This study examines the EEG spectral power and coherence changes that occur as a result of LORETA neurofeedback (LNFB) training, which is a recently developed spatial-specific neurofeedback protocol in which it has been demonstrated that human beings can learn to change activity in their own anterior cingulate gyrus. We trained individuals to increase low-beta (14-18 Hz) activity in the cognitive division of the anterior cingulate gyrus (ACcd). Methods. This study was conducted with eight non-clinical students with a mean age of 22. The participants completed over 30 sessions of LNFB training. We utilized the WAIS-III for pre- and post-psychometric measures to assess the influence of this training protocol. Results. We selected training Sessions 5, 10, 15, 20, 25, and 30 for comparison to Session 1. There are significant increases in absolute power and coherence over sessions. There is significant increase in the working memory and processing speed subtest scores. Discussion. The anterior regions of the cortex increase in the low-beta frequency relative to the ACcd at significant levels. The superior prefrontal cortex and occipital regions increase in the higher beta frequencies, but not in the trained frequency. The improvements in the working memory and processing speed scores suggest that LNFB had an overall positive effect in attentional processes, working memory, and processing speed. Copyright © by The Haworth Press, Inc. All rights reserved.

352. Cahn, B.R. and J. Polich, *Meditation states and traits: EEG, ERP, and neuroimaging studies*. Psychological Bulletin, 2006. **132**(2): p. 180-211.

Summary: Neuroelectric and imaging studies of meditation are reviewed. Electroencephalographic measures indicate an overall slowing subsequent to meditation, with theta and alpha activation related to proficiency of practice. Sensory evoked potential assessment of concentrative meditation yields amplitude and latency changes for some components and practices. Cognitive event-related potential evaluation of meditation implies that practice changes attentional allocation. Neuroimaging studies indicate increased regional cerebral blood flow measures during meditation. Taken together, meditation appears to reflect changes in anterior cingulate cortex and dorsolateral prefrontal areas. Neurophysiological meditative state and trait effects are variable but are beginning to demonstrate consistent outcomes for research and clinical applications. Psychological and clinical effects of meditation are summarized, integrated, and discussed with respect to neuroimaging data. © 2006 by the American psychological Association.

353. Bucher, K., T. Dietrich, V.L. Marcar, S. Brem, P. Halder, S. Boujraf, P. Summers, D. Brandeis, E. Martin, and T. Loenneker, *Maturation of luminance- and motion-defined form perception beyond adolescence: A combined ERP and fMRI study*. NeuroImage, 2006. **31**(4): p. 1625-1636.

Summary: Abilities to discriminate forms defined by motion continue to develop throughout childhood. To investigate late development of the visual motion system, we measured brain activity with event-related EEG potentials (ERPs) and functional magnetic resonance imaging (fMRI) in groups of adolescents (15-17 years) and adults (20-30 years) during a visual form discrimination task-with forms being either defined by motion or luminance contrast. We further explored whether possible developmental changes varied with the degree of motion coherence reflecting maturation specific to global motion processing. Both the fMRI activation patterns and ERP topographies were very similar between adolescents and adults, suggesting that the basic visual networks for processing motion and form are established by the age of 15-17. The ERP response to luminance- and motion-defined forms was dominated by a posterior negativity (N1: 120-270 ms). The N1 of the motion contrast was delayed in adolescents, whereas the N1 of the static condition did not differ between groups. Since the motion-evoked N1 is thought to arise in the middle temporal area MT/V5, our results indicate that visual motion processing in MT continues to get faster, becoming still more efficient during late development. Neither the ERP nor the fMRI results revealed maturation effects specific to motion coherence. This indicates that the specific mechanisms to process global dot motion are already mature in adolescence. The present findings support the view that static perception matures earlier than dynamic perception, and that these visual systems have different developmental courses. © 2006 Elsevier Inc. All rights reserved.

354. Browne, R.O., L.B. Moyal-Segal, D. Zumsteg, Y. David, O. Kofman, A. Berger, H. Soreq, and A. Friedman, *Coding region paraoxonase polymorphisms dictate accentuated neuronal reactions in chronic, sub-threshold pesticide exposure*. FASEB Journal, 2006. **20**(10).

Summary: Organophosphate pesticides (OPs), known inhibitors of acetylcholinesterase (AChE), are used extensively throughout the world. Recent studies have focused on the ACHE/PON1 locus as a determinant of inherited susceptibility to environmental OP exposure. To explore the relationship of the corresponding gene-environment interactions with brain activity, we integrated neurophysiologic, neuropsychological, biochemical, and genetic methods. Importantly, we found that subthreshold OP exposure leads to discernible physiological consequences that are significantly influenced by inherited factors. Cortical EEG analyses by LORETA revealed significantly decreased theta activity in the hippocampus, parahippocampal regions, and the cingulate cortex, as well as increased beta activity in the prefrontal cortex of exposed individuals - areas known to play a role in cholinergic-associated cognitive functions. Through neuropsychological testing, we identified an appreciable deficit in the visual recall in exposed individuals. Other neuropsychological tests revealed no significant differences between exposed and non-exposed individuals, attesting to the specificity of our findings. Biochemical analyses of blood samples revealed increases in paraoxonase and arylesterase activities and reduced serum acetylcholinesterase activity in chronically exposed individuals. Notably, specific paraoxonase genotypes were found to be associated with these exposure-related changes in blood enzyme activities and abnormal EEG patterns. Thus, gene-environment interactions involving the ACHE/PON1 locus may be causally involved in determining the physiological response to OP exposure. © FASEB.

355. Breun, P., M. Grosse-Wentrup, W. Utschick, and M. Buss, *Robust MEG source localization of event related potentials: Identifying relevant sources by non-Gaussianity*. Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics), 2006. **4174 LNCS**: p. 394-403.

Summary: Independent Component Analysis (ICA) is a frequently used preprocessing step in source localization of MEG and EEC data. By decomposing the measured data into maximally independent components (ICs), estimates of the time course and the topographies of neural sources are obtained. In this

paper, we show that when using estimated source topographies for localization, correlations between neural sources introduce an error into the obtained source locations. This error can be avoided by reprojecting ICs onto the observation space, but requires the identification of relevant ICs. For Event Related Potentials (ERPs), we identify relevant ICs by estimating their non-Gaussianity. The efficacy of the approach is tested on auditory evoked potentials (AEPs) recorded by MEG. It is shown that ten trials are sufficient for reconstructing all important characteristics of the AEP, and source localization of the reconstructed ERP yields the same focus of activity as the average of 250 trials. © Springer-Verlag Berlin Heidelberg 2006.

356. Brem, S., K. Bucher, P. Halder, P. Summers, T. Dietrich, E. Martin, and D. Brandeis, *Evidence for developmental changes in the visual word processing network beyond adolescence*. NeuroImage, 2006. **29**(3): p. 822-837.

Summary: Late development of specialization in the visual word processing system was examined using event-related potentials (ERP) and functional magnetic resonance imaging (fMRI) of word and symbol string processing in groups of adolescents (15.2-17.3 years) and adults (19.8-30.8 years). We focused our ERP analyses on fast visual activity: the occipital P1 (82-131 ms) modulated by physical stimulus characteristics and the occipito-temporal N1 (132-256 ms) reflecting visual tuning for print. Our fMRI analyses concentrated on basal occipito-temporal activations in the visual word form area VWFA. For words, the correlation of fMRI activation in the VWFA and N1 amplitude confirmed the close relationship of the electrophysiological N1 with metabolic activity in the VWFA. Further support for this relationship came from low resolution electromagnetic tomography localizing the word-specific N1 near the VWFA. Both imaging techniques revealed age-independent differences between words and symbol strings. Late development, however, was preferentially detected with ERPs. Decreases of P1 and N1 amplitudes with age were not limited to words and suggested further maturation of the underlying brain microstructure and function. Following adolescence, decreasing N1 latencies specific to words point to continued specialization of the visual word processing system. Both N1 and fMRI measures correlated with reading performance. In summary, the similarity of global fMRI activation patterns between groups suggests a fully established distribution of the reading network in adolescence, while the decreasing N1 latencies for words indicate protracted fine tuning after adolescence. © 2005 Elsevier Inc. All rights reserved.

357. Boehm, S.G., E.C. Klostermann, and K.A. Paller, *Neural correlates of perceptual contributions to nondeclarative memory for faces*. NeuroImage, 2006. **30**(3): p. 1021-1029.

Summary: Face priming is a nondeclarative memory phenomenon that can be observed when recognition is facilitated for a recently encountered face. This data-driven form of priming is distinct from conceptually driven priming. Moreover, it includes two dissociable components, the facilitated access to pre-existing representations and facilitation in perceptual processing of faces. In the present study, we measured neural correlates of perceptual contributions to face priming with event-related brain potentials. Faces appeared two times (separated by 7-17 s), while participants discriminated familiar from unfamiliar faces. Half of the initial face stimuli were inverted, thereby disrupting perceptual face processing and making possible an assessment of perceptual contributions to face priming. Whereas none of the brain waves previously linked to perceptual processing of faces showed indications of priming, such effects were observed between 200 and 600 ms at left occipito-parieto-temporal recording sites. This electrical activity was present for both unfamiliar and familiar faces. The scalp topography of this effect was consistent with sources within the temporal and occipital cortices of the left hemisphere (based on a LORETA source localization). These findings suggest that priming of perceptual face processing is subserved by prolonged neural activity from 200 to 600 ms primarily in the left hemisphere. We propose that this priming reflects facilitated selection based on second-order relations among facial features. © 2005 Elsevier Inc. All rights reserved.

358. Bellebaum, C. and I. Daum, *Time course of cross-hemispheric spatial updating in the human parietal cortex.* Behavioural Brain Research, 2006. **169**(1): p. 150-161.

Summary: In human parietal cortex, the retinal location of a just seen visual stimulus is updated from one hemisphere to the other, when a horizontal eye movement brings the representation of the stimulus into the opposite visual hemifield. The present study aimed to elucidate the time course of this process. Twelve subjects performed an updating task, in which a filled circle was shown before a horizontal saccade, requiring updating of stimulus location, and a control task without visual stimulation before the saccade. Electroencephalogram (EEG) and electrooculogram (EOG) were recorded while subjects performed the tasks and LORETA source analysis was performed on event-related potential (ERP) components. ERP amplitudes were more positive in the updating condition in comparison to the control condition in two latency windows. An early positive wave starting at about 50 ms after saccade offset and originating in the posterior parietal cortex contralateral to saccade direction probably reflects the integration of saccade-related and visual information and thus the updating process. A shift of the representation of the to-be-updated stimulus to the opposite hemisphere is reflected in a later component starting approximately 400 ms after saccade offset, which is related to memory and originates in the PPC ipsilateral to saccade direction and thus contralateral to the spatial location of the updated visual stimulus. © 2006 Elsevier B.V. All rights reserved.

359. Bayram, A., E. Yildirm, T. Demiralp, and A. Ademoğlu, *Spatial frequency components of to the Event Related brain Potentials (ERP).* Olaya İlişkin beyin Potansiyellerinin (OİP) mekansal frekans bileşenleri, 2006. **2006**.

Summary: The highest temporal resolution, which is crucial for temporal localization of intracerebral activities, is achieved by ERP, but spatial resolution of scalp topography is low. To overcome the limitation of scalp topography, several current-density estimation techniques were developed whose goal is to find the locations of the three-dimensional (3D) intracerebral activities by solving an inverse problem (such as LORETA). However, scalp topologies constituted by multiple sources which makes the inverse problem complicated. The overall objective of this work is to isolate spatial frequency components of scalp topography by 2-D wavelet transform and to interpret spatial frequency formation via corresponding current-density estimations. Moreover, by achieving less complex scalp maps, obstacle of the inverse problem due to the multiple sources might be lessen. At the first step, main topologies of ERP recordings were investigated by hierarchical clustering algorithm. Secondly, different spatial frequencies of these main topologies were separated by 2-D wavelet transform. Finally, main topological maps and topographic maps of different spatial frequencies derived from them were used to find corresponding cortical activities by LORETA. Assessment of our spatial analysis results was made according to the current density estimation results. © 2006 IEEE.

360. Baumgartner, T., L. Valko, M. Esslen, and L. Jäncke, *Neural correlate of spatial presence in an arousing and noninteractive virtual reality: An EEG and psychophysiology study*. Cyberpsychology and Behavior, 2006. **9**(1): p. 30-45.

Summary: Using electroencephalography (EEG), psychophysiology, and psychometric measures, this is the first study which investigated the neurophysiological underpinnings of spatial presence. Spatial presence is considered a sense of being physically situated within a spatial environment portrayed by a medium (e.g., television, virtual reality). Twelve healthy children and 11 healthy adolescents were watching different virtual roller coaster scenarios. During a control session, the roller coaster cab drove through a horizontal roundabout track. The following realistic roller coaster rides consisted of spectacular ups, downs, and loops. Low-resolution brain electromagnetic tomography (LORETA) and event-related desynchronization (ERD) were used to analyze the EEG data. As expected, we found that, compared to the control condition, experiencing a virtual roller coaster ride evoked in both groups strong SP experiences, increased electrodermal reactions, and activations in parietal brain areas known to be involved in spatial navigation. In addition, brain areas that receive homeostatic afferents from somatic and visceral sensations of the body were strongly activated. Most interesting, children (as compared to adolescents) reported higher spatial presence experiences and demonstrated a different frontal activation pattern. While adolescents showed increased activation in prefrontal areas known to be involved in the control of executive functions, children demonstrated a decreased activity in these brain regions. Interestingly, recent neuroanatomical and neurophysiological studies have shown that the frontal brain continues to develop to adult status well into adolescence. Thus, the result of our study implies that the increased spatial presence experience in children may result from the not fully developed control functions of the frontal cortex. © Mary Ann Liebert, Inc.

361. Barry, R.J. and J.A. Rushby, *An orienting reflex perspective on anteriorisation of the P3 of the event-related potential*. Experimental Brain Research, 2006. **173**(3): p. 539-545.

Summary: In the Go/NoGo task, the P3 component of the event-related potential elicited by NoGo stimuli is topographically anterior to that from Go stimuli. This anteriorisation has been linked to the response inhibition thought to be required when NoGo stimuli are presented, and suggested as an index of inhibition. We report a preliminary investigation of this question from an orienting reflex (OR) perspective, in which the autonomic skin conductance response (SCR) was used as an OR "yardstick". We presented subjects with a random mix of 15 target and 15 non-target auditory stimuli with a short inter-stimulus interval, and explored the sources of the resultant P3s using low-resolution electromagnetic tomography (LORETA). Across-subject mean SCRs showed exponential decrement over trials and a larger response to targets, as expected from the OR perspective. LORETA analysis of the across-subject mean initial P3s showed exponential response decrement of their common sources, suggestive of the Novelty P3. Grand mean P3s to targets and non-targets appeared to correspond to the P3b and P3a, respectively. These results suggest that anteriorisation of the P3 to NoGo stimuli may reflect processing related to the basic involuntary OR to indifferent (non-significant) stimuli rather than an active inhibitory process. © Springer-Verlag 2006.

362. Barbati, G., R. Sigismondi, F. Zappasodi, C. Porcaro, S. Graziadio, G. Valente, M. Balsi, P.M. Rossini, and F. Tecchio, *Functional source separation from magnetoencephalographic signals*. Human Brain Mapping, 2006. **27**(12): p. 925-934.

Summary: We propose a novel cerebral source extraction method (functional source separation, FSS) starting from extra-cephalic magnetoencephalographic (MEG) signals in humans. It is obtained by adding a functional constraint to the cost function of a basic independent component analysis (ICA) model, defined according to the specific experiment under study, and removing the orthogonality constraint, (i.e., in a single-unit approach, skipping decorrelation of each new component from the subspace generated by the components already found). Source activity was obtained all along processing of a simple separate sensory stimulation of thumb, little finger, and median nerve. Being the sources obtained one by one in each stage applying different criteria, the a posteriori "interesting sources selection" step is avoided. The obtained solutions were in agreement with the homuncular organization in all subjects, neurophysiologically reacting properly and with negligible residual activity. On this basis, the separated sources were interpreted as satisfactorily describing highly superimposed and interconnected neural networks devoted to cortical finger representation. The proposed procedure significantly improves the quality of the extraction with respect to a standard BSS algorithm. Moreover, it is very flexible in including different functional constraints, providing a promising tool to identify neuronal networks in very general cerebral processing. © 2006 Wiley-Liss, Inc.

363. Bai, X. and B. He, *Estimation of number of independent brain electric sources from the scalp EEGs*. IEEE Transactions on Biomedical Engineering, 2006. **53**(10): p. 1883-1892.

Summary: In electromagnetic source analysis, many source localization strategies require the number of sources as an input parameter (e.g., spatio-temporal dipole fitting and the multiple signal classification). In the present study, an information criterion method, in which the penalty functions are selected based on the spatio-temporal source model, has been developed to estimate the number of independent dipole sources from electromagnetic measurements such as the electroencephalogram (EEG). Computer simulations were conducted to evaluate the effects of various parameters on the estimation of the source number. A three-concentric-spheres head model was used to approximate the head volume conductor. Three kinds of typical signal sources, i.e., the damped sinusoid sources, sinusoid sources with one frequency band and sinusoid sources with two separated frequency bands, were used to simulate the oscillation characteristics of brain electric sources. The simulation results suggest that the present method can provide a good estimate of the number of independent dipole sources from the EEG measurements. In addition, the present simulation results suggest that choosing the optimal penalty function can successfully reduce the effect of noise on the estimation of number of independent sources. The present study suggests that the information criterion method may provide a useful means in estimating the number of independent brain electrical sources from EEG/MEG measurements. © 2006 IEEE.

364. Babiloni, C., L. Benussi, G. Binetti, E. Cassetta, G. Dal Forno, C. Del Percio, F. Ferreri, R. Ferri, G. Frisoni, R. Ghidoni, C. Miniussi, G. Rodriguez, G.L. Romani, R. Squitti, M.C. Ventriglia, and P.M. Rossini, *Apolipoprotein E and alpha brain rhythms in mild cognitive impairment: A multicentric electroencephalogram study*. Annals of Neurology, 2006. **59**(2): p. 323-334.

Summary: Objective: Relationships between the apolipoprotein E ε4 allele and electroencephalographic (EEG) rhythmicity have been demonstrated in Alzheimer's disease (AD) patients but not in the preclinical stage prodromic to it, namely, mild cognitive impairment (MCI). The present multicentric EEG study tested the hypothesis that presence of ε4 affects sources of resting EEG rhythms in both MCI and AD subjects. Methods: We enrolled 89 MCI subjects (34.8% with ε4) and 103 AD patients (50.4% with ε4). Resting eyes-closed EEG data were recorded for all subjects. EEG rhythms of interest were delta (2-4Hz), theta (4-8Hz), alpha 1 (8-10.5Hz), alpha 2 (10.5-13Hz), beta 1 (13-20Hz), and beta 2 (20-30Hz). EEG cortical sources were estimated by low-resolution brain electromagnetic tomography. Results: Results showed that amplitude of alpha 1 and 2 sources in occipital, temporal, and limbic areas was lower in subjects carrying the ε4 allele than in those not carrying the ε4 allele ($p < 0.01$). This was true for both MCI and AD. For the first time to our knowledge, a relationship was shown between ApoE genotype and global neurophysiological phenotype (ie, cortical alpha rhythmicity) in a preclinical AD condition, MCI, in addition to

clinically manifest AD. Interpretation: Such a demonstration motivates future genotype-EEG phenotype studies for the early prediction of AD conversion in individual MCI subjects. © 2006 American Neurological Association.

365. Atcherson, S.R., H.J. Gould, M.A. Pousson, and T.M. Prout, *Long-term stability of N1 sources using low-resolution electromagnetic tomography*. Brain Topography, 2006. **19**(1-2): p. 11-20.

Summary: The purpose of this study was to investigate the long-term stability of auditory N1 sources using low-resolution electromagnetic tomography (LORETA). Data collected from 72 electrodes in ten young adult female participants were analyzed. For each participant, N1 peak amplitude and latency values at Cz (referred to M2) were compared for right, left, and bilateral stimulation across three separate recording sessions. Further, sources calculated by LORETA were analyzed in three regions of interest: right temporal, left temporal, and frontal. Peak amplitude and latency measurements were stable across session and ear of stimulation. Three-way RM-ANOVAs revealed relatively stable source amplitudes and stable three-dimensional locations of the sources in each region of interest with shifts of up to 2 cm around the mean locations. The 2 cm variability may be attributable both to normal hemispheric asymmetries and electrode placement variability. These results suggest that N1 scalp activity and its underlying sources are stable. © 2006 Springer Science + Business Media, Inc.

366. An, K.O., C.H. Im, C. Lee, H.K. Jung, and K.Y. Jung, *Improved magnetoencephalography source reconstruction considering anatomical connectivity of cortical sources*. IEEE Transactions on Magnetics, 2006. **42**(4): p. 1379-1382.

Summary: In this paper, an improved magnetoencephalography (MEG) source reconstruction technique considering anatomical connectivity of cortical sources is proposed. The anatomical connectivity information was taken into account by calculating three-dimensional geodesic distance between neighboring sources, and then the resultant inverse solutions were compared with those of other cases: 1) inverse estimate without connectivity information; 2) use of Euclidean distance instead of geodesic distance. The proposed technique was applied to realistic simulations for a real brain anatomy, and the results showed that estimated sources can be smoother and more accurate by using the anatomical connectivity information. © 2006 IEEE.

367. Alhaj, H.A., A.E. Massey, and R.H. McAllister-Williams, *Effects of DHEA administration on episodic memory, cortisol and mood in healthy young men: A double-blind, placebo-controlled study*. Psychopharmacology, 2006. **188**(4): p. 541-551.

Summary: Rationale: Dehydroepiandrosterone (DHEA) has been reported to enhance cognition in rodents, although there are inconsistent findings in humans. Objectives: The aim of this study was to investigate the effects of DHEA administration in healthy young men on episodic memory and its neural correlates utilising an event-related potential (ERP) technique. Methods: Twenty-four healthy young men were treated with a 7-day course of oral DHEA (150 mg b.d.) or placebo in a double blind, random, crossover and balanced order design. Subjective mood and memory were measured using visual analogue scales (VASs). Cortisol concentrations were measured in saliva samples. ERPs were recorded during retrieval in an episodic memory test. Low-resolution brain electromagnetic tomography (LORETA) was used to identify brain regions involved in the cognitive task. Results: DHEA administration led to a reduction in evening cortisol concentrations and improved VAS mood and memory. Recollection accuracy in the episodic memory test was significantly improved following DHEA administration. LORETA revealed significant hippocampal activation associated with successful episodic memory retrieval following placebo. DHEA modified ERPs associated with retrieval and led to a trend towards an early differential activation of the anterior cingulate cortex (ACC). Conclusions: DHEA treatment improved memory recollection and mood and decreased trough cortisol levels. The effect of DHEA appears to be via neuronal recruitment of the steroid sensitive ACC that may be involved in pre-hippocampal memory processing. These findings are distinctive, being the first to show such beneficial effects of DHEA on memory in healthy young men. © 2005 Springer-Verlag.

368. Zumsteg, D., R.A. Wennberg, V. Treyer, A. Buck, and H.G. Wieser, *H215O or 13NH3 PET and electromagnetic tomography (LORETA) during partial status epilepticus*. Neurology, 2005. **65**(10): p. 1657-1660.

Summary: The authors evaluated the feasibility and source localization utility of H215O or 13NH3 PET and low-resolution electromagnetic tomography (LORETA) in three patients with partial status epilepticus (SE). Results were correlated with findings from intraoperative electrocorticographic recordings and surgical outcomes. PET studies of cerebral blood flow and noninvasive source modeling with LORETA using statistical nonparametric mapping provided useful information for localizing the ictal activity in patients with partial SE. Copyright © 2005 by AAN Enterprises, Inc.

369. Zumsteg, D., A. Friedman, R.A. Wennberg, and H.G. Wieser, *Source localization of mesial temporal interictal epileptiform discharges: Correlation with intracranial foramen ovale electrode recordings*. Clinical Neurophysiology, 2005. **116**(12): p. 2810-2818.

Summary: Objective: We have investigated the localization accuracy of low-resolution electromagnetic tomography (LORETA) for mesial temporal interictal epileptiform discharges (IED) on a statistical basis by using clinical electroencephalographic (EEG) data of simultaneous scalp and intracranial foramen ovale (FO) electrode recordings. Methods: We retrospectively analyzed the IED of 15 patients who underwent presurgical assessment for intractable temporal lobe epilepsy. All patients have subsequently undergone amygdalohippocampectomy. The scalp signals were averaged time-locked to the peak activity in bilateral 10-contact FO electrode recordings. Source modeling was carried out by using statistical non-parametric mapping (SNPM) of LORETA values and by calculating raw LORETA values of averaged IED. The results were compared to intracranial data obtained from FO electrode recordings. Results: Two thousand six hundred and fifteen discharges could be attributed to 19 different patterns of intracranial mesial temporal IED. SNPM of LORETA revealed confined ipsilateral mesial temporal solutions for 14 (73.7%) and no significant solutions for five (26.3%) of these patterns. Raw LORETA current density distributions of the 19 averaged IED patterns revealed ipsilateral basal to lateral temporal solutions for the 14 IED patterns with a sufficient signal to noise ratio (SNR), but spurious results for those five IED with a low SNR. Conclusions: SNPM of LORETA but not LORETA analysis of averaged IED patterns accurately localizes the source generators of mesial temporal IEDs. Significance: SNPM of raw LORETA values might be appropriate for localizing restricted mesial temporal lobe sources. © 2005 International Federation of Clinical Neurophysiology. Published by Elsevier Ireland Ltd. All rights reserved.

370. Yvert, B., C. Fischer, O. Bertrand, and J. Pernier, *Localization of human supratemporal auditory areas from intracerebral auditory evoked potentials using distributed source models*. NeuroImage, 2005. **28**(1): p. 140-153.

Summary: While source localization methods are increasingly developed to identify brain areas underlying scalp electro/magnetoencephalographic data (EEG/MEG), these methods have not yet been used to identify the sources of intracerebral signals which offer highly detailed information. Here, we adapted the minimum current estimates method to intracranial data in order to localize supratemporal sources of intracerebral auditory 1-kHz-tone-evoked potentials occurring within 100 ms after stimulus onset. After an evaluation of localization method and despite inter-subject variability, we found a common spatiotemporal pattern of activities, which involved the first Heschl's gyrus (H1) and sulcus (HS), the Planum Temporale (PT), H2/H3 when present, and the superior temporal gyrus (STG). Four time periods of activity were distinguished, corresponding to the time range of the scalp components P0, Na, Pa/Pb, and N100. The sources of the earliest components P0 (16-19 ms) and Na (20-25 ms) could be identified in the postero-medial portion of HS or H1. Then, several areas became simultaneously active after 25 ms. The Pa/Pb time range (30-50 ms) was characterized by a medio-lateral and postero-anterior propagation of activity over the supratemporal plane involving successively H1/HS, the Planum Temporale, H2/H3 when present, and the STG. Finally, we found to a large extent that the N100 (55-100 ms) involved almost the same areas as those active during the Pa/Pb complex, with a similar propagation of activities. Reconstructing scalp data from these sources on fictive EEG/MEG channels reproduced classical auditory evoked waveforms and topographies. In conclusion, the spatiotemporal pattern of activation of supratemporal auditory areas could be identified on the individual anatomy using current estimates from intracerebral data. Such

detailed localization approach could also be used prior to epilepsy surgery to help identify epileptogenic foci and preserve functional cortical areas. © 2005 Elsevier Inc. All rights reserved.

371. Yoshimura, N., M. Kawamura, Y. Masaoka, and I. Homma, *The amygdala of patients with Parkinson's disease is silent in response to fearful facial expressions*. Neuroscience, 2005. **131**(2): p. 523-534.

Summary: We previously found that patients with Parkinson's disease (PD) were impaired with respect to recognition of fear and disgust in facial expressions. To investigate the neural mechanisms that underlie this impairment, we recorded visual event-related potentials (ERPs) in response to the viewing of fearful facial expressions. Ten normal elderly volunteers and nine patients with PD were studied. Fearful, surprised, and neutral facial expressions were presented randomly for 500 ms each, with a probability of 0.1, 0.1, and 0.8, respectively. The locations of the components of the ERPs were analyzed using a scalp-skull-brain/dipole tracing method. The ERPs elicited in response to the facial stimuli consisted of a negative peak (N1), two positive peaks, and a subsequent slow negative shift. For N1, the equivalent current dipoles were concentrated in the fusiform gyrus, right superior temporal gyrus, parahippocampal gyrus, cingulate cortex, and cerebellum, in normal subjects. In response to the fearful stimulus, dipoles were also generated from the amygdala in seven out of 10 normal subjects. In contrast, in patients with PD, N1 was centered bilaterally in the angular gyrus and supramarginal gyrus, and there was no neuronal activity in the amygdala. After N1, dipoles moved toward the frontal region in normal subjects, whereas they remained in the parietal lobes in patients with PD. These results suggest that neither the amygdala nor the temporal visual-associated cortices are involved in responding to fearful expressions in patients with PD. Corticostriatal connections may be variably affected by a lack of dopamine or by pathological changes in the amygdala. Thus, somatosensory recruitment may overcome the mild cognitive emotional deficits that are present in patients with PD owing to a dysfunction of the amygdala. © 2005 IBRO. Published by Elsevier Ltd. All rights reserved.

372. Yao, J. and J.P.A. Dewald, *Evaluation of different cortical source localization methods using simulated and experimental EEG data*. NeuroImage, 2005. **25**(2): p. 369-382.

Summary: Different cortical source localization methods have been developed to directly link the scalp potentials with the cortical activities. Up to now, these methods are the only possible solution to noninvasively investigate cortical activities with both high spatial and time resolutions. However, the application of these methods is hindered by the fact that they have not been rigorously evaluated nor compared. In this paper, the performances of several source localization methods (moving dipoles, minimum Lp norm, and low resolution tomography (LRT) with Lp norm, p equal to 1, 1.5, and 2) were evaluated by using simulated scalp EEG data, scalp somatosensory evoked potentials (SEPs), and

upper limb motor-related potentials (MRPs) obtained on human subjects (all with 163 scalp electrodes). By using simulated EEG data, we first evaluated the source localization ability of the above methods quantitatively. Subsequently, the performance of the various methods was evaluated qualitatively by using experimental SEPs and MRPs. Our results show that the overall LRT Lp norm method with p equal to 1 has a better source localization ability than any of the other investigated methods and provides physiologically meaningful reconstruction results. Our evaluation results provide useful information for choosing cortical source localization approaches for future EEG/MEG studies. © 2004 Elsevier Inc. All rights reserved.

373. Weber, D.L., C.R. Clark, A.C. McFarlane, K.A. Moores, P. Morris, and G.F. Egan, *Abnormal frontal and parietal activity during working memory updating in post-traumatic stress disorder.* Psychiatry Research - Neuroimaging, 2005. **140**(1): p. 27-44.

Summary: This study used event-related potentials (ERPs) to investigate the timing and scalp topography of working memory in post-traumatic stress disorder (PTSD). This study was designed to investigate ERPs associated with a specific working memory updating process. ERPs were recorded from 10 patients and 10 controls during two visual tasks where (a) targets were a specific word or (b) targets were consecutive matching words. In the first task, nontarget words are not retained in working memory. In the second task, as in delay-match-to-sample tasks, a non-target word defines a new target identity, so these words are retained in working memory. This working memory updating process was related to large positive ERPs over frontal and parietal areas at 400-800 ms, which were smaller in PTSD. Estimation of cortical source activity indicated abnormal patterns of frontal and parietal activity in PTSD, which were also observed in regional cerebral blood flow [Clark, C.R., McFarlane, A.C., Morris, P., Weber, D.L., Sonkkilla, C., Shaw, M., Marcina, J., Tochon-Danguy, H., Egan, G., 2003. Cerebral function in posttraumatic stress disorder during verbal working memory updating: a positron emission tomography study. Biological Psychiatry 53, 474-481]. Frontal and parietal cortex are known to be involved in distributed networks for working memory processes, interacting with medial temporal areas during episodic memory processes. Abnormal function in these brain networks helps to explain everyday concentration and memory difficulties in PTSD. © 2005 Elsevier Ireland Ltd. All rights reserved.

374. Urrestarazu, E. and J. Iriarte, *Mathematical analyses in the study of electroencephalographic signals*. Análisis matemáticos en el estudio de señales electroencefalográficas, 2005. **41**(7): p. 423-434.

Summary: Aim. The principal mathematical techniques applied to the EEG are reviewed. Development. After the introduction of digital EEG, new mathematical tools have been developed for the EEG analysis. Nowadays there are several techniques that analyse the EEG signal in different ways, getting a better understanding of the EEG: development of new montages; artifact removal;

analysis in time domain, phase coherence and synchrony; source analysis; epileptic seizures detection and prediction; superposition of electrical activity and other neuroimaging techniques. Although they have demonstrated their efficacy, the comparison between them is not always easy. Conclusions. The development of mathematical tools for EEG analysis has improved the knowledge of the electric cerebral activity in normal and pathological conditions. They study many different aspects of the EEG signal. Their continuous development will produce an increase the knowledge of the normal and pathological cerebral functions. © 2005, Revista de Neurología.

375. Tišlerová, B., J. Horáček, M. Brunovský, and M. Kopeček, *18FDG PET and qEEG imaging of hebephrenic schizophrenia. A case study.* Hebefrenní schizofrenie v obraze 18FDG PET a qEEG. Kazuistika, 2005. **9**(2): p. 144-149.

Summary: Hebephrenic (disorganized) schizophrenia is an uncommon type characterized by clinical course and symptoms. The pathophysiology and metabolic brain changes (regional brain metabolizm) of this type are not well established. In our case study we present results of 18FDG PET (18F-deoxyglucose Positron Emission Tomography) and qEEG (quantitative EEG analysis) investigation of an 18-years old man with the first episode of disorganized schizophrenia. METHODS: The regional brain metabolizm was investigated by the use of 18FDG PET in the resting state. The one-sample t-test (SPM99) was used to determine the differences between the hebephrenic patient and the control group of healthy people. The 3D intracerebral distribution of neuronal electrical activity (current density) from the scalp-recorded potential distribution was assessed with Low Resolution Brain Electromagnetic Tomography (LORETA) qEEG. RESULTS: We found increased metabolism in the uncus, middle and superior temporal gyrus, inferior and middle frontal gyrus and precuneus on the right side, in the left inferior parietal lobulus and superior temporal gyrus and in the occipital regions bilaterally. The lower metabolism (18FDG uptake) was found only in the right precentral gyrus (p = 0.001). In comparison with healthy controls, we found a significantly higher current density in the delta band on the right side particularly in the inferior and middle frontal gyrus, inferior temporal and middle occipital gyrus, cuneus and also in limbic structures: in the uncus, posterior cingulum, and insula. On the left side, the current density was higher in superior frontal gyrus, middle temporal gyrus, cingulum and precuneus. In the theta band, we identified higher current density in inferior and superior frontal gyrus, inferior part of gyrus praecentralis and superior temporal gyrus. In the beta3 band, we found a significant decrease of current density in the precuneus (p = 0.001). In the frequency bends alfa1 alfa2, beta1 and beta2, we did not found any significant changes in current density. CONCLUSIONS: Our data indicate the increase of brain metabolism in the right fronto-temporo-limbic and parietal structures as the substrate for the characteristic neurobiological dysfunction in the hebephrenic schizophrenia. The results of quantitative analysis of EEG (LORETA) are in accordance with previous studies focused on metabolic and neurophysiologic changes in schizophrenia.

376. Thatcher, R.W., D. North, and C. Biver, *Parametric vs. Non-parametric statistics of low resolution electromagnetic tomography (LORETA)*. Clinical EEG and Neuroscience, 2005. **36**(1): p. 1-8.

Summary: This study compared the relative statistical sensitivity of non-parametric and parametric statistics of 3-dimensional current sources as estimated by the EEG inverse solution Low Resolution Electromagnetic Tomography (LORETA). One would expect approximately 5% false positives (classification of a normal as abnormal) at the $P < .025$ level of probability (two tailed test) and approximately 1% false positives at the $P < .005$ level. EEG digital samples (2 second intervals sampled 128 Hz, 1 to 2 minutes eyes closed) from 43 normal adult subjects were imported into the Key Institute's LORETA program. We then used the Key Institute's cross-spectrum and the Key Institute's LORETA output files (*.lor) as the 2,394 gray matter pixel representation of 3-dimensional currents at different frequencies. The mean and standard deviation *.lor files were computed for each of the 2,394 gray matter pixels for each of the 43 subjects. Tests of Gaussianity and different transforms were computed in order to best approximate a normal distribution for each frequency and gray matter pixel. The relative sensitivity of parametric vs. non-parametric statistics were compared using a "leave-one-out" cross validation method in which individual normal subjects were withdrawn and then statistically classified as being either normal or abnormal based on the remaining subjects. Log10 transforms approximated Gaussian distribution in the range of 95% to 99% accuracy. Parametric Z score tests at $P < .05$ cross-validation demonstrated an average misclassification rate of approximately 4.25%, and range over the 2,394 gray matter pixels was 27.66% to 0.11%. At $P < .01$ parametric Z score cross-validation false positives were 0.26% and ranged from 6.65% to 0% false positives. The non-parametric Key Institute's t-max statistic at $P < .05$ had an average misclassification error rate of 7.64% and ranged from 43.37% to 0.04% false positives. The non-parametric t-max at $P < .01$ had an average misclassification rate of 6.67% and ranged from 41.34% to 0% false positives of the 2,394 gray matter pixels for any cross-validated normal subject. In conclusion, adequate approximation to Gaussian distribution and high cross-validation can be achieved by the Key Institute's LORETA programs by using a log10 transform and parametric statistics, and parametric normative comparisons had lower false positive rates than the non-parametric tests.

377. Thatcher, R.W., D. North, and C. Biver, *Evaluation and validity of a LORETA normative EEG database*. Clinical EEG and Neuroscience, 2005. **36**(2): p. 116-122.

Summary: To evaluate the reliability and validity of a Z-score normative EEG database for Low Resolution Electromagnetic Tomography (LORETA), EEG digital samples (2 second intervals sampled 128 Hz, 1 to 2 minutes eyes closed) were acquired from 106 normal subjects, and the cross-spectrum was computed and multiplied by the Key Institute's LORETA 2,394 gray matter pixel T Matrix. After a log10 transform or a Box-Cox transform the mean and standard deviation of the Mor files were computed for each of the 2,394 gray matter pixels, from 1 to

30 Hz, for each of the subjects. Tests of Gaussianity were computed in order to best approximate a normal distribution for each frequency and gray matter pixel. The relative sensitivity of a Z-score database was computed by measuring the approximation to a Gaussian distribution. The validity of the LORETA normative database was evaluated by the degree to which confirmed brain pathologies were localized using the LORETA normative database. Log10 and Box-Cox transforms approximated Gaussian distribution in the range of 95.64% to 99.75% accuracy. The percentage of normative Z-score values at 2 standard deviations ranged from 1.21% to 3.54%, and the percentage of Z-scores at 3 standard deviations ranged from 0% to 0.83%. Left temporal lobe epilepsy, right sensory motor hematoma and a right hemisphere stroke exhibited maximum Z-score deviations in the same locations as the pathologies. We conclude: (1) Adequate approximation to a Gaussian distribution can be achieved using LORETA by using a log10 transform or a Box-Cox transform and parametric statistics, (2) a Z-Score normative database is valid with adequate sensitivity when using LORETA, and (3) the Z-score LORETA normative database also consistently localized known pathologies to the expected Brodmann areas as an hypothesis test based on the surface EEG before computing LORETA.

378. Teyler, T.J., J.P. Hamm, W.C. Clapp, B.W. Johnson, M.C. Corballis, and I.J. Kirk, *Long-term potentiation of human visual evoked responses*. European Journal of Neuroscience, 2005. **21**(7): p. 2045-2050.

Summary: Long-term potentiation (LTP) is a candidate synaptic mechanism underlying learning and memory that has been studied extensively at the cellular and molecular level in laboratory animals. To date, LTP has only been directly demonstrated in humans in isolated cortical tissue obtained from patients undergoing surgery, where it displays properties identical to those seen in non-human preparations. Inquiry into the functional significance of LTP has been hindered by the absence of a human model. Here we give the first demonstration that the rapid repetitive presentation of a visual checkerboard (a photic 'tetanus') leads to a persistent enhancement of one of the early components of the visual evoked potential in normal humans. The potentiated response is largest in the hemisphere contralateral to the tetanized visual hemifield and is limited to one component of the visual evoked response (the N1b). The selective potentiation of only the N1b component makes overall brain excitability changes unlikely and suggests that the effect is due instead to an LTP process. While LTP is known to exist in the human brain, the ability to elicit LTP from non-surgical patients will provide a human model system allowing the detailed examination of synaptic plasticity in normal subjects and may have future clinical applications in the assessment of cognitive disorders. © 2005 Federation of European Neuroscience Societies.

379. Tenke, C.E. and J. Kayser, *Reference-free quantification of EEG spectra: Combining current source density (CSD) and frequency principal components analysis (fPCA)*. Clinical Neurophysiology, 2005. **116**(12): p. 2826-2846.

Summary: Objective: Definition of appropriate frequency bands and choice of recording reference limit the interpretability of quantitative EEG, which may be further compromised by distorted topographies or inverted hemispheric asymmetries when employing conventional (non-linear) power spectra. In contrast, fPCA factors conform to the spectral structure of empirical data, and a surface Laplacian (2-dimensional CSD) simplifies topographies by minimizing volume-conducted activity. Conciseness and interpretability of EEG and CSD fPCA solutions were compared for three common scaling methods. Methods: Resting EEG and CSD (30 channels, nose reference, eyes open/closed) from 51 healthy and 93 clinically-depressed adults were simplified as power, log power, and amplitude spectra, and summarized using unrestricted, Varimax-rotated, covariance-based fPCA. Results: Multiple alpha factors were separable from artifact and reproducible across subgroups. Power spectra produced numerous, sharply-defined factors emphasizing low frequencies. Log power spectra produced fewer, broader factors emphasizing high frequencies. Solutions for amplitude spectra showed optimal intermediate tuning, particularly when derived from CSD rather than EEG spectra. These solutions were topographically distinct, detecting multiple posterior alpha generators but excluding the dorsal surface of the frontal lobes. Instead a low alpha/theta factor showed a secondary topography along the frontal midline. Conclusions: CSD amplitude spectrum fPCA solutions provide simpler, reference-independent measures that more directly reflect neuronal activity. Significance: A new quantitative EEG approach affording spectral components is developed that closely parallels the concept of an ERP component in the temporal domain. © 2005 International Federation of Clinical Neurophysiology. Published by Elsevier Ireland Ltd. All rights reserved.

380. Tao, J.X., A. Ray, S. Hawes-Ebersole, and J.S. Ebersole, *Intracranial EEG substrates of scalp EEG interictal spikes*. Epilepsia, 2005. **46**(5): p. 669-676.

Summary: Purpose: To determine the area of cortical generators of scalp EEG interictal spikes, such as those in the temporal lobe epilepsy. Methods: We recorded simultaneously 26 channels of scalp EEG with subtemporal supplementary electrodes and 46 to 98 channels of intracranial EEG in 16 surgery candidates with temporal lobe epilepsy. Cerebral discharges with and without scalp EEG correlates were identified, and the area of cortical sources was estimated from the number of electrode contacts demonstrating concurrent depolarization. Results: We reviewed ~~00 interictal spikes recorded with intracranial EEG. Only a very few of these cortical spikes were associated with scalp recognizable potentials; 90% of cortical spikes with a source area of > 10 cm2 produced scalp EEG spikes, whereas only 10% of cortical spikes having < 10 cm2 of source area produced scalp potentials. Intracranial spikes with <6 cm2 of area were never associated with scalp EEG spikes. Conclusions: Cerebral sources of scalp EEG spikes are larger than commonly thought. Synchronous or at least temporally overlapping activation of 10-20 cm2 of gyral cortex is common. The attenuating property of the skull may actually serve a useful role in filtering out all but the most significant interictal discharges that can recruit substantial surrounding cortex. © 2005 International League Against Epilepsy.

381. Szelenberger, W., T. Piotrowski, and A.J. Da□browska, *Increased prefrontal event-related current density after sleep deprivation*. Acta Neurobiologiae Experimentalis, 2005. **65**(1): p. 19-28.

Summary: To investigate how partial sleep loss affects temporal and spatial pattern of information flow, we analyzed sources of brain electrical activity during continuous attention test. Sixteen physicians recruited from the university hospitals participated in the study. Each participant served as his own control. All participants underwent two test sessions including the Stanford Sleepiness Scale (SSS), the Beck Depression Inventory (BDI), the Selective Reminding Test (SRT), and the Continuous Attention Test (CAT). The CAT items were used as stimuli in event-related potential (ERP) recordings. EEG was recorded from 21 electrodes, according to the international 10-20 system. The sources of bioelectrical activity were computed with low resolution electromagnetic tomography (LORETA). Estimated sleep time was significantly shorter on nights spent on duty than on nights of normal sleep at home. Sleep loss resulted in significant increase in SSS and BDI scoring, and impairment of immediate recall. Performance on the CAT remained relatively intact. Under the sleep loss condition compared to baseline, significant differences in brain activity occurred only for targets. Within the P1 time frame, sleep loss led to greater activation in the right Brodmann's area 9/10. For the N1 component, significant differences were localized on the lateral surface of the right frontal lobe, in Brodmann's areas 8 and 9. No significant effects of sleep deprivation on the P3 component were found. Our results are consistent with earlier data indicating that increased activation of the prefrontal cortex allows the maintainance of performance during periods of sleep loss.

382. Suzuki, T., *Parallel optimization applied to magnetoencephalography*. Journal of Computational and Applied Mathematics, 2005. **183**(1): p. 177-190.

Summary: This paper studies a new numerical scheme applicable to magnetoencephalography (MEG), that is, clustering. This method is based on a new theory to the under-determined ill-posed problem, called parallel optimization, and clusters several electric current elements distributed in a volume conductor by one point in time data, without prescribing the number of dipoles. Numerical experiments and optional algorithms are also included. © 2005 Elsevier B.V. All rights reserved.

383. Stevens, M.C., V.D. Calhoun, and K.A. Kiehl, *Hemispheric differences in hemodynamics elicited by auditory oddball stimuli*. NeuroImage, 2005. **26**(3): p. 782-792.

Summary: Evidence from neuroimaging studies suggests that the right hemisphere of the human brain might be more specialized for attention than the left hemisphere. However, differences between right and left hemisphere in the magnitude of hemodynamic activity (i.e., 'functional asymmetry') rarely have been explicitly examined in previous neuroimaging studies of attention. This study used a new voxel-based comparison method to examine hemispheric differences in the amplitude of the hemodynamic response in response to infrequent target, infrequent novel, and frequent standard stimuli during an event-related fMRI auditory oddball task in 100 healthy adult participants. Processing of low probability task-relevant target stimuli, or 'oddballs', and low probability task-irrelevant novel stimuli is believed to engage in orienting and attentional processes. It was hypothesized that greater right-hemisphere activation compared to left would be observed to infrequent target and novel stimuli. Consistent with predictions, greater right hemisphere than left frontal, temporal, and parietal lobe activity was observed for target detection and novelty processing. Moreover, asymmetry effects did not differ with respect to age or gender of the participants. The results (1) support the proposal that the right hemisphere is differentially engaged in processing salient stimuli and (2) demonstrate the successful use of a new voxel-based laterality analysis technique for fMRI data.

384. Stevens, M.C., V.D. Calhoun, and K.A. Kiehl, *fMRI in an oddball task: Effects of target-to-target interval.* Psychophysiology, 2005. **42**(6): p. 636-642.

Summary: The amplitude of the P3 event-related potential (ERP) elicited by task-relevant target ("oddball") stimuli has been shown to vary in proportion to the length of time between targets. Here we use functional magnetic resonance imaging (fMRI) to identify neural systems modulated by target interval in a large sample of healthy adults (n=100) during performance of an auditory oddball task that included both target and novel stimuli. A positive relationship was found between target interval and hemodynamic activity in the anterior cingulate and in bilateral lateral prefrontal cortex, temporal-parietal junction, postcentral gryi, thalamus, and cerebellum. This modulation likely represents updating of the working memory template for the target stimuli. There was no such effect of novel interval, suggesting that neuronal modulation may only occur for task-relevant stimuli, possibly in the service of strategic resource allocation processes. Copyright © 2005 Society for Psychophysiological Research.

385. Soufflet, L. and P.H. Boeijinga, *Linear inverse solutions: Simulations from a realistic head model in MEG.* Brain Topography, 2005. **18**(2): p. 87-99.

Summary: Distributed linear solutions are widely used in source localization to solve the ill-posed EEG/MEG inverse problem. In the classical approach based on dipole sources, these methods estimate the current densities at a great number of brain sites, typically at the nodes of a 3-D grid which discretizes the chosen solution space. The estimated current density distributions are displayed as brain electromagnetic tomography (BET) images. We have tested well known minimum norm solutions (MN, WMN, LORETA) and other linear inverse solutions [WROP, sLORETA, interference uniform, gain uniform, weight vector normalized (WVN), and a new solution named SLF (Standardized Lead Field)], using a MEG configuration (BTi Magnes 2500 WH with 148 axial magnetometers) and a realistic head model using BEM (Boundary Element Method). The solutions were compared in a noise-free condition and in the

presence of noise using the classical dipole localization errors (DLE) together with a new figure of merit that we called max gain uniformity, which measures the capability of an inverse linear solution to show spots of activity with similar amplitudes on the brain electromagnetic tomographies when multiple dipole sources with similar moments are simultaneously active. Whereas some solutions (sLORETA, interference uniform and SLF) were capable of zero dipole localization errors in the noise-free case, none of them reached 100% of correct dipole localizations in the presence of a high level of Gaussian noise. The SLF solution, which has the advantage to be independent from any regularisation parameter, presented the best results with the lowest max gain uniformities, with almost 100% of correct dipole localizations with 10% of noise and more than 90% of correct localizations with 30% of noise added to the data. Nevertheless, no solution was able to combine at the same time a correct localization of single sources and the capability to visualize multiple sources with comparable amplitudes on the brain electromagnetic tomographies. Copyright © 2005 Springer Science + Business Media, Inc.

386. Sotillo, M., L. Carretié, J.A. Hinojosa, M. Tapia, F. Mercado, S. López-Martín, and J. Albert, *Neural activity associated with metaphor comprehension: Spatial analysis*. Neuroscience Letters, 2005. **373**(1): p. 5-9.

Summary: Though neuropsychological data indicate that the right hemisphere (RH) plays a major role in metaphor processing, other studies suggest that, at least during some phases of this processing, a RH advantage may not exist. The present study explores, through a temporally agile neural signal - the event-related potentials (ERPs) -, and through source-localization algorithms applied to ERP recordings, whether the crucial phase of metaphor comprehension presents or not a RH advantage. Participants (n = 24) were submitted to a S1-S2 experimental paradigm. S1 consisted of visually presented metaphoric sentences (e.g., "Green lung of the city"), followed by S2, which consisted of words that could (i.e., "Park") or could not (i.e., "Semaphore") be defined by S1. ERPs elicited by S2 were analyzed using temporal principal component analysis (tPCA) and source-localization algorithms. These analyses revealed that metaphorically related S2 words showed significantly higher N400 amplitudes than non-related S2 words. Source-localization algorithms showed differential activity between the two S2 conditions in the right middle/superior temporal areas. These results support the existence of an important RH contribution to (at least) one phase of metaphor processing and, furthermore, implicate the temporal cortex with respect to that contribution. © 2004 Elsevier Ireland Ltd. All rights reserved.

387. Sittiprapaporn, W., M. Tervaniemi, C. Chindaduangratn, and N. Kotchabhakdi, *Preattentive discrimination of across-category and within-category change in consonant-vowel syllable*. NeuroReport, 2005. **16**(13): p. 1513-1518.

Summary: Event-related potentials to infrequently presented spoken deviant syllables /pi/ and /po/ among repetitive standard /pinverted c sign/ syllables were recorded in Thai study participants who ignored these stimuli while reading books of their choices. The vowel across-category and within-category changes elicited a change-specific mismatch negativity response. The across-category and within-category change discrimination of vowels in consonant-vowel syllable was also assessed using the low-resolution electromagnetic tomography. The results of low-resolution electromagnetic tomography mismatch negativity generator analysis suggest that the within-category change perception of vowels is analyzed as the change in physical features of the stimuli, thus predominantly activating the right temporal cortex. In contrast, the left temporal cortex is predominantly activated in the across-category change perception of vowels, emphasizing the role of the left hemisphere in speech processing already at a preattentive processing level also in consonant-vowel syllables. The results support the hypothesis that a part of the superior temporal gyrus contains neurons specialized for speech perception. © 2005 Lippincott Williams & Wilkins.

388. Shishkin, S.L., A.Y. Kaplan, H. Bakardjian, and A. Cichocki, *Combining the extremities on the basis of separation: a new approach to EEG/ERP source localization*. International Congress Series, 2005. **1278**: p. 119-122.

Summary: Current methods for the localization of EEG and event-related potentials (ERP) sources assume that sources are either discrete (dipole-like) or distributed. While both types of sources are likely to contribute significantly to EEG and ERP signals, each method adopts only one of these models and thus may localize the sources of other type incorrectly or not find them at all. Recently introduced Independent Component Analysis (ICA) and more general approach, Blind Source Separation (BSS), make possible the separation of signals from various brain and extra-brain (related to artifacts) sources and can be used as preprocessing technique before applying the localizing algorithms. We suggest using this preprocessing step for combining different localization methods. A brain source, if extracted correctly, can be analyzed separately from the other sources, and thus, the most appropriate localization technique can be chosen for each source. Distributed sources are likely to be localized more precisely without detailed separation but after BSS "cleaning" data from strong localized sources.
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389. Saletu, B., P. Anderer, G.M. Saletu-Zyhlarz, and R.D. Pascual-Marqui, *EEG mapping and low-resolution brain electromagnetic tomography (LORETA) in diagnosis and therapy of psychiatric disorders: Evidence for a key-lock principle*. Clinical EEG and Neuroscience, 2005. **36**(2): p. 108-115.

Summary: Different psychiatric disorders, such as schizophrenia with predominantly positive and negative symptomatology, major depression, generalized anxiety disorder, agoraphobia, obsessive-compulsive disorder, multi-infarct dementia, senile dementia of the Alzheimer type and alcohol dependence, show EEG maps that differ statistically both from each other and from normal controls. Representative drugs of the main psychopharmacological classes, such as sedative and non-sedative neuroleptics and antidepressants, tranquilizers, hypnotics, psychostimulants and cognition-enhancing drugs, induce significant and typical changes to normal human brain function, which in many variables are opposite to the above-mentioned differences between psychiatric patients and normal controls. Thus, by considering these differences between psychotropic drugs and placebo in normal subjects, as well as between mental disorder patients and normal controls, it may be possible to choose the optimum drug for a specific patient according to a key-lock principle, since the drug should normalize the deviant bran function. This is supported by 3-dimensional low-resolution bran electromagnetic tomography (LORETA), which identifies regions within the brain that are affected by psychiatric disorders and psychopharmacological substances.

390. Saletu, B., P. Anderer, G.M. Saletu-Zyhlarz, D. Gruber, M. Metka, and J. Huber, *Identifying target regions for vigilance improvement under hormone replacement therapy in postmenopausal syndrome patients by means of electroencephalographic tomography (LORETA)*. Psychopharmacology, 2005. **178**(4): p. 389-399.

Summary: Rationale: Daytime fatigue, which at the neurophysiological level is due to vigilance decrements, is a frequent complaint in postmenopausal women. Objectives: In a three-arm, 2-month, parallel group-design study, vigilance-promoting effects of a novel continuous combination (=Climodien 2/3) of estradiol valerate (EV; 2 mg) and dienogest (DNG; 3 mg) were compared with the effects of both EV alone and placebo in 55 insomniac, postmenopausal syndrome patients. Methods: Low-resolution brain electromagnetic tomography (LORETA) was undertaken to identify the cerebral target regions of hormone replacement therapy. Results: An omnibus significance test revealed Climodien to increase activity in 882 of 2,394 voxels in the alpha-2 band, followed by 733, 706, and 664 voxels in the beta-2, beta-1, and beta-3 bands, and 509 voxels in the delta band, whereas 2 mg EV alone did not produce a significant suprathreshold activity. Current density increased predominantly in the right hemisphere, which had already been described in the literature as the center of the vigilance system. In the fast alpha range, which plays a major role in the context of vigilance, increased activity was found in the right prefrontal, temporal, and superior parietal cortices, i.e., those brain areas of the right-sided fronto-parietal neuronal network that are responsible for sustained attention. A further activity increase was seen in the anterior cingulate gyrus associated with attentional control and conflict monitoring. The right temporal lobe showed increased current density in all frequency bands. Conclusions: Electroencephalographic tomography (LORETA) identified the right-hemispheric vigilance system as the target region of Climodien. © Springer-Verlag 2004.

391. Rose, M., C. Schmid, A. Winzen, T. Sommer, and C. Büchel, *The functional and temporal characteristics of top-down modulation in visual selection*. Cerebral Cortex, 2005. **15**(9): p. 1290-1298.

Summary: Perceptual load of an attended task influences the processing of irrelevant background stimuli. In a series of behavioral, functional magnetic resonance (fMRI) and electroencephalography (EEG) experiments we examined the influence of working memory (WM) load related to a relevant visual stimulus on the processing of irrelevant backgrounds. We further addressed two open questions about the mechanism of load-dependent modulation: (i) is this modulation dependent on regional activity (i.e. phasic)? (ii) At what processing stage does this modulation take place? Load was manipulated by a WM task and concurrently the processing of irrelevant visual objects was assessed with fMRI and EEG. To examine the dependency of this modulation on intrinsic activity, we varied the activity level of visual areas by presenting objects with different levels of degradation. Activity in the lateral occipital complex (LOC) increased with object visibility and was phasically modulated by WM load. Event related potentials revealed that this phasic modulation occurred ~170 ms after stimulus onset, indicative of an early selection under high load. The results indicate a phasic modulatory effect of WM load on visual object processing in the LOC that is comparable to the effects found for perceptual load manipulations. © Oxford University Press 2005; all rights reserved.

392. Riba, J. and M.J. Barbanoj, *Bringing ayahuasca to the clinical research laboratory*. Journal of Psychoactive Drugs, 2005. **37**(2): p. 219-230.

Summary: Since the winter of 1999, the authors and their research team have been conducting clinical studies involving the administration of ayahuasca to healthy volunteers. The rationale for conducting this kind of research is twofold. First, the growing interest of many individuals for traditional indigenous practices involving the ingestion of natural psychotropic drugs such as ayahuasca demands the systematic study of their pharmacological profiles in the target species, i.e., human beings. The complex nature of ayahuasca brews combining a large number of pharmacologically active compounds requires that research be carried out to establish the safety and overall pharmacological profile of these products. Second, the authors believe that the study of psychedelics in general calls for renewed attention. Although the molecular and electrophysiological level effects of these drugs are relatively well characterized, current knowledge of the mechanisms by which these compounds modify the higher order cognitive processes in the way they do is still incomplete, to say the least. The present article describes the development of the research effort carried out at the Autonomous University of Barcelona, commenting on several methodological aspects and reviewing the basic clinical findings. It also describes the research currently underway in our laboratory, and briefly comments on two new studies we plan to undertake in order to further our knowledge of the phrmacology of ayahuasca.

393. Reischies, F.M., A.H. Neuhaus, M.L. Hansen, S. Mientus, C. Mulert, and J. Gallinat, *Electrophysiological and neuropsychological analysis of a delirious state: The role of the anterior cingulate gyrus*. Psychiatry Research - Neuroimaging, 2005. **138**(2): p. 171-181.

Summary: Functional neuroimaging studies in humans have provided evidence that a frontal network including the anterior cingulate cortex (ACC) plays an important role in attention and awareness. Disturbed attention and awareness are core symptoms of delirium, but imaging studies of attentional dysfunctions in delirium are lacking. However, an increase of slow electroencephalographic (EEG) activity (delta, theta) is a consistent biological finding in delirium. The question whether this slow activity is related to a disturbance in the frontal attentional network has not yet been addressed. The delirium after electroconvulsive therapy (ECT) has been investigated using 32-channel resting EEG before and shortly after ECT in 12 patients with major depressive disorder. During delirium compared with baseline studies, substantial increases of delta and theta power and a decrease of alpha power were observed. The decrease of theta activity at the Fz electrode position in the following 24 h was significantly related to the recovery of awareness and performance of free recall. Source analysis with Low Resolution Electromagnetic Tomography (LORETA) indicated that the main generators of the theta excess during delirium were significantly localized in the anterior cingulate cortex, and additionally in right fronto-temporal brain areas. The results support the concept that a disturbance of attention and awareness during delirium is related to a dysfunction of an attentional network involving the ACC. However, the localization of the theta excess may reflect some motor dysfunctions as well. This dysfunction of the ACC was shown for the first time in patients during a delirious state and may represent an important pathophysiological aspect of delirium. © 2004 Elsevier Ireland Ltd. All rights reserved.

394. Pratt, H., N. Bleich, and N. Mittelman, *The composite N1 component to gaps in noise*. Clinical Neurophysiology, 2005. **116**(11): p. 2648-2663.

Summary: Objective: To indicate whether the double peaked N1 to gaps in continuous white noise is a composite of onset and offset responses to transients or whether it reflects higher processing such as change or mismatch detection and to assess the role of attention in this process. Methods: Evoked potentials were recorded to two binaural stimulus types: (1) gaps of different durations randomly distributed in continuous white noise; and (2) click pairs at intervals identical to those between gap onsets and offsets in the continuous noise stimulus. Potentials to these stimuli were recorded while subjects read a text and while detecting gaps in noise or click pairs. Results: Potentials were detected to all click pairs and to gaps of 5 ms or longer, corresponding to the subjects' psychoacoustic gap detection threshold. With long gap durations of 200-800 ms, distinct potentials to gap onset and gap offset were observed. The waveforms to all click pairs and to offsets of long gaps were similar and single-peaked, while potentials to gaps of 10 ms and longer, and potentials to onsets of long gaps were double-peaked, consisting of two N1 negativities, 60 ms apart, irrespective of gap duration. The first (N 1a), was more frontal in its distribution and similar to that of clicks. The second (N1b) peak's distribution was more central/temporal and its source locations and time course of activity were distinct. No effects of attention on any of the varieties and constituents of N1 were observed. Conclusions:

Comparing potentials to gap onsets, to click pairs and to gap offsets, suggests that potentials to gap onsets involve not only sound onset/offset responses (N1, N1a) but also the subsequent pre-attentive perception of the cessation of an ongoing sound (N1b). We propose that N1b is distinct from change or mismatch detection and is associated with termination of an ongoing continuous stimulus. We propose to call it the N(egation)-process. Significance: A constituent of the N1 complex is shown to be associated with the pre-attentive perception of termination of an ongoing stimulus and to have distinct scalp distribution and intracranial sources. © 2005 International Federation of Clinical Neurophysiology. Published by Elsevier Ireland Ltd. All rights reserved.

395. Phillips, C., J. Mattout, M.D. Rugg, P. Maquet, and K.J. Friston, *An empirical Bayesian solution to the source reconstruction problem in EEG*. NeuroImage, 2005. **24**(4): p. 997-1011.

Summary: Distributed linear solutions of the EEG source localisation problem are used routinely. In contrast to discrete dipole equivalent models, distributed linear solutions do not assume a fixed number of active sources and rest on a discretised fully 3D representation of the electrical activity of the brain. The ensuing inverse problem is underdetermined and constraints or priors are required to ensure the uniqueness of the solution. In a Bayesian framework, the conditional expectation of the source distribution, given the data, is attained by carefully balancing the minimisation of the residuals induced by noise and the improbability of the estimates as determined by their priors. This balance is specified by hyperparameters that control the relative importance of fitting and conforming to various constraints. Here we formulate the conventional "Weighted Minimum Norm" (WMN) solution in terms of hierarchical linear models. An "Expectation-Maximisation" (EM) algorithm is used to obtain a "Restricted Maximum Likelihood" (ReML) estimate of the hyperparameters, before estimating the "Maximum a Posteriori" solution itself. This procedure can be considered a generalisation of previous work that encompasses multiple constraints. Our approach was compared with the "classic" WMN and Maximum Smoothness solutions, using a simplified 2D source model with synthetic noisy data. The ReML solution was assessed with four types of source location priors: no priors, accurate priors, inaccurate priors, and both accurate and inaccurate priors. The ReML approach proved useful as: (1) The regularisation (or influence of the a priori source covariance) increased as the noise level increased. (2) The localisation error (LE) was negligible when accurate location priors were used. (3) When accurate and inaccurate location priors were used simultaneously, the solution was not influenced by the inaccurate priors. The ReML solution was then applied to real somatosensory-evoked responses to illustrate the application in an empirical setting. © 2004 Elsevier Inc. All rights reserved.

396. Perfetti, C.A. and Y. Liu, *Orthography to phonology and meaning: Comparisons across and within writing systems*. Reading and Writing, 2005. **18**(3): p. 193-210.

Summary: According to the Universal Writing System Constraint, all writing systems encode language, and thus reflect basic properties of the linguistic system they encode. According to a second universal, the Universal Phonological Principle, the activation of word pronunciations occurs for skilled readers across all writing systems. We review recent research that illustrates the implications of these two universal principles both across and within writing systems. Within the family of alphabetic systems, differences between Korean and English arise in the languages, rather than the orthographies, while the reverse appears to be true for German and English differences. Across writing systems, new Event Related Potentials (ERP) experiments show the robustness of phonology across Chinese and English systems and chart the time course of word reading in Chinese and English for Chinese bilinguals and for English speakers learning Chinese. The ERP results show differences between Chinese and English for both groups and suggest that the time course of word processes and the brain areas identified as sources for the ERP components differ both as a result of writing system and the skill of the reader. We propose the System Accommodation Hypothesis, that reading processes and the neural structures that support them accommodate to specific visual and structural features of a new writing system. © Springer 2005.

397. Penny, W.D., N.J. Trujillo-Barreto, and K.J. Friston, *Bayesian fMRI time series analysis with spatial priors*. NeuroImage, 2005. **24**(2): p. 350-362.

Summary: We describe a Bayesian estimation and inference procedure for fMRI time series based on the use of General Linear Models (GLMs). Importantly, we use a spatial prior on regression coefficients which embodies our prior knowledge that evoked responses are spatially contiguous and locally homogeneous. Further, using a computationally efficient Variational Bayes framework, we are able to let the data determine the optimal amount of smoothing. We assume an arbitrary order Auto-Regressive (AR) model for the errors. Our model generalizes earlier work on voxel-wise estimation of GLM-AR models and inference in GLMs using Posterior Probability Maps (PPMs). Results are shown on simulated data and on data from an event-related fMRI experiment. © 2004 Elsevier Inc. All rights reserved.

398. Olbrich, H.M., H. Maes, G. Valerius, J.M. Langosch, and B. Feige, *Event-related potential correlates selectively reflect cognitive dysfunction in schizophrenics*. Journal of Neural Transmission, 2005. **112**(2): p. 283-295.

Summary: Schizophrenics show event-related potential (ERP) and particularly P3 abnormalities. To study the more detailed relationships between these ERP alterations and cognitive dysfunction we recorded and analyzed ERPs using a particular experimental approach. In 34 schizophrenics and 25 controls ERPs were obtained by a visual Go/Nogo task requiring response inhibition and were decomposed into temporally independent topographical components using Independent Component Analysis (ICA). ICA disentangled different subcomponents of P3. Subcomponent P3b with a parietal maximum amplitude was significantly reduced in the schizophrenics, probably reflecting their

attentional deficits. Subcomponent P3ng with a frontal maximum amplitude and enhanced during Nogo condition appeared as an electrophysiological index of response inhibition. A significantly reduced P3ng enhancement, found in schizophrenics, probably reflects their impaired response control. Conclusions: ICA can successfully identify ERP subcomponents with distinct scalp topographies representing significant differential indices of normal and abnormal cognitive processing. Involvement of frontal brain areas in disturbed executive control in schizophrenics is supported by our ICA findings. © Springer-Verlag 2004.

399. Okamoto, M. and I. Dan, *Automated cortical projection of head-surface locations for transcranial functional brain mapping*. NeuroImage, 2005. **26**(1): p. 18-28.

Summary: Recent advancements in two noninvasive transcranial neuroimaging techniques, near-infrared spectroscopy (NIRS) and transcranial magnetic stimulation (TMS), signify the increasing importance of establishing structural compatibility between transcranial methods and conventional tomographic methods, such as functional magnetic resonance imaging (fMRI) and positron emission tomography (PET). The transcranial data obtained from the head surface should be projected onto the cortical surface to present the transcranial brain-mapping data on the same platform as tomographic methods. Thus, we developed two transcranial projection algorithms that project given head-surface points onto the cortical surface in structural images, and computer programs based on them. The convex-hull algorithm features geometric handling of the cortical surface, while the balloon-inflation algorithm is faster, and better reflects the local cortical structure. The automatic cortical projection methods proved to be as effective as the manual projection method described in our previous study. These methods achieved perfect correspondence between any given point on the head surface or a related nearby point in space, and its cortical projection point. Moreover, we developed a neighbor-reference method that enables transcranial cortical projection of a given head-surface point in reference to three neighboring points and one additional standard point, even when no structural image of the subject is available. We also calculated an error factor associated with these probabilistic estimations. The current study presents a close topological link between transcranial and tomographic brain-mapping modalities, which could contribute to inter-modal data standardization. © 2005 Elsevier Inc. All rights reserved.

400. Ofek, E. and H. Pratt, *Neurophysiological correlates of subjective significance*. Clinical Neurophysiology, 2005. **116**(10): p. 2354-2362.

Summary: Objective: The neural substrates of emotional response have traditionally been studied using universal sets of emotionally loaded stimuli, regardless of their subjective significance for the individual subject. Related brain activity has been typically traced with fMRI's temporal resolution of seconds. In this study, unique brain responses to subjectively significant stimuli were

analyzed and traced with millisecond temporal resolution. Methods: Electrical brain activity (event related potentials) was recorded from 16 normal subjects, to subjectively significant auditory stimuli and its brain sources were imaged. Subjective significance of the stimuli was individually assessed for each subject. Results: Unique and significant brain activity to subjectively significant stimuli began as early as 200 ms after stimulus onset, with increased brain activity in the vicinity of several brain areas, including frontal gyri, Broca's area, Wernicke's area, insula, precuneus and cingulate gyri. The time course of activity in these areas was traced and found concurrent. Conclusions: Although the subjectively significant stimuli of this study were not divided according to their positive or negative affective valence, they elicited a distinct brain response compared to neutral stimuli, with a uniform pattern across subjects. Significance: These results demonstrate that subjectively significant stimuli are associated with characteristic brain activity, that studying the neural substrate and time course of processing subjectively significant stimuli is feasible and that the neurophysiological manifestations of emotions are attainable. © 2005 International Federation of Clinical Neurophysiology. Published by Elsevier Ireland Ltd. All rights reserved.

401. Oddy, B.W., R.J. Barry, S.J. Johnstone, and A.R. Clarke, *Removal of CNV effects from the N2 and P3 ERP components in a visual Go/NoGo task*. Journal of Psychophysiology, 2005. **19**(1): p. 24-34.

Summary: In an S1-S2 Go/NoGo task the impact of slow potentials following S1, particularly the late component of the contingent negative variation (CNV), on the following cognitive-processing waveforms to S2 (e.g., N2 and P3) remains unclear. A common method to correct for these confounding slow waves has used a forced baseline shortly before S2. The impact of this on ERP measures relating to S2 is unclear. An earlier method of CNV correction, devised to remove its effect on P3 measures by using different baselines for each condition, appears questionable. This study explored the removal of the CNV from both Go and NoGo waveforms to clarify the sensory and cognitive components elicited by S2. Principal Component Analysis (PCA) was performed on the ERP means, and a component relating to the CNV was subtracted from each subject's raw data for each site and condition. Results showed that this effectively removed the CNV without distortion of the S2 ERP morphology. This technique may prove useful in the analysis of the N2 and P3 as indicators of processes involved in response inhibition. © 2005 Federation of European Psychophysiology Societies.

402. Neuhaus, A.H., J. Gallinat, M. Bajbouj, and F.M. Reischies, *Interictal slow-wave focus in left medial temporal lobe during bilateral electroconvulsive therapy*. Neuropsychobiology, 2005. **52**(4): p. 183-189.

Summary: The interictal state between two electroconvulsive therapy (ECT) sessions is clinically characterised by possible cognitive adverse effects like mild amnestic syndrome. ECT-induced mnestic deficits can persist for several weeks after ECT. Electrophysiologically, slowing of brain electrical activity in the

interictal state has often been reported. Especially, for bilateral ECT a correlation between enhanced left frontotemporal theta activity and retrograde amnesia has been demonstrated. This study focuses on the topographic distribution of cortical slow-wave oscillations during the interictal state of a bilateral ECT cycle. Twelve patients with major depression have been investigated with 32-channel resting EEG 24 h after the 6th ECT session. As controls, 8 major depressive patients were investigated prior to antidepressive treatment. The generating sources of slow-wave activity are estimated within the theta frequency band with low-resolution brain electromagnetic tomography. Source analysis revealed a distinct pattern of theta activity in the depth of the left temporal lobe (fusiform and parahippocampal gyri, Brodmann areas 37 and 36, respectively; $p< 0.05$) during the interictal state. This finding suggests a dysfunction of the left medial temporal lobe memory system during the interictal state of a bilateral ECT cycle. It will further be discussed whether it is possible to obtain information about activity of deep brain structures like the hippocampal formation from scalp-recorded signals. Copyright © 2005 S. Karger AG.

403. Mulert, C., E. Menzinger, G. Leicht, O. Pogarell, and U. Hegerl, *Evidence for a close relationship between conscious effort and anterior cingulate cortex activity*. International Journal of Psychophysiology, 2005. **56**(1): p. 65-80.

Summary: The function of the anterior cingulate cortex (ACC) has been discussed in the last years in the context of conflict monitoring and error detection. In addition, ACC activity has been described in the context of "conscious effort". Recent neurophysiological and neuroimaging studies have described a negative correlation between ACC activity and reaction times in simple or choice reaction time experiments. One suggested explanation for this finding has been that there is a relationship between effort and ACC activity. The present ERP-LORETA study of healthy volunteers (n=35) was intended to directly investigate this relationship. In this experiment, three conditions were investigated: condition I was a choice reaction task with the instruction to stay relaxed during the task (relaxed condition), condition II was the same choice reaction task with the instruction to press the respective button as fast and correct as possible (effort condition). Condition III was just listening to the tones without button press (control condition). Subjects had to score directly after each experimental run on a visual analogue scale the amount of effort they have actually spent. The subjects showed significantly shorter reaction times during the high effort condition in comparison to the relaxed condition, as well as increased N1 amplitudes and increased ACC activity. In a subgroup analysis, this effect was present only in subjects who were (according to their self-ratings) following the instructions closely. These results provide direct evidence for a close relationship between conscious effort and ACC activity and suggest the usefulness of the applied effort-self-rating. © 2004 Elsevier B.V. All rights reserved.

404. Mulert, C., L. Jäger, S. Propp, S. Karch, S. Störmann, O. Pogarell, H.J. Möller, G. Juckel, and U. Hegerl, *Sound level dependence of the primary*

auditory cortex: Simultaneous measurement with 61-channel EEG and fMRI. NeuroImage, 2005. **28**(1): p. 49-58.

Summary: Sound level dependence has been investigated for years with event-related potentials (ERP). A serotonergic modulation of the sound level dependence only of the primary auditory cortex but not of the auditory association cortex has been suggested by a number of clinical and preclinical studies. Therefore, a precise covering of the activity of the primary auditory cortex seems necessary if sound level dependence is used as an indicator of the central serotonergic system. Recent fMRI studies described a pronounced sound level dependence only in the Heschl gyrus/primary auditory cortex but not in auditory association areas. In the present simultaneous 61-channel EEG and fMRI study investigating fourteen healthy subjects, we found a high correlation between the loudness-dependent change of the extent of fMRI activation (number of activated voxels) and the corresponding changes of the mean current source density within the same region of interest covering the primary auditory cortex ($r = 0.84$, $P < 0.001$). Our findings suggest a close relationship between the fMRI signal and event-related potential activity. In addition, the correspondence of the ERP-based data and the fMRI results further supports the validity of the ERP localization approach. © 2005 Elsevier Inc. All rights reserved.

405. Mucci, A., S. Galderisi, P. Bucci, E. Tresca, A. Forte, T. Koenig, and M. Maj, *Hemispheric lateralization patterns and psychotic experiences in healthy subjects*. Psychiatry Research - Neuroimaging, 2005. **139**(2): p. 141-154.

Summary: The hypothesis that psychotic experiences in healthy subjects are associated with a dysfunction of the right hemisphere is supported by some, but not all, available studies. Differences in gender composition of study samples may explain in part the divergent findings. The present study was carried out in 42 healthy, right-handed university students. Scores on the Schizophrenia and Paranoia scales of the Minnesota Multidimensional Personality Inventory-2 were used in correlation analyses and to define a High- and a Low-Psychotic group. Brain Electrical Microstates and Low Resolution Electromagnetic Tomography (LORETA) source analyses of the auditory P300 (P3a and P3b) components of the event-related potential, as well as a battery of neuropsychological tests, were used to assess hemispheric functioning. Scores on the Paranoia scale were positively associated with a leftward shift of the P3a topographic descriptors in females but not in males. When comparing High-Psychotic and Low-Psychotic females, a leftward shift of P3a descriptors and an increased cortical activation in left fronto-temporal areas were observed in the High-Psychotic group. Our results demonstrated gender-related differences in the pattern of hemispheric imbalance associated with psychotic experiences in healthy subjects. © 2005 Elsevier Ireland Ltd. All rights reserved.

406. Moisescu-Yiflach, T. and H. Pratt, *Auditory event related potentials and source current density estimation in phonologic/auditory dyslexics*. Clinical Neurophysiology, 2005. **116**(11): p. 2632-2647.

Summary: Objective: To determine the generality of auditory processing impairment in phonologic dyslexics by studying their auditory Event-Related Potentials (ERPs) and the spatio-temporal distribution of their brain activity to auditory linguistic and non-linguistic stimuli with temporal and spectral discriminating cues. Methods: Fourteen adult phonologic dyslexics and 14 normal reading students, all with high academic achievements, were compared. ERP waveform analysis and current density source estimation (Low resolution Electromagnetic Tomographic Analysis-LORETA) were conducted on 21-channel records from subjects who passively listened or actively discriminated 4 types of auditory stimuli: linguistic and non-linguistic stimuli that differed in spectral or temporal characteristics. Results: Significant differences were found for all ERP latencies (N1, P2, N2, P3) in response to all stimuli, with dyslexics presenting longer latencies compared to normal readers. Current density distributions and their time courses also differed significantly, regardless of stimulus type or attention allocation. Among normal readers, early activity (around N1) was characterized by a rapid change of maximum activity from right to left temporal lobe. Later activity (around P3) was characterized by a stable temporal activity with bilaterally synchronous peak activity. Among the dyslexics, the early N1 activity was stable with left hemisphere prominence, with no alternation between the hemispheres, while the later P3 activity peaked earlier in the right hemisphere than in the left. Conclusions: Dyslexics were different from controls in processing all auditory stimuli: verbal and non-verbal stimuli with temporal as well as with spectral discriminating cues. The differences mainly consisted of latency and time courses of current density distributions, beginning as early as N1 and extending to the late P3. Significance: Differences in processing auditory stimuli by phonologic dyslexics are not restricted to linguistic (phonological) stimuli, supporting a general auditory processing impairment in phonologic dyslexia. © 2005 International Federation of Clinical Neurophysiology. Published by Elsevier Ireland Ltd. All rights reserved.

407. Mittelman, N., N. Bleich, and H. Pratt, *Early ERP components to gaps in white noise: onset and offset effects*. International Congress Series, 2005. **1278**: p. 3-6.

Summary: Evoked potentials to two stimulus types were compared: (1) binaural continuous white noise with randomly distributed gaps of different durations and (2) click pairs presented with intervals identical to the gap durations. Potentials were detected in response to gaps of 5 ms or longer, corresponding to the subjects' psychoacoustic gap detection threshold. The waveforms to all click pairs and to gap offsets were similar and single-peaked, while response to gap onset included two N1 negativities about 60 ms apart, regardless of gap duration. The first peak (N1a) was more frontal in its distribution and similar to that of clicks. The second (N1b) peak's scalp distribution was more central/temporal. The

differences between waveforms to click pairs and gap offsets, compared with gap onsets, suggest that potentials to gap onsets involve more than just onset/offset responses (N1, N1a) but also the subsequent perception of the cessation of an ongoing sound (N1b). In previous studies, two processes were defined: (1) M-process to deviation from the preceding auditory pattern and (2) C-process in response to acoustic change within an ongoing stream. We propose that N1b is different from these processes because it relates to the negation of an ongoing stimulus, and we thus call it an N-process. © 2004 Elsevier B.V. All rights reserved.

408. Maurer, U., S. Brem, K. Bucher, and D. Brandeis, *Emerging neurophysiological specialization for letter strings*. Journal of Cognitive Neuroscience, 2005. **17**(10): p. 1532-1552.

Summary: In adult readers, printed words and other letter strings activate specialized visual functions within 200 msec, as evident from neurophysiological recordings of brain activity. These fast, specialized responses to letter strings are thought to develop through plastic changes in the visual system. However, it is unknown whether this specialization emerges only with the onset of word reading, or represents a precursor of literacy. We compared 6-year-old kindergarten children who could not yet read words to adult readers. Both age groups detected immediate repetitions of visually presented words, pseudowords, symbol strings, and pictures during event-related potential (ERP) mapping. Maps from seven corresponding ERP segments in children and adults were analyzed regarding fast (<250 msec) and slow (>300 msec) specialization for letter strings. Adults reliably differentiated words through increased fast (<150 msec) occipito-temporal N1 activity from symbols. Children showed a later, more mid-occipital N1 with marginal word-symbol differences, which were absent in those children with low letter knowledge. Children with high letter knowledge showed some fast sensitivity to letter strings, which was confined to right occipito-temporal sites, unlike the stronger adult N1 specialization. This suggests that a critical degree of early literacy induces some immature, but fast, specialization for letter strings before word reading becomes possible. Children also differentiated words from symbols in later segments through increased right occipito-temporal negativity for words. This slow specialization for letter strings was not modulated by letter knowledge and was absent in adults, possibly reflecting a visual precursor of literacy due to visual familiarity with letter strings. © 2005 Massachusetts Institute of Technology.

409. Matysiak, A., P.J. Durka, E.M. Montes, M. Barwiński, P. Zwoliński, M. Roszkowski, and K.J. Blinowska, *Time-frequency-space localization of epileptic EEG oscillations*. Acta Neurobiologiae Experimentalis, 2005. **65**(4): p. 435-442.

Summary: This paper presents a hybrid method for localization of oscillatory EEG activity. It consists of two steps: multichannel matching pursuit with complex Gabor dictionary, and LORETA inverse solution. Proposed algorithm

was successfully applied to the localization of epileptogenic EEG in a single patient.

410. Mathiak, K. and A.J. Fallgatter, *Combining Magnetoencephalography and Functional Magnetic Resonance Imaging*. International Review of Neurobiology, 2005. **68**: p. 121-148.

Summary: Method integration is a promising approach to overcome limitations of each single imaging modality. In general, neuromagnetic and hemodynamic signals indicate roughly similar neuronal networks. Moreover, fMRI analyses have been augmented by adding the temporal resolution of MEG to activated spatial clusters, and less active sources could be described by combined measures. However, investigations that benefit from the combination of both methods are rather scarce. This might be due in part to the competing EEG technique. Indeed the spatial information from fMRI can improve the localization in EEG and, thus, reduce one disadvantage as compared to MEG. EEG allows recording simultaneously with fMRI. Data fusion of MEG and fMRI is not trivial. Currently, software packages for functional imaging tend to use at least a common spatial reference frame such as the MNI coordinates (Montreal Neurological Institute, Evans et al., 1993; internet resource: Brett, 2002). However, the spatial resolution shows different characteristics and it is still rather unclear which time range in evoked fields should be compared to the temporally integrated BOLD response. Even connectivity measures in MEG and fMRI refer to completely different frequencies. So far no general solution can be given of how to integrate the time developing extracranial data from MEG with the rather static tomographic data from fMRI. There are some practical limitations for using a combination of MEG and fMRI. Not many sites can provide the infrastructure for both techniques. Most researchers are only experts in one modality and they need to find a working cooperation to integrate both measures. Moreover, the costs add up and double measurements need to be organized as well. These problems might hinder many of the examinations. With patients, we had the experience that also some of the subjects rejected the second measurement block after disliking the first one or for other reasons which increased the drop-out rate. To manage these difficulties, there needs to be a specific reason and drive to plan and conduct combined MEG and fMRI studies. We think there are some good reasons to overcome the problems of method integration. Due to the low degree of distortions in MEG, it is well suited to be compared with tomographic methods such as fMRI. The two rather independent measures can validate each other. This is useful in presurgical planning but can be rather painful to a researcher in cognitive neuroscience if findings are hardly comparable. Moreover, the combination can provide insight into the relation of metabolic with neuroelectric activity and its disturbances. This is important to understand the mechanisms involved in neuroimaging and how hemodynamic coupling, neural synchronization, and connectivity are affected in neurofunctional disorders. We consider this the most important field for future applications of the combination of MEG and fMRI. © 2005 Elsevier Inc. All rights reserved.

411. Martín-Loeches, M., P. Casado, J.A. Hinojosa, L. Carretié, F. Muñoz, and M.A. Pozo, *Higher-order activity beyond the word level: Cortical dynamics of simple transitive sentence comprehension*. Brain and Language, 2005. **92**(3): p. 332-348.

Summary: Slow electrophysiological effects, which fluctuate throughout the course of a sentence, independent of transient responses to individual words, have been reported. However, this type of activity has scarcely been studied, and with only limited use of electrophysiological information, so that the brain areas in which these variations originate have not been clearly identified. To improve this state of affairs, a principal component analysis and a modern source analysis algorithm (LORETA) were applied to the slow activity underlying transitive sentence reading. Four components explained 97.3% of the variance. Of key interest was a slow variation that occurred throughout the entire sentence but peaked with the appearance of the verb. The main solution for this component was localized in prefrontal and temporal regions presumably involved in semantic sentence processing. This constitutes empirical evidence for cortical activity-related to semantic processes thought to be involved in thematic role assignment-developing throughout the sentence but presenting a conspicuous maximum with the appearance of the verb. This finding also highlights the central role of verb information in the understanding of transitive sentences. © 2004 Elsevier Inc. All rights reserved.

412. Marco-Pallarés, J., C. Grau, and G. Ruffini, *Combined ICA-LORETA analysis of mismatch negativity*, in *NeuroImage*. 2005. p. 471-477.

413. Marco, J., L. Fuentemilla, and C. Grau, *Auditory sensory gating deficit in abstinent chronic alcoholics*. Neuroscience Letters, 2005. **375**(3): p. 174-177.

Summary: P50 event-related potential was studied in abstinent chronic alcoholics to determine whether they had normal sensory gating. Repeated tones were presented to 17 recently detoxified chronic alcoholic patients and 17 healthy subjects while EEG was recorded. Low-resolution tomography (LORETA) was performed to obtain cerebral sources of P50. Abstinent chronic alcoholics showed reduced P50 sensory gating. Present results suggest an inhibitory deficit in early pre-attentive auditory sensory processing in chronic alcoholism. © 2004 Elsevier Ireland Ltd. All rights reserved.

414. Mangina, C.A., *Neuroscientific Psychophysiology: The International Organization of Psychophysiology (I.O.P.) associated with the United Nations (New York) in the 21st Century*. International Journal of Psychophysiology, 2005. **58**(2-3 SPEC. ISS.): p. 111-114.

Summary: This Presidential Address 2004 emphasizes the pivotal role of Psychophysiology as an integrated neuroscience with a panoply of electrophysiological and neuroimaging technologies for the establishment of methodologically crucial conceptual links for the understanding and mapping of

brain functions pertaining to cognitive, emotional and motivational processes. Moreover, Psychophysiology's unique neuroscientific perspective by integrating functions of central and autonomic nervous systems with behavior in health and disease is underlined. Based on these developments, the progress of rigorous neuroscientific Clinical Psychophysiology offers possibilities for diagnosis, treatment and objective evaluation of therapeutic outcome in various pathological conditions.

415. Ma, X. and X. Guan, *LORETA-contracting algorithm for solving EEG source distribution problems*. COMPEL - The International Journal for Computation and Mathematics in Electrical and Electronic Engineering, 2005. **24**(3): p. 821-828.

Summary: Purpose - The electroencephalography (EEG) source tomography in bio-electromagnetics is to estimate current dipole sources inside the brain from the measured electric potential distribution on the scalp surface. A traditional algorithm is the low-resolution electromagnetic tomography algorithm (LORETA). In order to obtain high-resolution tomography, the LORETA-contracting algorithm is proposed. Design/methodology/approach - The relation between the dipolar current source J at the nodes in source region and the potential U at the observed points on the scalp surface can be expressed as a matrix equation U=KJ after discretization. K is a coefficient matrix. Usually its simultaneous equation is an under-determined system. The LORETA approach is to find out minBWJ2, under constraint U=KJ where B is the discrete Laplacian operator matrix, W is a weighting diagonal matrix. Its solution is J=(WB TBW)-1KT{K(WBTBW)-1K T}+U where {}+ denotes the Moore-Penrose pseudo-inverse matrix. The improvement on this approach is to establish an iterative program to repeat LORETA and reduce the number of unknown J quantities in the step i+1 by contracting the source region excluding some extreme little quantities of J given in the step i. The simultaneous equations will gradually turn to a properly determined system or to an over-determined system. Finally, its solution can be obtained by using the least square method. Findings - Repeating to make the low-resolution tomography by contracting the source region, we can get a high-resolution tomography easily. Research limitations/implications - The LORETA-contracting algorithm is based on the assumption that the dipolar current sources inside the brain are sparse and concentrated based on the physiological study of the brain activity. Originality/value - It is new to repeat LORETA combined with the contracting technique. This algorithm can be developed to solve EEG problems of realistic head models. © Emerald Group Publishing Limited.

416. Liu, H., P.H. Schimpf, G. Dong, X. Gao, F. Yang, and S. Gao, *Standardized shrinking LORETA-FOCUSS (SSLOFO): A new algorithm for spatio-temporal EEG source reconstruction*. IEEE Transactions on Biomedical Engineering, 2005. **52**(10): p. 1681-1691.

Summary: This paper presents a new algorithm called Standardized Shrinking LORETA-FOCUSS (SSLOFO) for solving the electroencephalogram (EEG) inverse problem. Multiple techniques are combined in a single procedure to robustly reconstruct the underlying source distribution with high spatial resolution. This algorithm uses a recursive process which takes the smooth estimate of sLORETA as initialization and then employs the re-weighted minimum norm introduced by FOCUSS. An important technique called standardization is involved in the recursive process to enhance the localization ability. The algorithm is further improved by automatically adjusting the source space according to the estimate of the previous step, and by the inclusion of temporal information. Simulation studies are carried out on both spherical and realistic head models. The algorithm achieves very good localization ability on noise-free data. It is capable of recovering complex source configurations with arbitrary shapes and can produce high quality images of extended source distributions. We also characterized the performance with noisy data in a realistic head model. An important feature of this algorithm is that the temporal waveforms are clearly reconstructed, even for closely spaced sources. This provides a convenient way to estimate neural dynamics directly from the cortical sources. © 2005 IEEE.

417. Lehmann, D., P.L. Faber, S. Galderisi, W.M. Herrmann, T. Kinoshita, M. Koukkou, A. Mucci, R.D. Pascual-Marqui, N. Saito, J. Wackermann, G. Winterer, and T. Koenig, *EEG microstate duration and syntax in acute, medication-naïve, first-episode schizophrenia: A multi-center study*. Psychiatry Research - Neuroimaging, 2005. **138**(2): p. 141-156.

Summary: In young, first-episode, productive, medication-naive patients with schizophrenia, EEG microstates (building blocks of mentation) tend to be shortened. Koenig et al. [Koenig, T., Lehmann, D., Merlo, M., Kochi, K., Hell, D., Koukkou, M., 1999. A deviant EEG brain microstate in acute, neuroleptic-naïve schizophrenics at rest. European Archives of Psychiatry and Clinical Neuroscience 249, 205-211] suggested that shortening concerned specific microstate classes. Sequence rules (microstate concatenations, syntax) conceivably might also be affected. In 27 patients of the above type and 27 controls, from three centers, multichannel resting EEG was analyzed into microstates using k-means clustering of momentary potential topographies into four microstate classes (A-D). In patients, microstates were shortened in classes B and D (from 80 to 70 ms and from 94 to 82 ms, respectively), occurred more frequently in classes A and C, and covered more time in A and less in B. Topography differed only in class B where LORETA tomography predominantly showed stronger left and anterior activity in patients. Microstate concatenation (syntax) generally were disturbed in patients; specifically, the class sequence A→C→D→A predominated in controls, but was reversed in patients (A→D→C→A). In schizophrenia, information processing in certain classes of mental operations might deviate because of precocious termination. The intermittent occurrence might account for Bleuler's "double bookkeeping." The disturbed microstate syntax opens a novel physiological comparison of mental operations between patients and controls. © 2004 Elsevier Ireland Ltd. All rights reserved.

418. Laufer, I. and H. Pratt, *The 'F-complex' and MMN tap different aspects of deviance.* Clinical Neurophysiology, 2005. **116**(2): p. 336-352.

Summary: To compare the 'F(fusion)-complex' with the Mismatch negativity (MMN), both components associated with automatic detection of changes in the acoustic stimulus flow. Ten right-handed adult native Hebrew speakers discriminated vowel-consonant-vowel (V-C-V) sequences /ada/ (deviant) and /aga/ (standard) in an active auditory 'Oddball' task, and the brain potentials associated with performance of the task were recorded from 21 electrodes. Stimuli were generated by fusing the acoustic elements of the V-C-V sequences as follows: base was always presented in front of the subject, and formant transitions were presented to the front, left or right in a virtual reality room. An illusion of a lateralized echo (duplex sensation) accompanied base fusion with the lateralized formant locations. Source current density estimates were derived for the net response to the fusion of the speech elements (F-complex) and for the MMN, using low-resolution electromagnetic tomography (LORETA). Statistical non-parametric mapping was used to estimate the current density differences between the brain sources of the F-complex and the MMN. Occipito-parietal regions and prefrontal regions were associated with the F-complex in all formant locations, whereas the vicinity of the supratemporal plane was bilaterally associated with the MMN, but only in case of front-fusion (no duplex effect). MMN is sensitive to the novelty of the auditory object in relation to other stimuli in a sequence, whereas the F-complex is sensitive to the acoustic features of the auditory object and reflects a process of matching them with target categories. The F-complex and MMN reflect different aspects of auditory processing in a stimulus-rich and changing environment: content analysis of the stimulus and novelty detection, respectively. © 2004 International Federation of Clinical Neurophysiology. Published by Elsevier Ireland Ltd. All rights reserved.

419. Latif, M.A., S. Sanei, and J.A. Chambers, *Localization of abnormal EEG sources incorporating constrained BSS.* Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics), 2005. **3697 LNCS**: p. 703-708.

Summary: An effective method has been developed to solve the localization problem of the brain sources. A priori knowledge about normal source locations has been effectively exploited in estimating the rotation matrix, which inherently permutes the estimated separating matrix in the blind source separation (BSS) algorithm. An important application of this method is to localize the Focal epilepsy sources, which causes changes in attention, movement and behavior. Here, an effective and simple technique for both separation and localization of the EEG sources has been developed incorporating BSS. The criterion is subject to having some of the sources known. The constraint is then incorporated into the separation objective function using Lagrange multipliers whereby changing it to an unconstrained problem. © Springer-Verlag Berlin Heidelberg 2005.

420. Lamm, C., F.P.S. Fischmeister, and H. Bauer, *Individual differences in brain activity during visuo-spatial processing assessed by slow cortical potentials and LORETA*. Cognitive Brain Research, 2005. **25**(3): p. 900-912.

Summary: Using slow-cortical potentials (SCPs), Vitouch et al. (International Journal of Psychophysiology 27 (1997) 183-199) demonstrated that subjects with low ability to solve a complex visuo-spatial imagery task show higher activity in occipital, parietal and frontal cortex during task processing than subjects with high ability. This finding has been interpreted in the sense of the so-called "neural efficiency" hypothesis, which assumes that the central nervous system of individuals with higher intellectual abilities is functioning in a more efficient way than the one of individuals with lower abilities. Using a higher spatial resolution of SCP recordings, and by employing the source localization method of LORETA (low-resolution electromagnetic tomography), we investigated this hypothesis by performing an extended replication of Vitouch et al.'s study. SCPs during processing of a visuo-spatial imagery task were recorded in pre-selected subjects with either high or low abilities in solving the imagery task. Topographic and LORETA analyses of SCPs revealed that a distributed network of extrastriate occipital, superior parietal, temporal, medial frontal and prefrontal areas was active during task solving. This network is well in line with former studies of the functional neuroanatomy of visuo-spatial imagery. Contrary to our expectations, however, the results of Vitouch et al. as well as of other studies supporting the neural efficiency hypothesis could not be confirmed since no difference in brain activity between groups was observed. This inconsistency between studies might be due to differing task processing strategies. While subjects with high abilities in the Vitouch et al. study seemed to use a visuo-perceptual task solving approach, all other subjects relied upon a visuo-motor task processing strategy. © 2005 Elsevier B.V. All rights reserved.

421. Lai, Y., W. Van Drongelen, L. Ding, K.E. Hecox, V.L. Towle, D.M. Frim, and B. He, *Estimation of in vivo human brain-to-skull conductivity ratio from simultaneous extra- and intra-cranial electrical potential recordings*. Clinical Neurophysiology, 2005. **116**(2): p. 456-465.

Summary: The present study aims to accurately estimate the in vivo brain-to-skull conductivity ratio by means of cortical imaging technique. Simultaneous extra- and intra-cranial potential recordings induced by subdural current stimulation were analyzed to get the estimation. The effective brain-to-skull conductivity ratio was estimated in vivo for 5 epilepsy patients. The estimation was performed using multi-channel simultaneously recorded scalp and cortical electrical potentials during subdural electrical stimulation. The cortical imaging technique was used to compute the inverse cortical potential distribution from the scalp recorded potentials using a 3-shell head volume conductor model. The brain-to-skull conductivity ratio, which leads to the most consistent cortical potential estimates with respect to the direct intra-cranial measurements, is considered to be the effective brain-to-skull conductivity ratio. The present estimation provided consistent results in 5 human subjects studied. The in vivo

effective brain-to-skull conductivity ratio ranged from 18 to 34 in the 5 epilepsy patients. The effective brain-to-skull conductivity ratio can be estimated from simultaneous intra- and extra-cranial potential recordings and the averaged value/standard deviation is 25±7. The present results provide important experimental data on the brain-to-skull conductivity ratio, which is of significance for accurate brain source localization using piece-wise homogeneous head models. © 2004 International Federation of Clinical Neurophysiology. Published by Elsevier Ireland Ltd. All rights reserved.

422. Korn, A., H. Golan, I. Melamed, R. Pascual-Marqui, and A. Friedman, *Focal cortical dysfunction and blood-brain barrier disruption in patients with postconcussion syndrome*. Journal of Clinical Neurophysiology, 2005. **22**(1): p. 1-9.

Summary: Postconcussion syndrome (PCS) refers to symptoms and signs commonly occurring after mild head injury. The pathogenesis of PCS is unknown. The authors quantitatively analyzed EEG recordings, localized brain sources for abnormal activity, and correlated it with imaging studies. Data from 17 patients with neurologic symptomatology consistent with ICD-10 criteria for PCS was analyzed. Normalized quantitative EEG (QEEG) revealed significantly higher power in the delta band and lower power in the alpha band compared with matched controls. The generators for the abnormal rhythms were focally localized in neocortical regions. Brain computerized tomography and/or MRI did not reveal focal abnormality at the time of diagnosis. Single photon emission computed tomography (SPECT) after 99mTc-ethylcysteinate dimer administration showed a focal reduction in perfusion in 85% (n = 11) of the patients, and abnormal blood-brain barrier (BBB) after 99mTc-diethylenetriaminepentaacetic acid administration in 73% (n = 8). In 75% of these patients, low-resolution brain electromagnetic tomography analysis showed that the generators for abnormal rhythms were closely related to the anatomic location of the BBB lesion. These data point to focal cortical dysfunction in conjunction with BBB disruption and hypoperfusion as a possible mechanism of pathogenesis in at least some PCS patients, and offer QEEG and SPECT as important tools in evaluating these patients.

423. Kopeček, M., M. Brunovský, M. Bareš, F. Španiel, T. Novák, C. Dockery, and J. Horáček, *Regional cerebral metabolic abnormalities in individual patients with nonquantitative 18FDG PET and qEEG (LORETA)*. Psychiatrie, 2005. **9**(SUPPL. 3): p. 56-63.

Summary: The authors discuss the clinical usefulness of individualized PET SPM analysis in the detection of pathophysiological correlates of psychopathology and in localizing the target for rTMS therapy. The article presents case studies about patients with musical hallucinations and OCD, organic schizoform disorder in temporal lobe epilepsy and depersonalization and derealization syndrome. Individualized PET SPM analysis could be a useful tool in psychiatry but it is not available for general psychiatric practice. LORETA, which uses an EEG machine is inexpensive, generally available and our preliminary clinical experience suggest that it could be sensitive to changes following TMS and can show at least partially similar abnormalities as revealed in 18FDG PET.

424. Kaiser, D.A., *Basic principles of quantitative EEG*. Journal of Adult Development, 2005. **12**(2-3): p. 99-104.

Summary: Principles of quantitative electroencephalography (EEG) relevant to neurotherapy are reviewed. A brief history of EEG, the general properties of human EEG, and the issues and obstacles associated with quantitative methods are discussed. Fourier analysis is also described. © 2005 Springer Science + Business Media, Inc.

425. Jun, S.C., J.S. George, J. Paré-Blagoev, S.M. Plis, D.M. Ranken, D.M. Schmidt, and C.C. Wood, *Spatiotemporal Bayesian inference dipole analysis for MEG neuroimaging data*. NeuroImage, 2005. **28**(1): p. 84-98.

Summary: Recently, we described a Bayesian inference approach to the MEG/EEG inverse problem that used numerical techniques to estimate the full posterior probability distributions of likely solutions upon which all inferences were based [Schmidt, D.M., George, J.S., Wood, C.C., 1999. Bayesian inference applied to the electromagnetic inverse problem. Human Brain Mapping 7, 195; Schmidt, D.M., George, J.S., Ranken, D.M., Wood, C.C., 2001. Spatial-temporal bayesian inference for MEG/EEG. In: Nenonen, J., Ilmoniemi, R. J., Katila, T. (Eds.), Biomag 2000: 12th International Conference on Biomagnetism. Espoo, Norway, p. 671]. Schmidt et al. (1999) focused on the analysis of data at a single point in time employing an extended region source model. They subsequently extended their work to a spatiotemporal Bayesian inference analysis of the full spatiotemporal MEG/EEG data set. Here, we formulate spatiotemporal Bayesian inference analysis using a multi-dipole model of neural activity. This approach is faster than the extended region model, does not require use of the subject's anatomical information, does not require prior determination of the number of dipoles, and yields quantitative probabilistic inferences. In addition, we have incorporated the ability to handle much more complex and realistic estimates of the background noise, which may be represented as a sum of Kronecker products of temporal and spatial noise covariance components. This reduces the effects of undermodeling noise. In order to reduce the rigidity of the multi-dipole formulation which commonly causes problems due to multiple local minima, we treat the given covariance of the background as uncertain and marginalize over it in the analysis. Markov Chain Monte Carlo (MCMC) was used to sample the many possible likely solutions. The spatiotemporal Bayesian dipole analysis is demonstrated using simulated and empirical whole-head MEG data. © 2005 Elsevier Inc. All rights reserved.

426. Jokisch, D., I. Daum, B. Suchan, and N.F. Troje, *Structural encoding and recognition of biological motion: Evidence from event-related potentials and source analysis*. Behavioural Brain Research, 2005. **157**(2): p. 195-204.

Summary: In the present study, we investigated how different processing stages involved in the perceptual analysis of biological motion (BM) are reflected by modulations in event-related potentials (ERP) in order to elucidate the time course and location of neural processing of BM. Data analysis was carried out using conventional averaging techniques as well as source localization with low resolution brain electromagnetic tomography (LORETA). ERPs were recorded in response to point-light displays of a walking person, an inverted walking person and displays of scrambled motion. Analysis yielded a pronounced negativity with a peak at 180 ms after stimulus onset which was more pronounced for upright walkers than for inverted walkers and scrambled motion. A later negative component between 230 and 360 ms after stimulus onset had a larger amplitude for upright and inverted walkers as compared to scrambled walkers. In the later component, negativity was more pronounced in the right hemisphere revealing asymmetries in BM perception. LORETA analysis yielded evidence for sources specific to BM within the right fusiform gyrus and the right superior temporal gyrus for the second component, whereas sources for BM in the early component were located in areas associated with attentional aspects of visual processing. The early component might reflect the pop-out effect of a moving dot pattern representing the highly familiar form of a human figure, whereas the later component might be associated with the specific analysis of motion patterns providing biologically relevant information. © 2004 Elsevier B.V. All rights reserved.

427. Jandl, M., R. Bittner, A. Sack, B. Weber, T. Günther, D. Pieschl, W.P. Kaschka, and K. Maurer, *Changes in negative symptoms and EEG in schizophrenic patients after repetitive Transcranial Magnetic Stimulation (rTMS): An open-label pilot study*. Journal of Neural Transmission, 2005. **112**(7): p. 955-967.

Summary: The effects of repetitive transcranial magnetic stimulation (rTMS) on schizophrenic negative symptoms (NS) and EEG topography were investigated in this pilot study. 10 patients with predominant NS were treated with 10 Hz rTMS over the left dorsolateral prefrontal cortex for 5 days. For NS ratings, the Scale for the Assessment of Negative Symptoms (SANS) was used. Both ratings and EEG recordings were obtained pre- and post-rTMS. Electrical activity changes were computed by Low Resolution Brain Electromagnetic Tomography. SANS showed an improvement after rTMS, from 49.0 (SD: 10.7) to 44.7 (SD: 11.8) (means). EEG frequency bands were changed fronto-temporally (right) and were mainly decreases in delta- and beta- and increases in alpha1-activity, as well as decreases in beta-activity in the temporal and parieto-occipital regions (left). Although we are aware of the limitations of this study, we assume a slight improvement in NS. The EEG findings refer to a possible neurophysiologic correlate of their improvement after rTMS. © Springer-Verlag 2004.

428. Im, C.H., C. Lee, H.K. Jung, Y.H. Lee, and S. Kuriki, *Magnetoencephalography cortical source imaging using spherical mapping*. IEEE Transactions on Magnetics, 2005. **41**(5): p. 1984-1987.

Summary: This paper proposes a novel approach to enhancing results of magnetoencephalography cortical source imaging. The proposed approach utilizes bell-shaped functions defined on an inflated cortical surface, which has one-to-one correspondence with original tessel-lated cortical surface. The coefficients of the functions are then determined using sensitivity analysis with conjugate gradient updating scheme. Applications of the approach to a simulation study and a practical experiment have resulted in more stable and smoother brain source distribution, compared to conventional linear inverse approach. © 2005 IEEE.

429. Hong, B., H. Liu, P.H. Schimpf, S. Gao, and N.V. Thakor, *Spatio-temporal analysis of P300 using ICA and SSLOFO*. 2nd International IEEE EMBS Conference on Neural Engineering, 2005. **2005**: p. 640-643.

Summary: Spatial information of EEG source activity revealed by inverse methods may contribute to an improvement of the BCI systems. This paper proposes an approach that integrates the Independent Component Analysis (ICA) and a newly developed inverse algorithm termed SSLOFO to robustly reconstruct cortical sources of P300. The target independent components are first extracted using a spatio-temporal optimization process and then SSLOFO is employed to localize the sources of the target components. Preliminary studies demonstrate our method is able to localize sources of P300 based on 5-trial-averaged EEG and the results are consistent with the findings of other functional imaging studies such as fMRI. The robustness of our approach is also proved by a study which indicates the P300 sources are stably reconstructed around the left and right TPJ areas. © 2005 IEEE.

430. Hoffmann, K., A.M. Popov, S.E. Pevtsov, and I.A. Fedulova, *Modeling the spatio-temporal electrical activity of neuron sources*. Computational Mathematics and Modeling, 2005. **16**(3): p. 235-247.

Summary: An evolutionary dipole model is constructed describing the spatio-temporal behavior of the electric potential on the surface of the head (EEG data). An approach is proposed to the solution of the direct three-dimensional EEG problem (finding the induced field). This approach finds the solution as a semi-analytical representation of an approximate solution in spherical functions with indeterminate coefficients. The coefficients are then determined by least squares. The method works with arbitrary (nonspherical) boundary surfaces, unbounded regions, finite conductivity outside the head, and complex spatial dependence of electrical conductivity. A nonhomogeneous conductivity model is considered with conductivity varying sharply across layers. An accurate numerical solution can be obtained if the conductivity of the layers differs by a factor of 80, which ensures sufficient accuracy in estimating dipole localization. Optimal dipole placement is reconstructed by a genetic algorithm, which also determines the best combination and the best number of dipoles. The method works also when several brain zones are active simultaneously. During the iterative fitting of the dipole parameters to minimize the error functional, the evolution of the genetic

algorithm is directly linked with the temporal variation of the EEG signal. © 2005 Springer Science+Business Media, Inc.

431. Hillebrand, A., K.D. Singh, I.E. Holliday, P.L. Furlong, and G.R. Barnes, *A new approach to neuroimaging with magnetoencephalography*. Human Brain Mapping, 2005. **25**(2): p. 199-211.

Summary: We discuss the application of beamforming techniques to the field of magnetoencephalography (MEG). We argue that beamformers have given us an insight into the dynamics of oscillatory changes across the cortex not explored previously with traditional analysis techniques that rely on averaged evoked responses. We review several experiments that have used beamformers, with special emphasis on those in which the results have been compared to those observed in functional magnetic resonance imaging (fMRI) and on those studying induced phenomena. We suggest that the success of the beamformer technique, despite the assumption that there are no linear interactions between the mesoscopic local field potentials across distinct cortical areas, may tell us something of the balance between functional integration and segregation in the human brain. What is more, MEG beamformer analysis facilitates the study of these complex interactions within cortical networks that are involved in both sensory-motor and cognitive processes. © 2005 Wiley-Liss, Inc.

432. Herrmann, M.J., A.C. Ehlis, A. Muehlberger, and A.J. Fallgatter, *Source localization of early stages of face processing*. Brain Topography, 2005. **18**(2): p. 77-85.

Summary: Recent studies using ERPs in face recognition revealed that face processing starts around 100 ms after stimulus onset, 70 ms earlier than suggested before. While the neural sources of the N170 component have repeatedly been found to be localized in the gyrus fusiformis and the inferior occipital cortex, sources have not yet been investigated for the P100 component during face processing. Therefore, we measured the ERPs elicited by faces and control stimuli in 72 subjects in order to localize the neural sources of both the P100 and the N170 component. We observed significantly higher P100 and N170 amplitudes to faces compared to control stimuli. LORETA source localization revealed significantly higher brain activity in the left and right gyrus fusiformis for the N170 component, with additional regions of increased brain activation in a parieto-temporal-occipital network. For the P100, faces activated the left and right gyrus fusiformis significantly stronger than control stimuli. This study reveals that the first step of face processing (about 100 ms after stimulus presentation) is localized in the gyrus fusiformis. The second step of face processing around 170 ms involves the gyrus fusiformis, with additional activation in a more distributed network, including the occipital cortex. Copyright © 2005 Springer Science + Business Media, Inc.

433. He, B., *High-resolution functional source and impedance imaging*. Annual International Conference of the IEEE Engineering in Medicine and Biology - Proceedings, 2005. **7 VOLS**: p. 4178-4182.

Summary: Functional imaging has played a significant role in bettering our understanding of mechanisms of brain function and dysfunctions. We review recent research on electrophysiological neuroimaging, multimodal neuroimaging integrating functional MRI with EEG, and our development of magnetoacoustic tomography with magnetic induction for high resolution impedance imaging. Examples from research of our group will be shown to illustrate the concepts. The extensive work being pursued by a number of investigators suggests the promise of functional neuroimaging in imaging neural activity from noninvasive measurements. ©2005 IEEE.

434. Greenblatt, R.E., A. Ossadtchi, and M.E. Pflieger, *Local linear estimators for the bioelectromagnetic inverse problem*. IEEE Transactions on Signal Processing, 2005. **53**(9): p. 3403-3412.

Summary: Linear estimators have been used widely in the bioelectromagnetic inverse problem, but their properties and relationships have not been fully characterized. Here, we show that the most widely used linear estimators may be characterized by a choice of norms on signal space and on source space. These norms depend, in part, on assumptions about the signal space and source space covariances. We demonstrate that two estimator classes (standardized and weight vector normalized) yield unbiased estimators of source location for simple source models (including only the noise-free case) but biased estimators of source magnitude. In the presence of instrumental (white) noise, we show that the nonadaptive standardized estimator is a biased estimator of source location, while the adaptive weight vector normalized estimator remains unbiased. A third class (distortionless) is an unbiased estimator of source magnitude but a biased estimatof of source location. © 2005 IEEE.

435. Gjini, K., T. Maeno, K. Iramina, and S. Ueno, *Processing and encoding of Latin letters and kanji characters in the brain: a visual ERPs study*. International Congress Series, 2005. **1278**: p. 127-130.

Summary: Multichannel EEG was recorded from human subjects during the performance of a 1-back comparison short-term memory task with Latin alphabet single letters and Japanese single kanji words presented visually. Event-related potentials (ERPs) were analyzed from EEG recordings during two conditions (memory and control). Timing and source localization of different generators taking part in visual information processing and short-term memory encoding were estimated. The main generators of P1, N1, and P2 event-related potentials were estimated in the primary visual, lateral occipital and posterior temporal, and medial parietal regions of the cortex. Furthermore, from later ERPs related to encoding of stimuli in memory, subsequent activations were estimated in anterior regions of the left temporal and frontal cortex between 300 and 450 ms.

Definition of few most activated areas in these simple tasks (source localization was obtained from distributed and dipolar fitting inverse solutions) could be used in construction of simple, relatively reliable brain source models. Based on these multiple source models, applying weighted linear inverse filters to the continuous data, useful source signals could be extracted for time-frequency, event-related (de)synchronization and coherence analysis. The observed event-related theta frequency synchronizations and alpha frequency desynchronizations were related to stimulus encoding. © 2004 Elsevier B.V. All rights reserved.

436. Gjini, K., T. Maeno, K. Iramina, and S. Ueno, *Short-term episodic memory encoding in the human brain: A magnetoencephalography and electroencephalography study*. INTERMAG ASIA 2005: Digests of the IEEE International Magnetics Conference, 2005: p. 565.

Summary:

437. Fu, S., P.M. Greenwood, and R. Parasuraman, *Brain mechanisms of involuntary visuospatial attention: An event-related potential study*. Human Brain Mapping, 2005. **25**(4): p. 378-390.

Summary: The brain mechanisms mediating visuospatial attention were investigated by recording event-related potentials (ERPs) during a line-orientation discrimination task. Nonpredictive peripheral cues were used to direct participant's attention involuntarily to a spatial location. The earliest attentional modulation was observed in the P1 component (peak latency about 130 ms), with the valid trials eliciting larger P1 than invalid trials. Moreover, the attentional modulations on both the amplitude and latency of the P1 and N1 components had a different pattern as compared to previous studies with voluntary attention tasks. In contrast, the earliest visual ERP component, C1 (peak latency about 80 ms), was not modulated by attention. Low-resolution brain electromagnetic tomography (LORETA) showed that the earliest attentional modulation occurred in extrastriate cortex (middle occipital gyrus, BA 19) but not in the primary visual cortex. Later attention-related reactivations in the primary visual cortex were found at about 110 ms after stimulus onset. The results suggest that involuntary as well as voluntary attention modulates visual processing at the level of extrastriate cortex; however, at least some different processes are involved by involuntary attention compared to voluntary attention. In addition, the possible feedback from higher visual cortex to the primary visual cortex is faster and occurs earlier in involuntary relative to voluntary attention task. © 2005 Wiley-Liss, Inc.

438. Fu, S., D.M. Caggiano, P.M. Greenwood, and R. Parasuraman, *Event-related potentials reveal dissociable mechanisms for orienting and focusing visuospatial attention*. Cognitive Brain Research, 2005. **23**(2-3): p. 341-353.

Summary: The neural mechanisms supporting visuospatial orienting and focusing were investigated by recording event-related potentials (ERPs) in a

cued, line-orientation discrimination task. Search arrays flashed randomly in the left or right visual field and were preceded by peripheral cues that varied in validity (valid or invalid, with 50% each) and size (large or small, with 50% each). Facilitation of response time was observed for valid trials, regardless of cue size. In contrast to previous cued search studies, however, small (i.e., more precise) cues were associated with delayed responses. Both the timing and the amplitudes of the early ERP components, P1 and N1, were modulated by attentional orienting, with valid trials eliciting a larger and later contralateral vP1 (ventral P1) and a smaller and later contralateral N1 compared to invalid trials. Attentional focusing modulated only the amplitudes of the P1 component, with precisely cued trials eliciting a larger dP1 (dorsal P1) than less precisely cued trials at both contralateral and ipsilateral sites. Thus, both attentional orienting and focusing modulate early stimulus processing stages that overlap in time, but with dissociable effects on the scalp distribution of these components, indicating possibly different underlying mechanisms. In addition, the results support the notion that voluntary and involuntary allocations of visuospatial attention are mediated by different underlying neural processes. © 2004 Elsevier B.V. All rights reserved.

439. Ferri, R., F. Rundo, O. Bruni, M.G. Terzano, and C.J. Stam, *Dynamics of the EEG slow-wave synchronization during sleep*. Clinical Neurophysiology, 2005. **116**(12): p. 2783-2795.

Summary: Objective: To study the dynamics of spatial synchronization of the slow-wave activity recorded from different scalp electrodes during sleep in healthy normal controls. Methods: We characterized the different levels of EEG synchronization during sleep (in the 0.25-2.5 Hz band) of five healthy subjects by means of the synchronization likelihood (SL) algorithm and analyzed its long-range temporal correlations by means of the detrended fluctuation analysis (DFA). Results: We found higher levels of interregional synchronization during 'cyclic alternating pattern' (CAP) sleep than during nonCAP with a small but significant difference between its A and B phases. SL during CAP showed fluctuations probably corresponding to the single EEG slow-wave elements. DFA showed the presence of two linear scaling regions in the double-logarithmic plot of the fluctuations of SL level as a function of time scale. This indicates the presence of a characteristic time scale in the underlying dynamics which was very stable among the different subjects (1.23-1.33 s). We also computed the DFA exponent of the two scaling regions; the first, with values ≈1.5, corresponded to fluctuations with period 0.09-0.75 s and the second, with values ≈1, corresponded to fluctuations with period 1.5-24.0 s. Only the first exponent showed different values during the different sleep stages. Conclusions: All these results indicate a different role for each sleep stage and CAP condition in the EEG synchronization processes of sleep which show a complex time structure correlated with its neurophysiological mechanisms. Significance: Very slow oscillations in spatial EEG synchronization might play a critical role in the long-range temporal EEG correlations during sleep which might be the chain of events responsible for the maintenance and correct complex development of sleep structure during the night. © 2005 International Federation of Clinical Neurophysiology. Published by Elsevier Ireland Ltd. All rights reserved.

440. Ferri, R., O. Bruni, S. Miano, and M.G. Terzano, *Topographic mapping of the spectral components of the cyclic alternating pattern (CAP)*. Sleep Medicine, 2005. **6**(1): p. 29-36.

Summary: Background and purpose: The aim of this study was to define quantitatively the spectrum content of the sleep pattern termed 'cyclic alternating pattern' (CAP) A phases, their scalp topography and their probable cortical generators, by using data from sleep polygraphic recordings that included a large number of scalp EEG channels. Patients and methods: Polysomnographic recording that include 19 EEG channels were obtained from 5 normal healthy young controls. After sleep staging, for each subject, 5 different CAP A phase subtype epochs were selected, which served for subsequent analysis. Following the analysis of power spectra calculated on the C4 channel by means of the fast Fourier transform, two different frequency bands were detected: 0.25-2.5 and 7-12 Hz, representing the frequency peak in the profiles of the different CAP subtypes. All the subsequent analyses were performed on these two bands. Scalp topographic color mapping was carried out using the data from all the 19 EEG channels recorded, and by means of the 4-nearest neighbor algorithm. Individual average maps were obtained for both frequency bands. Finally, we used the low resolution brain electromagnetic tomography (LORETA) functional imaging for the source analysis of the two EEG frequency components of CAP A phases. Results: The quantitative spectral analysis of the different A phase subtypes shows the existence of two distinct spectral components characterizing CAP subtypes A1 (0.25-2.5 Hz) and A3 (7-12 Hz). These two components coexist in CAP A2 subtypes. The topography of these two components shows a clear prevalence over the anterior frontal regions for the 0.25-2.5 Hz band and over the parietal-occipital areas for the 7-12 Hz band. Finally, the generators of the low-frequency component of CAP seemed to be localized mostly over the frontal midline cortex; on the contrary, those of the high-frequency band involved both midline and hemispheric areas within the parietal and occipital areas. Conclusions: The results of this study confirm the presence of two fundamentally distinct frequency bands which are expressed individually (A1 and A3) or in association (A2) in the different CAP A phase subtypes. The analysis of scalp distribution maps indicates that the two frequency components recognized are distributed over clearly different areas of the scalp. Moreover, the LORETA analysis indicates that also the probable cortical generators of these two frequency bands are different and well separated and distinct. © 2004 Elsevier B.V. All rights reserved.

441. Ferri, R., O. Bruni, S. Miano, G. Plazzi, and M.G. Terzano, *All-night EEG power spectral analysis of the cyclic alternating pattern components in young adult subjects*. Clinical Neurophysiology, 2005. **116**(10): p. 2429-2440.

Summary: Objective: To analyze in detail the frequency content of the different EEG components of the Cyclic Alternating Pattern (CAP), taking into account the ongoing EEG background and the nonCAP (NCAP) periods in the whole night polysomnographic recordings of normal young adults. Methods: Sixteen normal healthy subjects were included in this study. Each subject underwent one polysomnographic night recording; sleep stages were scored following standard criteria. Subsequently, each CAP A phase was detected in all recordings, during NREM sleep, and classified into 3 subtypes (A1, A2, and A3). The same channel used for the detection of CAP A phases (C3/A2 or C4/A1) was subdivided into 2-s mini-epochs. For each mini-epoch, the corresponding CAP condition was determined and power spectra calculated in the frequency range 0.5-25 Hz. Average spectra were obtained for each CAP condition, separately in sleep stage 2 and SWS, for each subject. Finally, the first 6 h of sleep were subdivided into 4 periods of 90 min each and the same spectral analysis was performed for each period. Results: During sleep stage 2, CAP A subtypes differed from NCAP periods for all frequency bins between 0.5 and 25 Hz; this difference was most evident for the lowest frequencies. The B phase following A1 subtypes had a power spectrum significantly higher than that of NCAP, for frequencies between 1 and 11 Hz. The B phase after A2 only differed from NCAP for a small but significant reduction in the sigma band power; this was evident also after A3 subtypes. During SWS, we found similar results. The comparison between the different CAP subtypes also disclosed significant differences related to the stage in which they occurred. Finally, a significant effect of the different sleep periods was found on the different CAP subtypes during sleep stage 2 and on NCAP in both sleep stage 2 and SWS. Conclusions: CAP subtypes are characterized by clearly different spectra and also the same subtype shows a different power spectrum, during sleep stage 2 or SWS. This finding underlines a probable different functional meaning of the same CAP subtype during different sleep stages. We also found 3 clear peaks of difference between CAP subtypes and NCAP in the delta, alpha, and beta frequency ranges which might indicate the presence of 3 frequency components characterizing CAP subtypes, in different proportion in each of them. The B component of CAP differs from NCAP because of a decrease in power in the sigma frequency range. Significance: This study shows that A components of CAP might correspond to periods in which the very-slow delta activity of sleep groups a range of different EEG activities, including the sigma and beta bands, while the B phase of CAP might correspond to a period in which this activity is quiescent or inhibited. © 2005 International Federation of Clinical Neurophysiology. Published by Elsevier Ireland Ltd. All rights reserved.

442. Fallgatter, A.J., A.C. Ehlis, M. Rösler, W.K. Strik, D. Blocher, and M.J. Herrmann, *Diminished prefrontal brain function in adults with psychopathology in childhood related to attention deficit hyperactivity disorder.* Psychiatry Research - Neuroimaging, 2005. **138**(2): p. 157-169.

Summary: The aim of the present study was to investigate prefrontal brain function and cognitive response control in patients with personality disorders who either suffered or did not suffer from psychopathology related to attention deficit hyperactivity disorder (ADHD) during childhood. For this purpose, 36 psychiatric out-patients with personality disorders-24 of whom showed ADHD-related psychopathology during childhood assessed by the German short form of the Wender Utah Rating Scale-and 24 healthy controls were investigated electrophysiologically by means of a cued Go-NoGo task (Continuous Performance Test). Topographical analyses were conducted to individually quantify the NoGo anteriorisation (NGA), a neurophysiological correlate of prefrontal response control that has been suggested to reflect activation of the anterior cingulate cortex. ADHD patients exhibited a significantly reduced mean NGA and diminished amplitudes of the Global Field Power, as well as a reduced increase of fronto-central P300 amplitudes, in NoGo-trials compared with the healthy controls, whereas patients with personality disorders alone did not differ from the control group in any of the electrophysiological parameters. The results indicate that ADHD-related psychopathology is associated with prefrontal brain dysfunction, probably related to processes of response inhibition and/or cognitive response control. © 2005 Elsevier Ireland Ltd. All rights reserved.

443. Ehlis, A.C., J. Zielasek, M.J. Herrmann, T. Ringel, C. Jacob, A. Wagener, and A.J. Fallgatter, *Evidence for unaltered brain electrical topography during prefrontal response control in cycloid psychoses.* International Journal of Psychophysiology, 2005. **55**(2): p. 165-178.

Summary: Prefrontal structures such as the anterior cingulate cortex (ACC) play a decisive role in processes of action monitoring and response control, functions often impaired in schizophrenia. Patients with cycloid psychoses exhibit some characteristic neurophysiological features not indicative of the cerebral hypofrontality observed in schizophrenia. This study aimed at examining if cycloid psychoses-unlike schizophrenias-involve a normal brain-electrical topography during a task demanding prefrontal response control. Thirty-seven patients with cycloid psychoses and 37 healthy controls were investigated electrophysiologically while performing a Continuous Performance Test (CPT). Topographical analyses were conducted to individually quantify the Nogo-anteriorisation (NGA) as a neurophysiological index of prefrontal response control. The patients exhibited an unaltered topography with a mean NGA not significantly different from the controls. They did, however, differ from the control group regarding their Global Field Power (GFP), with a significantly reduced GFP ($p<0.001$) and decreased latencies ($p<0.01$) during Nogo trials. On a behavioral level, patients exhibited prolonged reaction times and an increased rate of omission errors. The investigated patients showed an activation of specific (presumably frontal) brain areas during Nogo trials, resulting in a frontalisation of the brain-electrical field comparable to the control group. However, the strength of this activation was apparently reduced. The patients' unaltered topographical pattern contrasts with previous findings in schizophrenic patients and supports the hypothesis that cycloid psychoses entail less severe prefrontal deficits than schizophrenias, which might be an indication of different biological

backgrounds for both groups of endogenous psychoses. © 2004 Elsevier B.V. All rights reserved.

444. Ehlis, A.C., J. Zielasek, M.J. Herrmann, T. Ringel, C. Jacob, and A.J. Fallgatter, *Beneficial effect of atypical antipsychotics on prefrontal brain function in acute psychotic disorders*. European Archives of Psychiatry and Clinical Neuroscience, 2005. **255**(5): p. 299-307.

Summary: Disturbance of prefrontal brain functions is assumed to be responsible for prominent psychopathological symptoms in psychotic disorders. Treatment with atypical, in contrast to typical antipsychotics is considered as a possible strategy for an improvement of prefrontal brain function. In the present study, response control as a specific prefrontal brain function was assessed by means of the Nogo-anteriorization (NGA) derived from the event-related potentials elicited during a Go-NoGo task in a consecutive sample of 39 patients suffering from acute psychotic disorders (brief psychotic disorders, 298.8, n = 34 and schizoaffective disorders, 295.70,n = 5; cycloid psychoses according to the Leonhard classification). A highly significant positive correlation between the amount of antipsychotic medication in terms of chlorpromazine equivalents per day and the NGA as a measure of prefrontal response control was only found in the subgroup of patients treated exclusively or predominantly with atypical antipsychotics but not for those treated with typical antipsychotics. These results are in line with the notion that atypical antipsychotics may exert a beneficial effect on prefrontal brain function.

445. Durka, P.J., A. Matysiak, E.M. Montes, P.V. Sosa, and K.J. Blinowska, *Multichannel matching pursuit and EEG inverse solutions*. Journal of Neuroscience Methods, 2005. **148**(1): p. 49-59.

Summary: We present a new approach to the preprocessing of the electroencephalographic time series for EEG inverse solutions. As the first step, EEG recordings are decomposed by multichannel matching pursuit algorithm - in this study we introduce a computationally efficient, suboptimal solution. Then, based upon the parameters of the waveforms fitted to the EEG (frequency, amplitude and duration), we choose those corresponding to the the phenomena of interest, like e.g. sleep spindles. For each structure, the corresponding weights of each channel define a topographic signature, which can be subject to an inverse solution procedure, like e.g. Loreta, used in this work. As an example, we present an automatic detection and parameterization of sleep spindles, appearing in overnight polysomnographic recordings. Inverse solutions obtained for single sleep spindles are coherent with the averages obtained for 20 overnight EEG recordings analyzed in this study, as well as with the results reported previously in literature as inter-subject averages of solutions for spectral integrals, computed on visually selected spindles. © 2005 Elsevier B.V. All rights reserved.

446. Ding, L., Y. Lai, and B. He, *Low resolution brain electromagnetic tomography in a realistic geometry head model: A simulation study*. Physics in Medicine and Biology, 2005. **50**(1): p. 45-56.

Summary: It is of importance to localize neural sources from scalp recorded EEG. Low resolution brain electromagnetic tomography (LORETA) has received considerable attention for localizing brain electrical sources. However, most such efforts have used spherical head models in representing the head volume conductor. Investigation of the performance of LORETA in a realistic geometry head model, as compared with the spherical model, will provide useful information guiding interpretation of data obtained by using the spherical head model. The performance of LORETA was evaluated by means of computer simulations. The boundary element method was used to solve the forward problem. A three-shell realistic geometry (RG) head model was constructed from MRI scans of a human subject. Dipole source configurations of a single dipole located at different regions of the brain with varying depth were used to assess the performance of LORETA in different regions of the brain. A three-sphere head model was also used to approximate the RG head model, and similar simulations performed, and results compared with the RG-LORETA with reference to the locations of the simulated sources. Multisource localizations were discussed and examples given in the RG head model. Localization errors employing the spherical LORETA, with reference to the source locations within the realistic geometry head, were about 20-30 mm, for four brain regions evaluated: frontal, parietal, temporal and occipital regions. Localization effors employing the RG head model were about 10 mm over the same four brain regions. The present simulation results suggest that the use of the RG head model reduces the localization error of LORETA, and that the RG head model based LORETA is desirable if high localization accuracy is needed. © 2005 IOP Publishing Ltd.

447. Ding, L. and B. He, *3-dimensional brain source imaging by means of Laplacian weighted minimum norm estimate in a realistic geometry head model*. Annual International Conference of the IEEE Engineering in Medicine and Biology - Proceedings, 2005. **7 VOLS**: p. 4480-4483.

Summary: We investigated the source localization performance of the Laplacian weighted minimum norm (LWMN) estimate technique in a realistic geometry (RG) head model in the present study. We simulated current sources at different brain regions with various noise levels. The present results show there is no obvious depth dependency on the three-dimensional (3D) source estimation. The average source localization error over all simulated cases is about 10 mm. The tangential sources exhibit larger localization errors than the radial sources when they are close to the epicortical surface. The localization error will increase when the noise level increases. The LWMN technique was applied to source imaging of motor potentials induced by finger movement in a human subject. Both activities in the motor and premotor cortex, which are related to the execution and coordinating of the finger movement, were reconstructed by the LWMN technique. The present study suggests that LWMN has great ability in 3D sources imaging. © 2005 IEEE.

448. Connemann, B.J., K. Mann, C. Lange-Asschenfeldt, M. Ruchsow, M. Schreckenberger, P. Bartenstein, and G. Gründer, *Anterior limbic alpha-like activity: A low resolution electromagnetic tomography study with lorazepam challenge*. Clinical Neurophysiology, 2005. **116**(4): p. 886-894.

Summary: Objective: To verify findings of an independently regulated anterior limbic alpha band source. Methods: In a randomised cross-over study, the spontaneous EEG was recorded in nine healthy subjects after i.v. lorazepam or placebo. Intracerebral current densities within classical frequency bands were estimated with low resolution electromagnetic tomography [LORETA] and compared between groups with t-statistical parametric mapping [SPM{t}]. A region-of-interest [ROI] based method was used to compare frontal and occipital alpha band activity changes. Results: Irrespective of treatment group, local maxima of alpha band power were localised both in the occipital lobe, Brodman area [BA] 18, and in the anterior cingulate cortex [ACC], BA 32. Statistical parametric mapping showed reduced parieto-occipital, but unaltered frontal alpha band power after lorazepam. This result was confirmed by ROI-based comparison of BA 18 and BA 32. Conclusions: There was an anterior limbic maximum of alpha band activity which, unlike occipital alpha, was not suppressed by lorazepam. Significance: The well-known anterior alpha band components may originate from a narrowly circumscribed source, located in the ACC. Frontal and occipital alpha band activities appear to be independently regulated. © 2004 International Federation of Clinical Neurophysiology. Published by Elsevier Ireland Ltd. All rights reserved.

449. Chauveau, N., J.P. Morucci, X. Franceries, P. Celsis, and B. Rigaud, *Resistor mesh model of a spherical head: Part 2: A review of applications to cortical mapping*. Medical and Biological Engineering and Computing, 2005. **43**(6): p. 703-711.

Summary: A resistor mesh model (RMM) has been validated with reference to the analytical model by consideration of a set of four dipoles close to the cortex. The application of the RMM to scalp potential interpolation was detailed in Part 1. Using the RMM and the same four dipoles, the different methods of cortical mapping were compared and have shown the potentiality of this RMM for obtaining current and potential cortical distributions. The lead-field matrices are well-adapted tools, but the use of a square matrix of high dimension does not permit the inverse solution to be improved in the presence of noise, as a regularisation technique is necessary with noisy data. With the RMM, the transfer matrix and the cortical imaging technique proved to be easy to implement. Further development of the RMM will include application to more realistic head models with more accurate conductivities. © IFMBE 2005.

450. Carretié, L., J.A. Hinojosa, F. Mercado, and M. Tapia, *Cortical response to subjectively unconscious danger*. NeuroImage, 2005. **24**(3): p. 615-623.

Summary: Cortical involvement in the evolution-favored automatic reaction to danger was studied. Electrical neural activity was recorded from 31 subjects, reporting fear of spiders, at 60 scalp locations. Visual stimuli containing spiders (negative elements) or, alternatively, nonnegative elements were presented to subjects, though they were unaware of their presence: a concurrent visual detection task using consciously perceived targets was administered. Spatial and temporal principal component analyses were employed to define and quantify, in a reliable manner, the main components of the neuroelectrical response to unconscious stimuli, and a source localization algorithm provided information on their neural origin. Results indicated that around 150 ms after stimulus onset, ventromedial prefrontal areas previously reported as responding rapidly to danger-related (conscious) stimuli were activated by unconsciously perceived spiders more markedly than by nonnegative unconscious stimuli. Subsequently, around 500 ms after stimulus onset, activation of the posterior cingulate and visual association cortices increased in this same direction. These data support previous results indicating that the ventromedial prefrontal cortex is involved in the top-down regulation of attention (through its capability to modulate the activity of posterior cortices in charge of visual processing) and that it automatically facilitates danger processing. © 2004 Elsevier Inc. All rights reserved.

451. Burton, D., P.S. Myles, I. Brown, M. Xu, and E. Zilberg, *Middle latency auditory evoked potential anaesthesia correlates of consciousness: Practicality & constraints*. Annual International Conference of the IEEE Engineering in Medicine and Biology - Proceedings, 2005. **7 VOLS**: p. 3676-3682.

Summary: The hypothesis of this study is that significant differentiation of consciousness (CO) and unconsciousness (UNCO) is possible, using individual ML+AEP (10-140 msec) latency measures, within the context of a practical routine clinical depth of anaesthesia monitoring device. We have assessed individual latency band measures of the middle-latency auditory evoked potential (ML+AEP) as candidates to measure depth of CO or UNCO amongst a group of anaesthetised surgical patients. We have also compared ML+AEP correlates with conventional auditory evoked potential (AEP) index and bispectral index (BIS). This study investigates amplitude measures, limits and the practicality of using a single EEG channel ML+AEP recording system. ML+AEP amplitude-related correlates were assessed against CO and UNCO events during anaesthesia. ML+AEP measures were computed for each of the following AEP component-related latency time bins (LTB): Na;15-25msec, Pa;25-35 msec, TP41;35-45 msec; Pb/P1;45-55 msec, N1;80-100 msec, <N1;0-80 msec, >N1;80-140 msec, and ML+AEP;0-140 msec. Twenty patients (aged 28-68 yrs) undergoing day surgery had their electroencephalography (EEG) monitored during binaural auditory stimulus presentation (6.8 clicks per second). The AEP grand mean waveform (AEP gmw) was computed for each consecutive stimulus AEP event, by way of

averaging the previous 256 AEPs. The mean and SD amplitude associated with each of the ML+AEP ranges were computed for the whole study period and also for the predetermined events 1 to 13 (CO:1;2;3;12;13 and UNCO:4-11). Results included BIS data, measures derived from the AEPgmw across both the ML+AEP range (0-140 msec), and also individual LTB segments. For each respective AEP LTB the mean and SD for AEP power distribution (AEPPD) and AEP Differential analysis (AEPDA) was computed. Two-sample t-tests were performed in order to test the hypothesis that AEPDA and AEP pA indices measured across ML+AEP LTB (during surgical procedure) present significant differences between CO and UNCO. Significant ($P<0.05$) values were derived for all computed AEP LTB correlates, and also for all AEPPD LTB except Pa, TP41 and N1. Overall the P-values resulting from the application of the AEPDA method were much lower than those of the AEPPD method. Conclusion: While the practical limitations and constraints of AEP-based anaesthesia monitoring cannot be overlooked, individual AEP component-related correlates and particularly those related to waveform deflection or AEP Differential analysis (AEPDA) were shown to be candidates for depth of consciousness measures. © 2005 IEEE.

452. Brunovský, M., J. Mlynář, and A. Stančák, *Imaging of electroencephalographic potentials using distributed source models in psychiatric research*. Zobrazování korové aktivace distribuční mi zdrojovými modely elektroencefalografických potenciálů v psychiatrickém výzkumu, 2005. **9**(SUPPL. 3): p. 51-55.

Summary: The article provides a review of methods of cortical mapping of brain electric activity. The first part of the article explains the neurophysiological background of functional localization using source dipole modelling of EEG potentials, and some methodological problems of source localization. Three steps in source localization (construction of head models, solving of the forward and inverse problem) are described. Finally, results obtained with low resolution electromagnetic tomography (LORETA) method in psychiatric research are reviewed.

453. Blinowska, K.J. and P.J. Durka, *Efficient application of internet databases for new signal processing methods*. Clinical EEG and Neuroscience, 2005. **36**(2): p. 123-130.

Summary: This paper highlights the ways in which Internet data-bases may be efficiently used to foster the application of progress in biomedical sciences via data sharing and new algorithms. Employing the Internet to accelerate the pace of interdisciplinary research has significant potential, yet as with all new technologies, the first applications often cause more disappointment than positive outcomes. We discuss examples of solutions to the basic issues: (1) finding the relevant datasets (in portals connected via the Inter-neuro infrastructure), (2) reading the particular format in which the data was stored (using the SignalML language for metadescription of time series), (3) choosing the right method for the data analysis (we provide a brief review of the methods used for the analysis of EEGs, and discuss two of them in detail: Directed Transfer Function and Matching Pursuit), and (4) sharing the software for chosen methods of analysis (via repositories such as the eeg.pl thematic portal).

454. Bénar, C.G., R.N. Gunn, C. Grova, B. Champagne, and J. Gotman, *Statistical maps for EEG dipolar source localization*. IEEE Transactions on Biomedical Engineering, 2005. **52**(3): p. 401-413.

Summary: We present a method that estimates three-dimensional statistical maps for electroencephalogram (EEG) source localization. The maps assess the likelihood that a point in the brain contains a dipolar source, under the hypothesis of one, two or three activated sources. This is achieved by examining all combinations of one to three dipoles on a coarse grid and attributing to each combination a score based on an F statistic. The probability density function of the statistic under the null hypothesis is estimated nonparametrically, using bootstrap resampling. A theoretical F distribution is then fitted to the empirical distribution in order to allow correction for multiple comparisons. The maps allow for the systematic exploration of the solution space for dipolar sources. They permit to test whether the data support a given solution. They do not rely on the assumption of uncorrelated source time courses. They can be compared to other statistical parametric maps such as those used in functional magnetic resonance imaging (fMRI). Results are presented for both simulated and real data. The maps were compared with LORETA and MUSIC results. For the real data consisting of an average of epileptic spikes, we observed good agreement between the EEG statistical maps, intracranial EEG recordings, and fMRI activations. © 2005 IEEE.

455. Bellebaum, C., K.P. Hoffmann, and I. Daum, *Post-saccadic updating of visual space in the posterior parietal cortex in humans*. Behavioural Brain Research, 2005. **163**(2): p. 194-203.

Summary: Updating of visual space takes place in the posterior parietal cortex to guarantee spatial constancy across eye movements. However, the timing of updating with respect to saccadic eye movements remains a matter of debate. In the present study, event-related potentials (ERPs) were recorded in 15 volunteers during a saccadic double-step task to elucidate the time course of the updating process. In the experimental condition updating of visual space was required, because both saccade targets had already disappeared before the first saccade was executed. A similar task without updating requirements served as control condition. ERP analysis revealed a significantly larger slow positive wave in the retino-spatial dissonance condition compared to the control condition, starting between 150 and 200 ms after first saccade onset. Source analysis showed an asymmetry with respect to the direction of the first saccade. Whereas the source was restricted to the right PPC in trials with leftward first saccades, left and right PPC were involved in rightward trials. The results of the present study suggest that updating of visual space in a saccadic double-step task occurs not earlier than 150 ms after the onset of the first saccade. We conclude that extraretinal information about the first saccade is integrated with motor information about the second saccade in the inter-saccade interval. © 2005 Elsevier B.V. All rights reserved.

456. Barr, M.S., J.P. Hamm, I.J. Kirk, and M.C. Corballis, *Early visual evoked potentials in callosal agenesis*. Neuropsychology, 2005. **19**(6): p. 707-727.

Summary: Three participants with callosal agenesis and 12 neurologically normal participants were tested on a simple reaction time task, with visual evoked potentials collected using a high-density 128-channel system. Independent-components analyses were performed on the averaged visual evoked potentials to isolate the components of interest. Contrary to previous research with acallosals, evidence of ipsilateral activation was present in all 3 participants. Although ipsilateral visual components were present in all 4 unilateral conditions in the 2 related acallosal participants, in the 3rd, these were present only in the crossed visual field-hand conditions and not in the uncrossed conditions. Suggestions are made as to why these results differ from earlier findings and as to the neural mechanisms facilitating this ipsilateral activation. Copyright 2005 by the American Psychological Association.

457. Bai, X. and B. He, *On the estimation of the number of dipole sources in EEG source localization*. Clinical Neurophysiology, 2005. **116**(9): p. 2037-2043.

Summary: Objective: The purpose of the present study was to determine the number of the equivalent dipole sources corresponding to the scalp EEG using the information criterion method based on the instantaneous-state modeling. Methods: A three-concentric-spheres head model was used to represent the head volume conductor. The Powell algorithm was used to solve the inverse problem of estimating the equivalent dipoles from the scalp EEG. The information criterion with different penalty functions was used to determine the dipole number. Computer simulations were conducted to evaluate effects of various parameters on the estimation of dipole number. Results: The present results suggest that the present method is able to estimate the number of equivalent current dipoles (ECDs) from instantaneous scalp EEG measurements, and that increase in the electrode number can improve the accuracy of estimation of the ECD number. For two ECDs, the best performance of estimation with 20% white noise were 85%, 92% and 94%, when 64, 128 and 256 electrodes are used, respectively. When there are 3 ECDs, the present results suggest that using 256 electrodes gave up to 82% estimation accuracy. The present simulation results also indicate that the accuracies of identification are similar when the minimum distance between dipoles is either 1 or 2 cm, which was used in the simulation. It was also found that the different penalty functions used in the information criterion method could have substantial influence on the estimation accuracy. Conclusions: The present method can estimate the number of ECDs from instantaneous scalp EEG distribution for up to three dipoles. Significance: The successful estimation of the number of ECDs will play an important role in expanding the applicability of dipole source localization to multiple sources. ©

2005 International Federation of Clinical Neurophysiology. Published by Elsevier Ireland Ltd. All rights reserved.

458. Arrouët, C., M. Congedo, J.E. Marvie, F. Lamarche, A. Lécuyer, and B. Arnaldi, *Open-ViBE: A three dimensional platform for real-time neuroscience*. Journal of Neurotherapy, 2005. **9**(1): p. 3-25.

Summary: Background. When the physiological activity of the brain (e.g., electroencephalogram, functional magnetic resonance imaging, etc.) is monitored in real-time, feedback can be returned to the subject and he/she can try to exercise some control over it. This idea is at the base of research on neurofeedback and brain-computer interfaces. Current advances in the speed of microprocessors, graphics cards and digital signal processing algorithms allow significant improvements in these methods. More meaningful features from the continuous flow of brain activation can be extracted and feedback can be more informative. Methods. Borrowing technology so far employed only in virtual reality, we have created Open-ViBE (Open Platform for Virtual Brain Environments). Open-ViBE is a general purpose platform for the development of three dimensional real-time virtual representations of brain physiological and anatomical data. Open-ViBE is a flexible and modular platform that integrates modules for brain physiological data acquisition, processing, and volumetric rendering. Results. When input data is the electroencephalogram, Open-ViBE uses the estimation of intra-cranial current density to represent brain activation as a regular grid of three dimensional graphical objects. The color and size of these objects co-vary with the amplitude and/or direction of the electrical current. This representation can be superimposed onto a volumetric rendering of the subject's MRI data to form the anatomical background of the scene. The user can navigate in this virtual brain and visualize it as a whole or only some of its parts. This allows the user to experience the sense of presence (being there) in the scene and to observe the dynamics of brain current activity in its original spatio-temporal relations. Conclusions. The platform is based on publicly available frameworks such as OpenMASK and OpenSG and is open source itself. In this way we aim to enhance the cooperation of researchers and to promote the use of the platform on a large scale. © 2005 by The Haworth Press, Inc. All rights reserved.

459. Alecu, T.I., P. Missonnier, S. Voloshynovskiy, P. Giannakopoulos, and T. Pun, *Soft/hard focalization in the EEG inverse problem*. IEEE Workshop on Statistical Signal Processing Proceedings, 2005. **2005**: p. 978-983.

Summary: We present in this paper a novel statistical based focalized reconstruction method for the underdetermined EEG (electro-encephalogram) inverse problem. The algorithm is based on the representation of non-Gaussian distributions as an Infinite Mixture of Gaussians (IMG) and relies on an iterative procedure consisting out of alternated variance estimation/ linear inversion operations. By taking into account noise statistics, it performs implicit spurious data rejection and produces robust focalized solutions allowing for straightforward discrimination of active/non-active brain regions. We apply the proposed reconstruction procedure to average evoked potentials EEG data and compare the reconstruction results with the corresponding known physiological responses. ©2005 IEEE.

460. Zou, J., Y.Q. Xie, J.S. Yuan, X.S. Ma, X. Cui, and S.M. Chen, *Source region contracting method for EEG source reconstructions*. IEEE Transactions on Magnetics, 2004. **40**(2 II): p. 1128-1131.

Summary: A new electroencephalogram (EEG) source reconstruction method is presented. The method reduces the number of unknown quantities of the basic EEG equation by contracting the source region iteratively. The simultaneous equation system turns from an underdetermined system to an overdetermined system step by step. At last the least square algorithm is used to get a unique solution. The simulation shows that a high-resolution result can be obtained by using the method proposed.

461. Zhang, Y.C., S.A. Zhu, and B. He, *A second-order finite element algorithm for solving the three-dimensional EEG forward problem*. Physics in Medicine and Biology, 2004. **49**(13): p. 2975-2987.

Summary: A finite element algorithm has been developed to solve the electroencephalogram (EEG) forward problem. A new computationally efficient approach to calculate the stiffness matrix of second-order tetrahedral elements has been developed for second-order tetrahedral finite element models. The present algorithm has been evaluated by means of computer simulations, by comparing with analytic solutions in a multi-spheres concentric head model. The developed finite element method (FEM) algorithm has also been applied to address questions of interest in the EEG forward problem. The present simulation study indicates that the second-order FEM provides substantially enhanced numerical accuracy and computational efficiency, as compared with the first-order FEM for comparable numbers of tetrahedral elements. The anisotropic conductivity distribution of the head tissue can be taken into account in the present FEM algorithm. The effects of dipole eccentricity, size of finite elements and local mesh refinement on solution accuracy are also addressed in the present simulation study. © 2004 IOP Publishing Ltd.

462. Zanow, F. and T.R. Knösche, *ASA - Advanced Source Analysis of continuous and event-related EEG/MEG signals*. Brain Topography, 2004. **16**(4): p. 287-290.

Summary: Sophisticated analysis methods for EEG and MEG play a key role in the better understanding of brain functions as measured by high-density EEG and MEG. Being commercially available since 1996, the ASA software (ANT Software BV, Enschede, Netherlands) has been gaining growing popularity among clinical and cognitive researchers. With the following article, we present an overview on the currently available functionality of the software and provide examples of its application.

463. Youn, T., H.J. Park, and J.S. Kwon, *Response to Rosburg: A Voxel-Based Statistical Parametric Mapping of MMN Current Densities*. Human Brain Mapping, 2004. **21**(1): p. 46-48.

Summary:

464. Yamashita, O., A. Galka, T. Ozaki, R. Biscay, and P. Valdes-Sosa, *Recursive Penalized Least Squares Solution for Dynamical Inverse Problems of EEG Generation*. Human Brain Mapping, 2004. **21**(4): p. 221-235.

Summary: In the dynamical inverse problem of electroencephalogram (EEG) generation where a specific dynamics for the electrical current distribution is assumed, we can impose general spatiotemporal constraints onto the solution by casting the problem into a state space representation and assuming a specific class of parametric models for the dynamics. The Akaike Bayesian Information Criterion (ABIC), which is based on the Type II likelihood, was used to estimate the parameters and evaluate the model. In addition, dynamic low-resolution brain electromagnetic tomography (LORETA), a new approach for estimating the current distribution is introduced. A recursive penalized least squares (RPLS) step forms the main element of our implementation. To obtain improved inverse solutions, dynamic LORETA exploits both spatial and temporal information, whereas LORETA uses only spatial information. A considerable improvement in performance compared to LORETA was found when dynamic LORETA was applied to simulated EEG data, and the new method was applied also to clinical EEG data. © 2004 Wiley-Liss, Inc.

465. Xu, X.L., B. Xu, and B. He, *An alternative substance approach to EEG dipole source localization*. Physics in Medicine and Biology, 2004. **49**(2): p. 327-343.

Summary: In the present study, we investigate a new approach to electroencephalography (EEG) three-dimensional (3D) dipole source localization by using a non-recursive subspace algorithm called FINES. In estimating source dipole locations, the present approach employs projections onto a subspace spanned by a small set of particular vectors (FINES vector set) in the estimated noise-only subspace instead of the entire estimated noise-only subspace in the case of classic MUSIC. The subspace spanned by this vector set is, in the sense of principal angle, closest to the subspace spanned by the array manifold associated with a particular brain region. By incorporating knowledge of the array manifold in identifying FINES vector sets in the estimated noise-only subspace for different brain regions, the present approach is able to estimate sources with enhanced accuracy and spatial resolution, thus enhancing the capability of resolving closely spaced sources and reducing estimation errors. The present computer simulations show, in EEG 3D dipole source localization, that compared to classic MUSIC, FINES has (1) better resolvability of two closely spaced dipolar sources and (2) better estimation accuracy of source locations. In comparison with RAP-MUSIC, FINES' performance is also better for the cases studied when the noise level is high and/or correlations among dipole sources exist.

466. Whittingstall, K., G. Stroink, and B. Dick, *Dipole localization accuracy using grand-average EEG data sets*. Clinical Neurophysiology, 2004. **115**(9): p. 2108-2112.

Summary: Objective: Dipole localization of grand-average event related potentials only give a tentative description of the estimated underlying neural sources. This study evaluates the differences in dipole solutions between individual and group-average data sets using a standard realistic head model. Methods: Auditory evoked potentials were recorded from 14 right-handed healthy subjects using a 64 electrode montage. Inverse dipole solutions were obtained for each individual data set, as well as for all individual responses averaged together (grand-average). Differences in dipole solutions between individual and grand-average responses are reported. Simulations using a two dipole model with 15 different electrode sets are then used to investigate the effects of electrode misplacement and random noise on dipole localization. These effects are compared to those due to grand-averaging. Results: The average differences in dipole locations between the individual and grand-averaged data sets were approximately 1.1 cm (SD=0.7 cm). This difference is larger than typical localization errors due to electrode misplacement and typical noise. Conclusions: Using a standard realistic head model, it is concluded that dipole solutions based on group-averaged EEG datasets are significantly different than those obtained using subject-specific data. © 2004 International Federation of Clinical Neurophysiology. Published by Elsevier Ireland Ltd. All rights reserved.

467. Wagner, M., M. Fuchs, and J. Kastner, *Evaluation of sLORETA in the presence of noise and multiple sources*. Brain Topography, 2004. **16**(4): p. 277-280.

Summary: The standardized Low Resolution Brain Electromagnetic Tomography method (sLORETA) can be used to compute statistical maps from EEG and MEG data that indicate the locations of the underlying source processes with low error. These maps are derived by performing a location-wise inverse weighting of the results of a Minimum Norm Least Squares (MNLS) analysis with their estimated variances. In this contribution, we evaluate the performance of the method under the presence of noise and with multiple, simultaneously active sources. It is shown that the sLORETA method localizes well, as compared to other linear approaches such as MNLS and LORETA. However, simultaneously active sources can only be separated if their fields are distinct enough and of similar strength. In the context of a strong or superficial source, weak or deep sources remain invisible, and nearby sources of similar orientation tend not to be separated but interpreted as one source located roughly in between.

468. Trujillo-Barreto, N.J., E. Aubert-Vázquez, and P.A. Valdés-Sosa, *Bayesian model averaging in EEG/MEG imaging*. NeuroImage, 2004. **21**(4): p. 1300-1319.

Summary: In this paper, the Bayesian Theory is used to formulate the Inverse Problem (IP) of the EEG/MEG. This formulation offers a comparison framework for the wide range of inverse methods available and allows us to address the problem of model uncertainty that arises when dealing with different solutions for a single data. In this case, each model is defined by the set of assumptions of the inverse method used, as well as by the functional dependence between the data and the Primary Current Density (PCD) inside the brain. The key point is that the Bayesian Theory not only provides for posterior estimates of the parameters of interest (the PCD) for a given model, but also gives the possibility of finding posterior expected utilities unconditional on the models assumed. In the present work, this is achieved by considering a third level of inference that has been systematically omitted by previous Bayesian formulations of the IP. This level is known as Bayesian model averaging (BMA). The new approach is illustrated in the case of considering different anatomical constraints for solving the IP of the EEG in the frequency domain. This methodology allows us to address two of the main problems that affect linear inverse solutions (LIS): (a) the existence of ghost sources and (b) the tendency to underestimate deep activity. Both simulated and real experimental data are used to demonstrate the capabilities of the BMA approach, and some of the results are compared with the solutions obtained using the popular low-resolution electromagnetic tomography (LORETA) and its anatomically constraint version (cLORETA). © 2004 Elsevier Inc. All rights reserved.

469. Tan, G. and L. Zhang, *EEG source localization using independent residual analysis*. Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics), 2004. **3174**: p. 442-447.

Summary: Determining the location of cortical activity from electroencephalographic (EEG) data is important theoretically and clinically. Estimating the location of electric current source from EEG recordings is not well-posed mathematically because different internal source configurations can produce an identical external electromagnetic field. In this paper we propose a new method for EEG source localization using Independent Residual Analysis (IRA). First, we apply Independent Residual Analysis on EEG data to divide the raw signals into the independent components. Then for each component, we employ the least square method to locate the dipole. By localizing multiple dipoles independently, we greatly reduce our search complexity and improve the localization accuracy. Computer simulation is also presented to show the effectiveness of the proposed method. Keywords: EEG, IRA, source localization, least square method © Springer-Verlag 2004.

470. Simon, G., C. Bernard, P. Largy, R. Lalonde, and M. Rebai, *Chronometry of visual word recognition during passive and lexical decision tasks: An ERP investigation*. International Journal of Neuroscience, 2004. **114**(11): p. 1401-1432.

Summary: In order to investigate the neuroanatomical chronometry of word processing, two experiments using: Event-Related Potentials (ERPs) have been performed. The first one was designed to test the effects of orthographic, phonologic, and lexical properties of linguistic items on the pre-semantic components of ERPs during a passive reading task and massive repetition used to reduce familiarity effect between words and nonwords. In a second study, the level of familiarity was investigated by varying stimulus repetition and frequency in a lexical decision task. Overall results suggest a functional discrimination between orthographic and nonorthographic stimuli begun as early as 170 ms (N170 component) whereas the next components (N230 and N320) were sensitive to the orthographic nature of the stimuli, but also to their lexical/phonologic proprieties. The N320 associated to phonological processing (Bentin et al, 1999) was modulated by word frequency and massive repetition caused its disappearance. This suggests that this component may reflect a nonobligatoty phonologic stage of grapheme-phoneme conversion postulated by the DRC model (Coltheart et al., 2001) or semantic phonologically mediated pathway (Harm & Seidenberg, in press).

471. Silva, C., J.C. Maltez, E. Trindade, A. Arriaga, and E. Ducla-Soares, *Evaluation of L1 and L2 minimum norm performances on EEG localizations*. Clinical Neurophysiology, 2004. **115**(7): p. 1657-1668.

Summary: Objective In this work we study the performance of minimum norm methods to estimate the localization of brain electrical activity. These methods are based on the simplest forms of L1 and L2 norm estimates and are applied to simulated EEG data. The influence of several factors like the number of electrodes, grid density, head model, the number and depth of the sources and noise levels was taken into account. The main objective of the study is to give information about the dependence, on these factors, of the localization sources, to allow for proper interpretation of the data obtained in real EEG records. Methods For the tests we used simulated dipoles and compared the localizations predicted by the L1 and L2 norms with the location of these point-like sources. We varied each parameter separately and evaluated the results. Results From this work we conclude that, the grid should be constructed with approximately 650 points, so that the information about the orientation of the sources is preserved, especially for L2 norm estimates; in favorable noise conditions, both L1 and L2 norm approaches are able to distinguish between more than one point-like sources. Conclusions The critical dependence of the results on the noise level and source depth indicates that regularized and weighted solutions should be used. Finally, all these results are valid both for spherical and for realistic head models. © 2004 International Federation of Clinical Neurophysiology. Published by Elsevier Ireland Ltd. All rights reserved.

472. Shigemura, J., A. Yoshino, Y. Kobayashi, Y. Takahashi, and S. Nomura, *Spatiotemporal differences between cognitive processes of spatially possible and impossible objects: A high-density electrical mapping study*. Cognitive Brain Research, 2004. **18**(3): p. 301-305.

Summary: Differences in cognitive processing between spatially possible and impossible figures were investigated using event-related potentials (ERPs). Two types of figures with identical luminance and equivalent spatial frequency were used as visual stimuli: possible three-dimensional figures (drawn with perspective and existing in the three-dimensional world) and impossible figures (drawn with perspective but not existing in the three-dimensional world). High-density electroencephalographic recording (72 channels) was performed for analysis of ERPs accompanying perception of each figure type; amplitude differences between the conditions were considered neurophysiologic correlates to perceptual differences between possible and impossible objects. Low-resolution brain electromagnetic tomography (LORETA) was used to identify the current source related to the differences. Compared with impossible three-dimensional figures, perception of possible figures showed a significant negative potential increase in the right inferior occipitotemporal region between 350 and 389 ms of latency. The current source was localized to the right fusiform gyrus. The results suggest that right fusiform gyrus is involved in discrimination between spatially possible and impossible objects. © 2003 Elsevier B.V. All rights reserved.

473. Schneider, S., G. Joppich, A.V.D. Lugt, J. Däuper, and T.F. Münte, *Brain potentials and self-paced random number generation in humans*. Neuroscience Letters, 2004. **367**(1): p. 51-55.

Summary: Random number generation (RNG) requires executive control. A novel paradigm using the eight drum pads of an electronic drum set as an input device was used to test 15 healthy subjects who engaged in random or ordered number generation (ONG). Brain potentials time-locked to the drum-beats revealed a more negative response during RNG compared to ONG which had a left frontal distribution. Source analysis pointed to Brodmann area 9, which has been reported previously in a PET study and is thought to be engaged in suppression of habitual responses such as counting up in steps of one during RNG. Lateralized readiness potentials reflecting the difference in activation of the contra and ipsilateral motor cortex were smaller during ONG reflecting the ability to preprogram such canonical sequences. © 2004 Elsevier Ireland Ltd. All rights reserved.

474. Sato, M.A., T. Yoshioka, S. Kajihara, K. Toyama, N. Goda, K. Doya, and M. Kawato, *Hierarchical Bayesian estimation for MEG inverse problem*. NeuroImage, 2004. **23**(3): p. 806-826.

Summary: Source current estimation from MEG measurement is an ill-posed problem that requires prior assumptions about brain activity and an efficient estimation algorithm. In this article, we propose a new hierarchical Bayesian method introducing a hierarchical prior that can effectively incorporate both structural and functional MRI data. In our method, the variance of the source current at each source location is considered an unknown parameter and estimated from the observed MEG data and prior information by using the Variational Bayesian method. The fMRI information can be imposed as prior information on the variance distribution rather than the variance itself so that it gives a soft constraint on the variance. A spatial smoothness constraint, that the neural activity within a few millimeter radius tends to be similar due to the neural connections, can also be implemented as a hierarchical prior. The proposed method provides a unified theory to deal with the following three situations: (1) MEG with no other data, (2) MEG with structural MRI data on cortical surfaces, and (3) MEG with both structural MRI and fMRI data. We investigated the performance of our method and conventional linear inverse methods under these three conditions. Simulation results indicate that our method has better accuracy and spatial resolution than the conventional linear inverse methods under all three conditions. It is also shown that accuracy of our method improves as MRI and fMRI information becomes available. Simulation results demonstrate that our method appropriately resolves the inverse problem even if fMRI data convey inaccurate information, while the Wiener filter method is seriously deteriorated by inaccurate fMRI information. © 2004 Elsevier Inc. All rights reserved.

475. Saletu, M., P. Anderer, G.M. Saletu-Zyhlarz, M. Mandl, O. Arnold, J. Zeitlhofer, and B. Saletu, *EEG-tomographic studies with LORETA on vigilance differences between narcolepsy patients and controls and subsequent double-blind, placebo-controlled studies with modafinil*. Journal of Neurology, 2004. **251**(11): p. 1354-1363.

Summary: The aim of the present study was to identify brain regions associated with vigilance in untreated and modafinil-treated narcoleptic patients by means of low-resolution brain electromagnetic tomography (LORETA). 16 drug-free narcoleptics and 16 normal controls were included in the baseline investigation. Subsequently patients participated in a double-blind, placebo-controlled crossover study receiving a three-week fixed titration of modafinil (200, 300, 400 mg) and placebo. Measurements comprised LORETA, the Multiple Sleep Latency Test (MSLT) and the Epworth Sleepiness Scale (ESS) obtained before and after three weeks' therapy. Statistical overall analysis by means of the omnibus significance test demonstrated significant inter-group differences in the resting (R-EEG), but not in the vigilance-controlled recordings (V-EEG). Subsequent univariate analysis revealed a decrease in alpha-2 and beta 1-3 power in prefrontal, temporal and parietal cortices, with the right hemisphere slightly more involved in this vigilance decrement. Modafinil 400 mg/d as compared with placebo induced changes opposite to the aforementioned baseline differences (key-lock principle) with a preponderance in the left hemisphere. This increase in vigilance resulted in an improvement in the MSLT and the ESS. LORETA provided evidence of a functional deterioration of the fronto-temporo-parietal network of the right-hemispheric vigilance system in narcolepsy and a

therapeutic effect of modafinil on the left hemisphere, which is less affected by the disease.

476. Sabbagh, M.A., M.C. Moulson, and K.L. Harkness, *Neural correlates of mental state decoding in human adults: An event-related potential study*. Journal of Cognitive Neuroscience, 2004. **16**(3): p. 415-426.

Summary: Successful negotiation of human social interactions rests on having a theory of mind - an understanding of how others' behaviors can be understood in terms of internal mental states, such as beliefs, desires, intentions, and emotions. A core theory-of-mind skill is the ability to decode others' mental states on the basis of observable information, such as facial expressions. Although several recent studies have focused on the neural correlates of reasoning about mental states, no research has addressed the question of what neural systems underlie mental state decoding. We used dense-array event-related potentials (ERP) to show that decoding mental states from pictures of eyes is associated with an N270-400 component over inferior frontal and anterior temporal regions of the right hemisphere. Source estimation procedures suggest that orbitofrontal and medial temporal regions may underlie this ERP effect. These findings suggest that different components of everyday theory-of-mind skills may rely on dissociable neural mechanisms.

477. Riba, J., P. Anderer, F. Jané, B. Saletu, and M.J. Barbanoj, *Effects of the South American psychoactive beverage Ayahuasca on regional brain electrical activity in humans: A functional neuroimaging study using low-resolution electromagnetic tomography*. Neuropsychobiology, 2004. **50**(1): p. 89-101.

Summary: Ayahuasca, a South American psychotropic plant tea obtained from Banisteriopsis caapi and Psychotria viridis, combines monoamine oxidase-inhibiting β-carboline alkaloids with N,N-dimethyltryptamine (DMT), a psychedelic agent showing 5-HT2A agonist activity. In a clinical research setting, ayahuasca has demonstrated a combined stimulatory and psychedelic effect profile, as measured by subjective effect self-assessment instruments and dose-dependent changes in spontaneous brain electrical activity, which parallel the time course of subjective effects. In the present study, the spatial distribution of ayahuasca-induced changes in brain electrical activity was investigated by means of low-resolution electromagnetic tomography (LORETA). Electroencephalography recordings were obtained from 18 volunteers after the administration of a dose of encapsulated freeze-dried ayahuasca containing 0.85 mg DMT/kg body weight and placebo. The intracerebral power density distribution was computed with LORETA from spectrally analyzed data, and subjective effects were measured by means of the Hallucinogen Rating Scale (HRS). Statistically significant differences compared to placebo were observed for LORETA power 60 and 90 min after dosing, together with increases in all six scales of the HRS. Ayahuasca decreased power density in the alpha-2, delta, theta and beta-1 frequency bands. Power decreases in the delta, alpha-2 and beta-1 bands were found predominantly over the temporo-parieto-occipital junction, whereas theta power was reduced in the temporomedial cortex and in frontomedial regions. The present results suggest the involvement of unimodal and heteromodal association cortex and limbic structures in the psychological effects elicited by ayahuasca. Copyright © 2004 S. Karger AG, Basel.

478. Pourtois, G., D. Grandjean, D. Sander, and P. Vuilleumier, *Electrophysiological correlates of rapid spatial orienting towards fearful faces.* Cerebral Cortex, 2004. **14**(6): p. 619-633.

Summary: We investigated the spatio-temporal dynamic of attentional bias towards fearful faces. Twelve participants performed a covert spatial orienting task while recording visual event-related brain potentials (VEPs). Each trial consisted of a pair of faces (one emotional and one neutral) briefly presented in the upper visual field, followed by a unilateral bar presented at the location of one of the faces. Participants had to judge the orientation of the bar. Comparing VEPs to bars shown at the location of an emotional (valid) versus neutral (invalid) face revealed an early effect of spatial validity: the lateral occipital P1 component (~ 130 ms post-stimulus) was selectively increased when a bar replaced a fearful face compared to when the same bar replaced a neutral face. This effect was not found with upright happy faces or inverted fearful faces. A similar amplification of P1 has previously been observed in electrophysiological studies of spatial attention using non-emotional cues. In a behavioural control experiment, participants were also better at discriminating the orientation of the bar when it replaced a fearful rather than a neutral face. In addition, VEPs time-locked to the face-pair onset revealed a C1 component (~90 ms) that was greater for fearful than happy faces. Source localization (LORETA) confirmed an extrastriate origin of the P1 response showing a spatial validity effect, and a striate origin of the C1 response showing an emotional valence effect. These data suggest that activity in primary visual cortex might be enhanced by fear cues as early as 90 ms post-stimulus, and that such effects might result in a subsequent facilitation of sensory processing for a stimulus appearing at the same location. These results provide evidence for neural mechanisms allowing rapid, exogenous spatial orienting of attention towards fear stimuli.

479. Pizzagalli, D.A., T.R. Oakes, A.S. Fox, M.K. Chung, C.L. Larson, H.C. Abercrombie, S.M. Schaefer, R.M. Benca, and R.J. Davidson, *Functional but not structural subgenual prefrontal cortex abnormalities in melancholia.* Molecular Psychiatry, 2004. **9**(4): p. 393-405.

Summary: Major depression is a heterogeneous condition, and the search for neural correlates specific to clinically defined subtypes has been inconclusive. Theoretical considerations implicate frontostriatal, particularly subgenual prefrontal cortex (PFC), dysfunction in the pathophysiology of melancholia - a subtype of depression characterized by anhedonia - but no empirical evidence has been found yet for such a link. To test the hypothesis that melancholic, but not nonmelancholic depression, is associated with the subgenual PFC impairment, concurrent measurement of brain electrical (electroencephalogram, EEG) and

metabolic (positron emission tomography, PET) activity were obtained in 38 unmedicated subjects with DSM-IV major depressive disorder (20 melancholic, 18 nonmelancholic subjects), and 18 comparison subjects. EEG data were analyzed with a tomographic source localization method that computed the cortical three-dimensional distribution of current density for standard frequency bands, allowing voxelwise correlations between the EEG and PET data. Voxel-based morphometry analyses of structural magnetic resonance imaging (MRI) data were performed to assess potential structural abnormalities in melancholia. Melancholia was associated with reduced activity in the subgenual PFC (Brodmann area 25), manifested by increased inhibitory delta activity (1.5-6.0 Hz) and decreased glucose metabolism, which themselves were inversely correlated. Following antidepressant treatment, depressed subjects with the largest reductions in depression severity showed the lowest post-treatment subgenual PFC delta activity. Analyses of structural MRI revealed no group differences in the subgenual PFC, but in melancholic subjects, a negative correlation between gray matter density and age emerged. Based on preclinical evidence, we suggest that subgenual PFC dysfunction in melancholia may be associated with blunted hedonic response and exaggerated stress responsiveness.

480. Pazo-Álvarez, P., E. Amenedo, L. Lorenzo-López, and F. Cadaveira, *Effects of stimulus location on automatic detection of changes in motion direction in the human brain*. Neuroscience Letters, 2004. **371**(2-3): p. 111-116.

Summary: We extended the results of a previous report by further exploring the underlying mechanisms of an electrophysiological index of attention-free memory-based detection mechanism to motion-direction changes in the human visual system. By means of presenting bilateral, right- and left-hemifield stimulation in separate conditions, we tried to assess whether the location of the stimuli within the peripheral visual field affected the processing of motion-direction deviations, and to identify brain regions involved in the detection of unattended infrequent changes of motion direction using low-resolution brain electromagnetic tomography (LORETA). Results indicated that the ERP component related to visual change was not affected by stimulus location, and that bilateral temporal and medial regions were activated during this deviance-related response regardless of the hemifield stimulated. The bilateral activation foci observed in this study suggest that brain generators of this deviance-related component could be located at the vicinity of motion processing areas. © 2004 Elsevier Ireland Ltd. All rights reserved.

481. Parra, J., S.N. Kalitzin, and F.H. Lopes da Silva, *Magnetoencephalography: An investigational tool or a routine clinical technique?* Epilepsy and Behavior, 2004. **5**(3): p. 277-285.

Summary: Magnetoencephalography (MEG) is a relatively novel noninvasive technique, with a much shorter history than EEG, that conveys neurophysiological information complementary to that provided by EEG, with high temporal and spatial resolution. Despite its a priori, highly competitive profile, the role of MEG in the clinical setting is still controversial. We briefly review the major obstacles MEG faces in becoming a routine clinical test and the different strategies needed to bypass them. The high cost and complexity associated with MEG equipment are powerful hindrances to wide acceptance of this relatively new technique in clinical practice. The most straightforward advantage is based on the relative facility of MEG recordings in the process of source localization, which also carries some degree of uncertainty, thus partly explaining why the development of clinical applications of MEG has been so slow. Obviously, a decrease in the cost and the elaboration of semiautomatic protocols that could reduce the complexity of the studies and favor the development of consensual strategies, as well as a major effort on the part of clinicians to identify clinical issues where MEG could be decisive, would be most welcome. © 2004 Elsevier Inc. All rights reserved.

482. Parmeggiani, L., S. Seri, P. Bonanni, and R. Guerrini, *Electrophysiological characterization of spontaneous and carbamazepine-induced epileptic negative myoclonus in benign childhood epilepsy with centro-temporal spikes*. Clinical Neurophysiology, 2004. **115**(1): p. 50-58.

Summary: Objective: Epileptic negative myoclonus (ENM), a transient muscular atonic phenomenon time-locked to epileptiform EEG abnormalities, is often observed in children with benign childhood epilepsy with centro-temporal spikes (BECTS). In some, for unknown reasons, ENM can be worsened by carbamazepine (CBZ). We describe two children aged 11 and 15 years, in whom CBZ precipitated seizure worsening and ENM. We investigated the morphological and topographic features of the EEG abnormalities while on CBZ and after CBZ withdrawal and compared them with those from 9 children with classical BECTS. The aim of the study was to identify possible electrophysiological specificities in patients who eventually develop ENM during CBZ treatment. Methods: The characterization of EEG abnormalities, related (R) and unrelated to ENM (U), in patients with ENM and rolandic discharges (RD) and in matched controls with BECTS was performed based on polygraphic digital EEG recordings. Off-line time-domain analysis included correlation coefficient between EEG and EMG channels, quantitative analysis on ENM, and topographic analysis on spike-and-wave complexes. Z-score test and paired t test were used when appropriate for statistical analysis on R, U and RD. Results: Recordings in both children with BECTS and ENM while on CBZ showed frequent R discharges (mean interval between $R=19.89\pm9.4$ s in patient 1; 2.16 ± 1.2 s in patient 2). Withdrawal of CBZ produced abatement of R (no R recorded in patient 1; 5.69 ± 7.1 s in patient 2) and reduction of the slow wave component of R ($P<0.01$). Morphology and topography of R and RD differed in field distribution, amplitude ($P<0.01$) and duration ($P<0.01$) of the slow wave component. RD and U did not show a significantly different morphology and field distribution. Conclusions: Our findings suggest that an increased cortical inhibition could be the electrophysiological correlate of CBZ-induced ENM. If confirmed on a larger series, the presence of spike-wave (rather than sharp waves) discharges in children with BECTS might be used as an electrophysiological predictor of an abnormal response to CBZ. © 2004 International Federation of Clinical Neurophysiology. Published by Elsevier Ireland Ltd. All rights reserved.

483. Ofek, E. and H. Pratt, *Ear advantage and attention: An ERP study of auditory cued attention*. Hearing Research, 2004. **189**(1-2): p. 107-118.

Summary: The neurophysiological manifestations of left ear advantage to tonal stimuli and its interaction with attention have rarely been studied. Cued attention is a behavioral paradigm to assess the behavioral benefits and costs of allocating attention. In this task a cue predicts the location of a subsequent target to which the subject responds. In most cases the cue correctly predicts the target (valid cues) but at times it does not (invalid cues). Cued attention is a spatial paradigm with stimuli presented to either side. The objectives of this study were: (1) to find the neurophysiological correlates of the ear advantage phenomenon and (2) to assess the interaction of the stimulated side (right vs. left ear advantage) with attention, in a cued attention task. Significant effects on event-related potentials (ERPs) in the cued attention task indicated left ear and right hemisphere advantage. Effects were mostly confined to the right hemisphere. The results indicate interactions among left ear advantage, attention and dominant hand utilization. Ear advantage and attention may involve the same neural mechanisms. In spite of the left ear advantage effect on ERP components, hand dominance determines the final behavioral results (reaction times). © 2003 Elsevier B.V. All rights reserved.

484. Oakes, T.R., D.A. Pizzagalli, A.M. Hendrick, K.A. Horras, C.L. Larson, H.C. Abercrombie, S.M. Schaefer, J.V. Koger, and R.J. Davidson, *Functional Coupling of Simultaneous Electrical and Metabolic Activity in the Human Brain*. Human Brain Mapping, 2004. **21**(4): p. 257-270.

Summary: The relationships between brain electrical and metabolic activity are being uncovered currently in animal models using invasive methods; however, in the human brain this relationship remains not well understood. In particular, the relationship between noninvasive measurements of electrical activity and metabolism remains largely undefined. To understand better these relations, cerebral activity was measured simultaneously with electroencephalography (EEG) and positron emission tomography using [18f] -fluoro-2-deoxy-D-glucose (PET-FDG) in 12 normal human subjects during rest. Intracerebral distributions of current density were estimated, yielding tomographic maps for seven standard EEG frequency bands. The PET and EEG data were registered to the same space and voxel dimensions, and correlational maps were created on a voxel-by-voxel basis across all subjects. For each band, significant positive and negative correlations were found that are generally consistent with extant understanding of EEG band power function. With increasing EEG frequency, there was an increase in the number of positively correlated voxels, whereas the lower α band (8.5-10.0 Hz) was associated with the highest number of negative correlations. This work presents a method for comparing EEG signals with other more traditionally tomographic functional imaging data on a 3-D basis. This method

will be useful in the future when it is applied to functional imaging methods with faster time resolution, such as short half-life PET blood flow tracers and functional magnetic resonance imaging. © 2004 Wiley-Liss, Inc.

485. Mulert, C., O. Pogarell, G. Juckel, D. Rujescu, I. Giegling, D. Rupp, P. Mavrogiorgou, P. Bussfeld, J. Gallinat, H.J. Möller, and U. Hegerl, *The neural basis of the P300 potential: Focus on the time-course of the underlying cortical generators*. European Archives of Psychiatry and Clinical Neuroscience, 2004. **254**(3): p. 190-198.

Summary: The locations and time-courses of the neural generators of the event-related P300 potential have been well described using intracranial recordings. However, this invasive method is not adequate for usage in healthy volunteers or psychiatric patients and not all brain regions can be covered well with this approach. With functional MRI, a non-invasive method with high spatial resolution, most of these locations could be found again. However, the time-course of these activations can only be roughly determined with this method, even if an event-related fMRI design has been chosen. Therefore, we have now tried to analyse the time-course of the activations using EEG data providing a better time resolution. We have used Low Resolution Electromagnetic Tomography (LORETA) in the analysis of P300 data (27 electrodes) of healthy volunteers (n = 50) in the time frame 230-480 ms and found mainly the same activations that have been described using intracranial recordings or fMRI, i.e. the inferior patrietal lobe/temporo-parietal junction (TPJ), the supplementary motor cortex (SMA) and the anterior cingulate cortex (ACC), the superior temporal gyrus (STG), the insula and the dorsolateral prefrontal cortex. In these selected regions, an analysis of the activation time-courses has been performed.

486. Mulert, C., L. Jäger, R. Schmitt, P. Bussfeld, O. Pogarell, H.J. Möller, G. Juckel, and U. Hegerl, *Integration of fMRI and simultaneous EEG: Towards a comprehensive understanding of localization and time-course of brain activity in target detection*. NeuroImage, 2004. **22**(1): p. 83-94.

Summary: fMRI and EEG are complimentary methods for the analysis of brain activity since each method has its strength where the other one has limits: The spatial resolution is thus in the range of millimeters with fMRI and the time resolution is in the range of milliseconds with EEG. For a comprehensive understanding of brain activity in target detection, nine healthy subjects (age 24.2 ± 2.9) were investigated with simultaneous EEG (27 electrodes) and fMRI using an auditory oddball paradigm. As a first step, event-related potentials, measured inside the scanner, have been compared with the potentials recorded in a directly preceding session in front of the scanner. Attenuated amplitudes were found inside the scanner for the earlier N1/P2 component but not for the late P300 component. Second, an independent analysis of the localizations of the fMRI activations and the current source density as revealed by low resolution electromagnetic tomography (LORETA) has been done. Concordant activations were found in most regions, including the temporoparietal junction (TPJ), the supplementary motor area (SMA)/anterior cingulate cortex (ACC), the insula, and the middle frontal gyrus, with a mean Euclidean distance of 16.0 ± 6.6 mm between the BOLD centers of gravity and the LORETA-maxima. Finally, a time-course analysis based on the current source density maxima was done. It revealed different time-course patterns in the left and right hemisphere with earlier activations in frontal and parietal regions in the right hemisphere. The results suggest that the combination of EEG and fMRI permits an improved understanding of the spatiotemporal dynamics of brain activity. © 2004 Elsevier Inc. All rights reserved.

487. Moffitt, M.A. and W.M. Grill, *Electrical localization of neural activity in the dorsal horn of the spinal cord: A modeling study*. Annals of Biomedical Engineering, 2004. **32**(12): p. 1694-1709.

Summary: Intraspinal microstimulation is a means of eliciting co-ordinated motor responses for restoration of function. However, detailed maps of the neuroanatomy of the human spinal cord are lacking, and it is not clear where electrodes should be implanted. We developed an electrical approach to localize active neurons in the spinal cord using potentials recorded from the surface of the spinal cord. We evaluated this localization method using an analytical model of the spinal cord and two previously developed inverse algorithms (standardized low resolution brain electromagnetic tomography (sLORETA) and a locally optimal source (LOS) method). The results support electrical source localization as a feasible imaging approach for localizing (within 300 μm) active neurons in the spinal cord. The LOS method could localize the source when 16 recording electrodes were placed on the dorsolateral aspect of the cord and the noise level was 2%. When recording electrodes were positioned around the entire circumference of the spinal cord, either localization method could localize the source, even at 15% noise. Finally, localization error was not sensitive to inaccuracies in the expected electrode positions or the electrical parameters of the forward model, but was sensitive to a geometrical modification of the forward model in one case.

488. Miwakeichi, F., E. Martínez-Montes, P.A. Valdés-Sosa, N. Nishiyama, H. Mizuhara, and Y. Yamaguchi, *Decomposing EEG data into space-time-frequency components using Parallel Factor Analysis*. NeuroImage, 2004. **22**(3): p. 1035-1045.

Summary: Finding the means to efficiently summarize electroencephalographic data has been a long-standing problem in electrophysiology. A popular approach is identification of component modes on the basis of the time-varying spectrum of multichannel EEG recordings - in other words, a space/frequency/time atomic decomposition of the time-varying EEG spectrum. Previous work has been limited to only two of these dimensions. Principal Component Analysis (PCA) and Independent Component Analysis (ICA) have been used to create space/time decompositions; suffering an inherent lack of uniqueness that is overcome only by imposing constraints of orthogonality or independence of atoms. Conventional

frequency/time decompositions ignore the spatial aspects of the EEG. Framing of the data being as a three-way array indexed by channel, frequency, and time allows the application of a unique decomposition that is known as Parallel Factor Analysis (PARAFAC). Each atom is the tri-linear decomposition into a spatial, spectral, and temporal signature. We applied this decomposition to the EEG recordings of five subjects during the resting state and during mental arithmetic. Common to all subjects were two atoms with spectral signatures whose peaks were in the theta and alpha range. These signatures were modulated by physiological state, increasing during the resting stage for alpha and during mental arithmetic for theta. Furthermore, we describe a new method (Source Spectra Imaging or SSI) to estimate the location of electric current sources from the EEG spectrum. The topography of the theta atom is frontal and the maximum of the corresponding SSI solution is in the anterior frontal cortex. The topography of the alpha atom is occipital with maximum of the SSI solution in the visual cortex. We show that the proposed decomposition can be used to search for activity with a given spectral and topographic profile in new recordings, and that the method may be useful for artifact recognition and removal. © 2004 Elsevier Inc. All rights reserved.

489. Michel, C.M., M.M. Murray, G. Lantz, S. Gonzalez, L. Spinelli, and R. Grave De Peralta, *EEG source imaging*. Clinical Neurophysiology, 2004. **115**(10): p. 2195-2222.

Summary: Objective: Electroencephalography (EEG) is an important tool for studying the temporal dynamics of the human brain's large-scale neuronal circuits. However, most EEG applications fail to capitalize on all of the data's available information, particularly that concerning the location of active sources in the brain. Localizing the sources of a given scalp measurement is only achieved by solving the so-called inverse problem. By introducing reasonable a priori constraints, the inverse problem can be solved and the most probable sources in the brain at every moment in time can be accurately localized. Methods and Results: Here, we review the different EEG source localization procedures applied during the last two decades. Additionally, we detail the importance of those procedures preceding and following source estimation that are intimately linked to a successful, reliable result. We discuss (1) the number and positioning of electrodes, (2) the varieties of inverse solution models and algorithms, (3) the integration of EEG source estimations with MRI data, (4) the integration of time and frequency in source imaging, and (5) the statistical analysis of inverse solution results. Conclusions and Significance: We show that modern EEG source imaging simultaneously details the temporal and spatial dimensions of brain activity, making it an important and affordable tool to study the properties of cerebral, neural networks in cognitive and clinical neurosciences. © 2004 International Federation of Clinical Neurophysiology. Published by Elsevier Ireland Ltd. All rights reserved.

490. Martínez-Montes, E., P.A. Valdés-Sosa, F. Miwakeichi, R.I. Goldman, and M.S. Cohen, *Concurrent EEG/fMRI analysis by multiway Partial Least Squares*. NeuroImage, 2004. **22**(3): p. 1023-1034.

Summary: Data may now be recorded concurrently from EEG and functional MRI, using the Simultaneous Imaging for Tomographic Electrophysiology (SITE) method. As yet, there is no established means to integrate the analysis of the combined data set. Recognizing that the hemodynamically convolved time-varying EEG spectrum, S, is intrinsically multidimensional in space, frequency, and time motivated us to use multiway Partial Least-Squares (N-PLS) analysis to decompose EEG (independent variable) and fMRI (dependent variable) data uniquely as a sum of "atoms". Each EEG atom is the outer product of spatial, spectral, and temporal signatures and each fMRI atom the product of spatial and temporal signatures. The decomposition was constrained to maximize the covariance between corresponding temporal signatures of the EEG and fMRI. On all data sets, three components whose spectral peaks were in the theta, alpha, and gamma bands appeared; only the alpha atom had a significant temporal correlation with the fMRI signal. The spatial distribution of the alpha-band atom included parieto-occipital cortex, thalamus, and insula, and corresponded closely to that reported by Goldman et al. [NeuroReport 13(18) (2002) 2487] using a more conventional analysis. The source reconstruction from EEG spatial signature showed only the parieto-occipital sources. We interpret these results to indicate that some electrical sources may be intrinsically invisible to scalp EEG, yet may be revealed through conjoint analysis of EEG and fMRI data. These results may also expose brain regions that participate in the control of brain rhythms but may not themselves be generators. As of yet, no single neuroimaging method offers the optimal combination of spatial and temporal resolution; fusing fMRI and EEG meaningfully extends the spatio-temporal resolution and sensitivity of each method. © 2004 Elsevier Inc. All rights reserved.

491. Marroquin, J.L., T. Harmony, V. Rodriguez, and P. Valdes, *Exploratory EEG data analysis for psychophysiological experiments*. NeuroImage, 2004. **21**(3): p. 991-999.

Summary: A method for the exploratory analysis of electroencephalographic (EEG) data for neurophysiological experiments is presented. It is based on a time-frequency decomposition of the EEG time series, which is measured by several electrodes in the scalp surface, and includes the computation of a statistic that measures the deviations of the log-power with respect to the pre-stimulus average; the computation of a significance index for these deviations; a new type of display (the time-frequency-topography plot) for the visualization of these indices, and the segmentation of the time-frequency plane into regions with uniform activation patterns. As a particular example, an experiment to study EEG changes during figure and word categorization is analyzed in detail. © 2004 Elsevier Inc. All rights reserved.

492. Machado, C., E. Cuspineda, P. Valdés, T. Virues, F. Llopis, J. Bosch, E. Aubert, E. Hernández, A. Pando, M.A. Álvarez, E. Barroso, L. Galán, and Y. Avila, *Assessing acute middle cerebral artery ischemic stroke by quantitative electric tomography*. Clinical EEG and Neuroscience, 2004. **35**(3): p. 116-124.

Summary: This paper focuses on the application of quantitative electric tomography (qEEGT) to map changes in EEG generators for detection of early signs of ischemia in patients with acute middle cerebral artery stroke. Thirty-two patients were studied with the diagnosis of acute ischemic stroke of the left middle cerebral artery territory, within the first 24 hours of their clinical evolution. Variable Resolution Electrical Tomography was used for estimating EEG source generators. High resolution source Z-spectra and 3-dimensional images of Z values for all the sources at each frequency were obtained for all cases. To estimate statistically significant increments and decrements of brain electric activity within the frequency spectra, the t-Student vs. Zero test was performed. A significant increment of delta activity was observed on the affected vascular territory, and a more extensive increment of theta activity was detected. Asignificant alpha decrement was found in the parieto-occipital region of the affected cerebral hemisphere (left), and in the medial and posterior region of the right hemisphere. These findings suggest that qEEGT Z delta images are probably related to the main ischemic core within the affected arterial territory; penumbra, diaschisis, edema, might explain those observed theta and alpha abnormalities. It was concluded that qEEGT is useful for the detection of early signs of ischemia in acute ischemic stroke.

493. Liu, H., X. Gao, P.H. Schimpf, F. Yang, and S. Gao, *A recursive algorithm for the three-dimensional imaging of brain electric activty: Shrinking LORETA-FOCUSS*. IEEE Transactions on Biomedical Engineering, 2004. **51**(10): p. 1794-1802.

Summary: Estimation of intracranial electric activity from the scalp electroencephalogram (EEG) requires a solution to the EEG inverse problem, which is known as an ill-conditioned problem. In order to yield a unique solution, weighted minimum norm least square (MNLS) inverse methods are generally used. This paper proposes a recursive algorithm, termed Shrinking LORETA-FOCUSS, which combines and expands upon the central features of two well-known weighted MNLS methods: LORETA and FOCUSS. This recursive algorithm makes iterative adjustments to the solution space as well as the weighting matrix, thereby dramatically reducing the computation load, and increasing local source resolution. Simulations are conducted on a 3-shell spherical head model registered to the Talairach human brain atlas. A comparative study of four different inverse methods, standard Weighted Minimum Norm, L1-norm, LORETA-FOCUSS and Shrinking LORETA-FOCUSS are presented. The results demonstrate that Shrinking LORETA-FOCUSS is able to reconstruct a three-dimensional source distribution with smaller localization and energy errors compared to the other methods.

494. Lavric, A., D.A. Pizzagalli, and S. Forstmeier, *When 'go' and 'nogo' are equally frequent: ERP components and cortical tomography*. European Journal of Neuroscience, 2004. **20**(9): p. 2483-2488.

Summary: In human electrophysiology, a considerable corpus of studies using event-related potentials have investigated inhibitory processes by employing the 'go-nogo' paradigm, which requires responding to one type of event while withholding the response to another type of event. Two event-related potential waveform features (N2 and P3) have been associated with larger amplitude in nogo trials than in go trials. Traditionally, these differences were thought to reflect response inhibition. Recently, the source localization of N2 to the anterior cingulate cortex, as well as the colocalization of N2 with error-related negativity, has been interpreted in terms of conflict monitoring. In order to isolate the contribution of inhibitory processes, we matched the frequency of the go and nogo events, thus minimizing differences in response conflict between event types. A data-driven analytical procedure contrasted go with nogo events across the entire event-related potential segment and found that N2 reliably differentiated between the two conditions while P3 did not. Tomographical analyses of the N2 difference observed in conditions of equal go and nogo trial frequency localized N2 to the right ventral and dorsolateral prefrontal cortex. Because a growing body of evidence implicates these brain regions in inhibitory processes, we conclude that N2 does, at least in part, reflect inhibition.

495. Komssi, S., J. Huttunen, H.J. Aronen, and R.J. Ilmoniemi, *EEG minimum-norm estimation compared with MEG dipole fitting in the localization of somatosensory sources at S1*. Clinical Neurophysiology, 2004. **115**(3): p. 534-542.

Summary: Objective: Dipole models, which are frequently used in attempts to solve the electromagnetic inverse problem, require explicit a priori assumptions about the cerebral current sources. This is not the case for solutions based on minimum-norm estimates. In the present study, we evaluated the spatial accuracy of the L2 minimum-norm estimate (MNE) in realistic noise conditions by assessing its ability to localize sources of evoked responses at the primary somatosensory cortex (SI). Methods: Multichannel somatosensory evoked potentials (SEPs) and magnetic fields (SEFs) were recorded in 5 subjects while stimulating the median and ulnar nerves at the left wrist. A Tikhonov-regularized L2-MNE, constructed on a spherical surface from the SEP signals, was compared with an equivalent current dipole (ECD) solution obtained from the SEFs. Results: Primarily tangential current sources accounted for both SEP and SEF distributions at around 20 ms (N20/N20m) and 70 ms (P70/P70m), which deflections were chosen for comparative analysis. The distances between the locations of the maximum current densities obtained from MNE and the locations of ECDs were on the average 12-13 mm for both deflections and nerves stimulated. In accordance with the somatotopical order of SI, both the MNE and ECD tended to localize median nerve activation more laterally than ulnar nerve activation for the N20/N20m deflection. Simulation experiments further indicated that, with a proper estimate of the source depth and with a good fit of the head model, the MNE can reach a mean accuracy of 5 mm in 0.2-μV root-mean-square noise. Conclusions: When compared with previously reported localizations based on dipole modelling of SEPs, it appears that equally accurate localization of S1 can be obtained with the MNE. Significance: MNE can be used to verify parametric source modelling results. Having a relatively good localization accuracy and requiring minimal assumptions, the MNE may be useful for the localization of poorly known activity distributions and for tracking activity changes between brain areas as a function of time. © 2004 International Federation of Clinical Neurophysiology. Published by Elsevier Ireland Ltd. All rights reserved.

496. Koles, Z.J., J.C. Lind, and P. Flor-Henry, *A source-imaging (low-resolution electromagnetic tomography) study of the EEGs from unmedicated men with schizophrenia*. Psychiatry Research - Neuroimaging, 2004. **130**(2): p. 171-190.

Summary: Imaging studies and quantitative electroencephalography (EEG) have often, but not consistently, implicated the left hemisphere and the prefrontal cortex in schizophrenia. To help clarify this picture, a spatial filter shown to be effective for enhancing differences between EEG populations was combined with low-resolution electromagnetic tomography and used to compare the source-current densities from a group of 57 male subjects with schizophrenia and a group of 65 matched controls. To elicit differences, comparisons were made during resting conditions and during verbal and spatial cognitive challenges to the subjects. Estimates of the source-current density were derived from 43-electrode recordings of the EEG reduced to the delta, alpha and beta frequency bands. The patients were unmedicated and were selected according to DSM-IV criteria. As a group, they were severe, chronic states with both deficit negative and superimposed florid psychotic symptomatology. The results confirm that schizophrenia is a left-hemispheric disorder centered in the temporal and frontal lobes. They also suggest that, in schizophrenia, functions normally performed by these regions in controls are assumed by homologous regions in the opposite hemispheres. © 2003 Elsevier Ireland Ltd. All rights reserved.

497. Kawasaki, T., S. Tanaka, J. Wang, H. Hokama, and K. Hiramatsu, *Abnormalities of P300 cortical current density in unmedicated depressed patients revealed by LORETA analysis of event-related potentials*. Psychiatry and Clinical Neurosciences, 2004. **58**(1): p. 68-75.

Summary: The purpose of the present study was to investigate the neural substrates underlying event-related potential (ERP) abnormalities, with respect to the generators of the ERP components in depressed patients. Using an oddball paradigm, ERP from auditory stimuli were recorded from 22 unmedicated patients with current depressive episodes and compared with those from 22 age- and gender-matched normal controls. Cortical current densities of the N100 and P300 components were analyzed using low-resolution electromagnetic tomography (LORETA). Group differences in cortical current density were

mapped on a 3-D cortex model. The results revealed that N100 cortical current densities did not differ between the two groups, while P300 cortical current densities were significantly lower in depressed patients over the bilateral temporal lobes, the left frontal region, and the right temporal-parietal area. Furthermore, the cortical area in which the group difference in P300 current density had been identified was remarkably larger over the right than the left hemisphere, thus supporting the hypothesis of right hemisphere dysfunction in depression.

498. Joppich, G., J. Däuper, R. Dengler, S. Johannes, A. Rodriguez-Fornells, and T.F. Münte, *Brain potentials index executive functions during random number generation*. Neuroscience Research, 2004. **49**(2): p. 157-164.

Summary: The generation of random sequences is considered to tax different executive functions. To explore the involvement of these functions further, brain potentials were recorded in 16 healthy young adults while either engaging in random number generation (RNG) by pressing the number keys on a computer keyboard in a random sequence or in ordered number generation (ONG) necessitating key presses in the canonical order. Key presses were paced by an external auditory stimulus to yield either fast (1 press/800 ms) or slow (1 press/1300 ms) sequences in separate runs. Attentional demands of random and ordered tasks were assessed by the introduction of a secondary task (key-press to a target tone). The P3 amplitude to the target tone of this secondary task was reduced during RNG, reflecting the greater consumption of attentional resources during RNG. Moreover, RNG led to a left frontal negativity peaking 140 ms after the onset of the pacing stimulus, whenever the subjects produced a true random response. This negativity could be attributed to the left dorsolateral prefrontal cortex and was absent when numbers were repeated. This negativity was interpreted as an index for the inhibition of habitual responses. Finally, in response locked ERPs a negative component was apparent peaking about 50 ms after the key-press that was more prominent during RNG. Source localization suggested a medial frontal source. This effect was tentatively interpreted as a reflection of the greater monitoring demands during random sequence generation. © 2004 Elsevier Ireland Ltd and The Japan Neuroscience Society. All rights reserved.

499. Im, C.H., H.K. Jung, H. Kwon, and Y.H. Lee, *Multiresolutive reconstruction of magnetoencephalography source distribution*. IEEE Transactions on Magnetics, 2004. **40**(2 II): p. 1100-1103.

Summary: In this paper, an improved technique for multiresolutive reconstruction of magnetoencephalography source distribution is proposed. Using the proposed technique, focal source distribution with higher energy density can be reconstructed. Moreover, the proposed approach is very easy to implement compared with conventional ones. The usefulness of the proposed technique is verified using a cortical patch test for a realistic brain model.

500. Horovitz, S.G., B. Rossion, P. Skudlarski, and J.C. Gore, *Parametric design and correlational analyses help integrating fMRI and electrophysiological data during face processing*. NeuroImage, 2004. **22**(4): p. 1587-1595.

Summary: Face perception is typically associated with activation in the inferior occipital, superior temporal (STG), and fusiform gyri (FG) and with an occipitotemporal electrophysiological component peaking around 170 ms on the scalp, the N170. However, the relationship between the N170 and the multiple face-sensitive activations observed in neuroimaging is unclear. It has been recently shown that the amplitude of the N170 component monotonically decreases as gaussian noise is added to a picture of a face [Jemel et al., 2003]. To help clarify the sources of the N170 without a priori assumptions regarding their number and locations, ERPs and fMRI were recorded in five subjects in the same experiment, in separate sessions. We used a parametric paradigm in which the amplitude of the N170 was modulated by varying the level of noise in a picture, and identified regions where the percent signal change in fMRI correlated with the ERP data. N170 signals were observed for pictures of both cars and faces but were stronger for faces. A monotonic decrease with added noise was observed for the N170 at right hemisphere sites but was less clear on the left and occipital central sites. Correlations between fMRI signal and N170 amplitudes for faces were highly significant ($P < 0.001$) in bilateral fusiform gyrus and superior temporal gyrus. For cars, the strongest correlations were observed in the parahippocampal region and in the STG ($P < 0.005$). Besides contributing to clarify the spatiotemporal course of face processing, this study illustrates how ERP information may be used synergistically in fMRI analyses. Parametric designs may be developed further to provide some timing information on fMRI activity and help identify the generators of ERP signals. © 2004 Elsevier Inc. All rights reserved.

501. Herrmann, M.J., J. Römmler, A.C. Ehlis, A. Heidrich, and A.J. Fallgatter, *Source localization (LORETA) of the error-related-negativity (ERN/Ne) and positivity (Pe)*. Cognitive Brain Research, 2004. **20**(2): p. 294-299.

Summary: We investigated error processing of 39 subjects engaging the Eriksen flanker task. In all 39 subjects a pronounced negative deflection (ERN/Ne) and a later positive component (Pe) were observed after incorrect as compared to correct responses. The neural sources of both components were analyzed using LORETA source localization. For the negative component (ERN/Ne) we found significantly higher brain electrical activity in medial prefrontal areas for incorrect responses, whereas the positive component (Pe) was localized nearby but more rostral within the anterior cingulate cortex (ACC). Thus, different neural generators were found for the ERN/Ne and the Pe, which further supports the notion that both error-related components represent different aspects of error processing. © 2004 Elsevier B.V. All rights reserved.

502. Herrmann, M.J. and A.J. Fallgatter, *Stability of source localization with LORETA of visual target processing*. Journal of Psychophysiology, 2004. **18**(1): p. 1-12.

Summary: This study investigates whether LORETA, a method of source localization of EEG data, reveals replicable and valid sources of event-related potentials (ERPs), which are supposed to be generated in a widespread cortical network. For that purpose, the ERPs in a rare primer (=target) and frequent distractor condition(=nontarget) of a visually presented Continuous Performance Test (CPT) were analyzed in two independent samples of healthy subjects (n1=49,n2=38). At about 420 ms significantly higher global field power values (GFP) were observed in the target condition as compared to the nontarget condition. For both samples the LORETA source localization revealed significantly higher activation for the target-condition as compared to the nontarget condition in the anterior cingulum, the precuneus and superior-posterior parietal cortex parietal lobe), the insula, and the fusiform gyrus (temporal lobe). Only in the second sample were widespread areas in the frontal cortex also activated. The results indicate that LORETA localizes widespread cortical areas involved in target processing similar to results of fMRI studies. © 2004 Federation of European Psychophysiology Societies.

503. Henkin, Y., L. Kishon-Rabin, S. Tatin-Schneider, D. Urbach, M. Hildesheimer, and P.R. Kileny, *Low-resolution electromagnetic tomography (LORETA) in children with cochlear implants: A preliminary report*. International Journal of Audiology, 2004. **43**(SUPPL. 1).

Summary: The current preliminary report describes the utilization of low-resolution electromagnetic tomography (LORETA) in a small group of highly performing children using the Nucleus 22 cochlear implant (CI) and in normal-hearing (NH) adults. LORETA current density estimations were performed on an averaged target P3 component that was elicited by non-speech and speech oddball discrimination tasks. The results indicated that, when stimulated with tones, patients with right implants and NH adults (regardless of stimulated ear) showed enhanced activation in the right temporal lobe, whereas patients with left implants showed enhanced activation in the left temporal lobe. When stimulated with speech, patients with right implants showed bilateral activation of the temporal and frontal lobes, whereas patients with left implants showed only left temporal lobe activation. NH adults (regardless of stimulated ear) showed enhanced bilateral activation of the temporal and parietal lobes. The differences in activation patterns between patients with CI and NH subjects may be attributed to the long-term exposure to degraded input conditions which may have resulted in reorganization in terms of functional specialization. The difference between patients with right versus left implants, however, is intriguing and requires further investigation.

504. Harmony, T., T. Fernández, J. Gersenowies, L. Galán, A. Fernández-Bouzas, E. Aubert, and L. Díaz-Comas, *Specific EEG frequencies signal general common*

cognitive processes as well as specific task processes in man. International Journal of Psychophysiology, 2004. **53**(3): p. 207-216.

Summary: The EEG of 10 normal male young adults was recorded during the performance of three different tasks: mental calculation, verbal working memory (VWM) and spatial working memory (SWM). The stimuli used in the three tasks were the same, only the instructions to the subjects were different. Narrow band analysis of the EEG and distributed sources for each EEG frequency were calculated using variable resolution electromagnetic tomography (VARETA). At some frequencies (1.56, 4.68, 7.80 to 10.92 Hz) at least two tasks produced similar EEG patterns that were interpreted as the reflex of common cognitive processes, such as attention, inhibition of irrelevant stimuli, etc. Specific changes were also observed at 2.34, 3.12, 3.90, 5.46 and 6.24 Hz. The first three of these frequencies showed similar changes during VWM and calculus at the left frontal cortex, suggesting the activation of working memory (WM) processes. The interaction effect at these frequencies was mainly observed at the anterior cingulate cortex and frontal cortex. At 5.46 and 6.24 Hz, changes were only observed during mental calculation. © 2004 Elsevier B.V. All rights reserved.

505. Halgren, E., *How can intracranial recordings assist MEG source localization?* Neurology and Clinical Neurophysiology, 2004. **2004**.

Summary: MEG/EEG are the only non-invasive methods to instantaneously and directly measure the currents underlying cerebral information processing, but their ability to localize those currents is limited. Source localization from MEG is always uncertain, unless the signal is already known to be coming exclusively from a single focal source, or a few highly separated focal sources. Furthermore, since many cerebral currents produce little or no MEG signal, even accurate localization of the MEG sources may provide a very incomplete map of brain activation. Intracranial EEG (iEEG) can unambiguously localize sources, using steep voltage gradients, doubly-inverting gradients, traverses of the source structure from multiple directions, and/or spatial arrays of microelectrodes. These recordings show that except for a few milliseconds after the first cortical sensory response, multiple overlapping sources are active. For the commonly-studied cognitive potential components, N400 and P3b, iEEG demonstrates distributed sources in multiple lobes with similar time-courses. These data, as well as basic cortical neurophysiology from animal studies, do not support the common assumptions that the MEG generating sources are focal, and/or independent. Although focal hemodynamic activation is often described, this may be an artefact of the usual data analysis schemes. In summary, MEG source localization depends on prior assumptions of unknown accuracy, and MEG is insensitive to much cerebral activity. MEG publications should explicitly acknowledge these limitations. If possible, reference should be made to more certain knowledge, which in some cases includes iEEG.

506. Greenblatt, R.E. and M.E. Pflieger, *Randomization-based hypothesis testing from event-related data*. Brain Topography, 2004. **16**(4): p. 225-232.

Summary: Methods are described for non-parametric significance testing from event-related encephalographic data, using randomization tests. These methods may be applied in both signal space and source space. The methods include within-subject between-condition comparisons, paired and unpaired comparisons, and within-group and between-group comparisons. Test statistics are also derived for comparing the spatial or temporal response patterns, independent of specific changes at individual locations. Novel methods for testing peak-height significance, and also for making map-wide comparisons, are described. These methods have been validated using simulated data.

507. Gottselig, J.M., D. Brandeis, G. Hofer-Tinguely, A.A. Borbély, and P. Achermann, *Human Central Auditory Plasticity Associated with Tone Sequence Learning*. Learning and Memory, 2004. **11**(2): p. 162-171.

Summary: We investigated learning-related changes in amplitude, scalp topography, and source localization of the mismatch negativity (MMN), a neurophysiological response correlated with auditory discrimination ability. Participants (n = 32) underwent two EEG recordings while they watched silent films and ignored auditory stimuli. Stimuli were a standard (probability = 85%) and two deviant (probability = 7.5% each for high [HD] and low [LD]) eight-tone sequences that differed in the frequency of one tone. Between recordings, subjects practiced discriminating the HD or LD from the standard for 6 min. The amplitude of the LD MMN increased significantly across recordings in both groups, whereas the amplitude of the HD MMN did not. The LD was easier to discriminate than was the HD. Thus, practicing either discrimination increased the MMN for the easier discrimination. Learning and changes in the LD MMN amplitude were highly correlated. Source localizations of event-related potentials (ERPs) to all stimuli revealed bilateral sources in superior temporal regions. Compared with the standard ERP, the LD ERP revealed a stronger source in the left superior temporal region in both recordings, whereas the right-sided source became stronger after learning. Consistent with prior studies of auditory plasticity in animals and humans, tone sequence learning induced rapid neurophysiological plasticity in the human central auditory system. The results also suggest that there is asymmetric hemispheric involvement in tone sequence discrimination learning and that discrimination difficulty influences the time course of learning-related neurophysiological changes.

508. Gotman, J., C.G. Bénar, and F. Dubeau, *Combining EEG and fMRI in epilepsy: Methodological challenges and clinical results*. Journal of Clinical Neurophysiology, 2004. **21**(4): p. 229-240.

Summary: It is now possible to combine continuous recording of the EEG and continuous functional MRI scanning. This makes it possible to determine the regions of the brain showing changes in the fMRI signal in response to epileptic spikes occurring in the EEG. This article reviews the experience with this method in more than 100 studies performed over the last 4 years at the Montreal Neurological Institute. The technique is complex, and the authors review the various issues related to obtaining a good-quality EEG in the hostile environment of the magnetic resonance scanner, the statistical analysis of magnetic resonance images, in particular the issue of knowing what is the hemodynamic response function appropriate for the analysis of epileptic spikes, and the combination of EEG and fMRI results. The difficult theoretical issues raised by the interpretation of activation and deactivation, both frequently seen in response to spikes, are discussed. Finally, the authors give examples of fMRI responses seen with focal spikes and with generalized spike and wave discharges.

509. Gavaret, M., J.M. Badier, P. Marquis, F. Bartolomei, and P. Chauvel, *Electric source imaging in temporal lobe epilepsy*. Journal of Clinical Neurophysiology, 2004. **21**(4): p. 267-282.

Summary: The objective of this study was to determine the validity of interictal spike (IIS) source localization in temporal lobe epilepsies (TLE) using stereoelectroencephalography as a validating method. Twenty patients with drug-resistant TLE were studied with high-resolution EEG and stereoelectroencephalography. Sixty-four scalp channels, a realistic head model, and different algorithms were used. For each patient, the intracerebral interictal distribution was studied and classified into one of three groups: L (mainly lateral), ML (mediolateral), and M (medial). In group L (three patients), surface IIS were recorded with a high signal-to-noise ratio. Source localizations designated all or part of the intracerebral interictal distribution. In group ML (11 patients), 8 patients had surface IIS, only 5 of which were localizable. High-resolution EEG permitted localization of the more lateral portion and definition of its rostrocaudal extension. A common pattern was identified in three patients with a predominant role of the temporal pole. In group M (six patients), four patients had rare surface IIS, none of which were localizable. Surface EEG does not record IIS limited to medial temporal lobe structures. In TLE with a mediolateral or a lateral interictal distribution, only the lateral component is detectable on surface EEG and accurately localizable by source localization tools.

510. Garcell, J.R., *Contributions of the conventional electroencephalogram and frecuency analysis to study attention deficit disorder. Part II*. Aportes del electroencefalograma convencional y el análisis de frecuencias para el estudio del trastorno por déficit de a tención. Segunda parte, 2004. **27**(2): p. 7-14.

Summary:

511. Gamma, A., D. Lehmann, E. Frei, K. Iwata, R.D. Pascual-Marqui, and F.X. Vollenweider, *Comparison of simultaneously recorded [H215O]-PET and LORETA during cognitive and pharmacological activation*. Human Brain Mapping, 2004. **22**(2): p. 83-96.

Summary: The complementary strengths and weaknesses of established functional brain imaging methods (high spatial, low temporal resolution) and EEG-based techniques (low spatial, high temporal resolution) make their

combined use a promising avenue for studying brain processes at a more fine-grained level. However, this strategy requires a better understanding of the relationship between hemodynamic/metabolic and neuroelectric measures of brain activity. We investigated possible correspondences between cerebral blood flow (CBF) as measured by [H2O]-PET and intracerebral electric activity computed by Low Resolution Brain Electromagnetic Tomography (LORETA) from scalp-recorded multichannel EEG in healthy human subjects during cognitive and pharmacological stimulation. The two imaging modalities were compared by descriptive, correlational, and variance analyses, the latter carried out using statistical parametric mapping (SPM99). Descriptive visual comparison showed a partial overlap between the sets of active brain regions detected by the two modalities. A number of exclusively positive correlations of neuroelectric activity with regional CBF were found across the whole EEG frequency range, including slow wave activity, the latter finding being in contrast to most previous Studies Conducted in patients. Analysis of variance revealed an extensive lack of statistically significant correspondences between brain activity changes as measured by PET vs. EEG-LORETA. In general, correspondences, to the extent they were found, were dependent on experimental condition, brain region, and EEG frequency. © 2004 Wiley-Liss, Inc.

512. Galka, A., O. Yamashita, T. Ozaki, R. Biscay, and P. Valdés-Sosa, *A solution to the dynamical inverse problem of EEG generation using spatiotemporal Kalman filtering*. NeuroImage, 2004. **23**(2): p. 435-453.

Summary: We present a new approach for estimating solutions of the dynamical inverse problem of EEG generation. In contrast to previous approaches, we reinterpret this problem as a filtering problem in a state space framework; for the purpose of its solution, we propose a new extension of Kalman filtering to the case of spatiotemporal dynamics. The temporal evolution of the distributed generators of the EEG can be reconstructed at each voxel of a discretisation of the gray matter of brain. By fitting linear autoregressive models with neighbourhood interactions to EEG time series, new classes of inverse solutions with improved resolution and localisation ability can be explored. For the purposes of model comparison and parameter estimation from given data, we employ a likelihood maximisation approach. Both for instantaneous and dynamical inverse solutions, we derive estimators of the time-dependent estimation error at each voxel. The performance of the algorithm is demonstrated by application to simulated and clinical EEG recordings. It is shown that by choosing appropriate dynamical models, it becomes possible to obtain inverse solutions of considerably improved quality, as compared to the usual instantaneous inverse solutions. © 2004 Elsevier Inc. All rights reserved.

513. Galka, A., O. Yamashita, and T. Ozaki, *GARCH modelling of covariance in dynamical estimation of inverse solutions*. Physics Letters, Section A: General, Atomic and Solid State Physics, 2004. **333**(3-4): p. 261-268.

Summary: The problem of estimating unobserved states of spatially extended dynamical systems poses an inverse problem, which can be solved approximately by a recently developed variant of Kalman filtering; in order to provide the model of the dynamics with more flexibility with respect to space and time, we suggest to combine the concept of GARCH modelling of covariance, well known in econometrics, with Kalman filtering. We formulate this algorithm for spatiotemporal systems governed by stochastic diffusion equations and demonstrate its feasibility by presenting a numerical simulation designed to imitate the situation of the generation of electroencephalographic recordings by the human cortex. © 2004 Elsevier B.V. All rights reserved.

514. Fuchs, M., M.R. Ford, S. Sands, and H.L. Lew, *Overview of dipole source localization*. Physical Medicine and Rehabilitation Clinics of North America, 2004. **15**(1): p. 251-262.

Summary: Truly accurate dipole source localization relies on having (1) reliable, artifact-free EP/ERP (or magnetoelectroencephalogram) data to start with; (2) landmark and electrode position data obtained with a three-dimensional digitizer; (3) MRI (or CT) data from the same subject (with a means to measure the same landmarks); (4) the capability to apply different dipole and volume conductor models; and (5) the ability to coregister the functional and anatomic data to display the final source solutions. Most important is to have a thorough understanding of the fundamental principles of the localization programs and neurophysiologic processes. Localization programs are simply tools. Used incorrectly, they can yield meaningless results. Used correctly, they can provide a window into neurophysiologic functioning that is not available through any other means.

515. Fontanarosa, J.B., R.E. Lasky, H.C. Lee, and W. Van Drongelen, *Localization of brainstem auditory evoked potentials in primates: A comparison of localization techniques applied to deep brain sources*. Brain Topography, 2004. **17**(2): p. 99-108.

Summary: Summary: The objective of this study was to evaluate the performance of source localization techniques through localization of deep brain sources. To accomplish this, two replications of a brainstem auditory evoked potential (BAEP, left ear 60 dB nHL clicks) were recorded from five normal rhesus monkeys. We analyzed waves III and IV, as this portion of the BAEP corresponds to the deepest signal. Data were analyzed using five different source localization techniques: Moving Dipoles, Fixed Dipoles, MUSIC (Multiple Signal Classification) dipole scan, LORETA (Low Resolution Tomography), and LCMV (Linearly Constrained Minimum Variance) spatial filtering. The moving dipole, fixed dipole and MUSIC solutions were found to be, on average, 25.1 mm from the brainstem generators. LORETA detected sources within the brainstem 65% of the time. However, 90% of these localization results also included false detections defined as regions of the brain that were more than 2 cm away from the auditory pathway. LCMV included the brainstem in 90% of the trials and false detections

in 40% of the cases. These findings indicate that evoked electrical activity from deep brain sources can be localized with cm accuracy. The dipole methods performed better than LORETA and LCMV. Given the depth and amplitude of the sources analyzed in this study, these results can be interpreted as an upper bound on the accuracy of each technique.

516. Flor-Henry, P., J.C. Lind, and Z.J. Koles, *A source-imaging (low-resolution electromagnetic tomography) study of the EEGs from unmedicated males with depression*. Psychiatry Research - Neuroimaging, 2004. **130**(2): p. 191-207.

Summary: Imaging studies and quantitative EEG have often, but not consistently, implicated the right hemisphere and the left prefrontal cortex in depression. To help clarify this picture, a spatial filter shown to be effective for enhancing differences between EEG populations was combined with an electrical tomographic approach called low-resolution electromagnetic tomography and used to compare the source-current densities from a group of 25 male subjects with depression and a group of 65 matched controls. To elicit differences, comparisons were made during resting conditions and during verbal and spatial cognitive challenges to the subjects. Estimates of the source-current density were derived from 43-electrode recordings of the EEG reduced to the delta, alpha and beta frequency bands. The depressed subjects were unmedicated and selected according to DSM IV criteria. Regions of significantly increased current density in depression compared to controls were generally right hemispheric, while regions of significantly decreased current density were generally frontal and left hemispheric. A within-group comparison of the depressed subjects during the two cognitive challenges suggested a left anterior functional hypoactivation in depression. Retrospective classification of the two groups indicated that the spatial challenge best separated the groups irrespective of frequency band. © 2003 Elsevier Ireland Ltd. All rights reserved.

517. Fallgatter, A.J., A.C. Ehlis, J. Seifert, W.K. Strik, P. Scheuerpflug, K.E. Zillessen, M.J. Herrmann, and A. Warnke, *Altered response control and anterior cingulate function in attention-deficit/hyperactivity disorder boys*. Clinical Neurophysiology, 2004. **115**(4): p. 973-981.

Summary: Objective: To investigate mechanisms and structures underlying prefrontal response control and inhibition in boys suffering from attention-deficit/ hyperactivity disorder (ADHD). Method: Sixteen boys with ADHD and 19 healthy controls were investigated electrophysiologically during performance of a visual Go-Nogo task (Continuous Performance Test, CPT). An electrophysiological source localization method was employed to further analyze the data. Results: The ADHD boys showed a significantly diminished central Nogo-P3, due to a lack of Nogo-related frontalization of the positive brain electrical field in this group. This two-dimensional effect was associated with a significantly reduced activation of the anterior cingulate cortex (ACC) in the ADHD boys in the Nogo condition of the CPT. Both groups did not significantly differ regarding the amplitude of the Nogo-N2. Conclusions: The results indicate

deficits in prefrontal response control in unmedicated ADHD boys that do not seem to be specifically inhibitory in nature. A supposed dysfunction of the ACC in ADHD was confirmed. © 2004 International Federation of Clinical Neurophysiology. Published by Elsevier Ireland Ltd. All rights reserved.

518. Esslen, M., R.D. Pascual-Marqui, D. Hell, K. Kochi, and D. Lehmann, *Brain areas and time course of emotional processing*. NeuroImage, 2004. **21**(4): p. 1189-1203.

Summary: The aims of the present study were to identify brain regions involved in emotional processing as well as to follow the time sequence of these processes in the millisecond-range resolution using low resolution brain electromagnetic tomography (LORETA). Different emotional (happy, sad, angry, fearful, and disgust) and neutral faces were presented to 17 healthy, right-handed volunteers on a computer screen while 25-channel EEG data were recorded. Subjects were instructed to generate the same emotion as shown in the presented faces. Event-related potentials (ERPs) were computed for each emotion and neutral condition, and analyzed as sequences of potential distribution maps. Paired topographic analysis of variance tests of the ERP maps identified time segments of significant differences between responses to emotional and neutral faces. For these significant segments, statistical analyses of functional LORETA images were performed to identify active brain regions for the different emotions. Significant differences occurred in different time segments within the first 500 ms after stimulus onset. Each emotional condition showed specific activation patterns in different brain regions, changing over time. In the majority of significant time segments, activation was highest in the right frontal areas. Strongest activation was found in the happy, sad, and disgust conditions in extended fronto-temporal areas. Happy, sad, and disgust conditions also produced earlier and more widely distributed differences than anger and fear. Our findings are in good agreement with other brain-imaging studies (PET/fMRI). But unlike other imaging techniques, LORETA allows to follow the time sequence in the millisecond-range resolution. © 2004 Elsevier Inc. All rights reserved.

519. Darvas, F., D. Pantazis, E. Kucukaltun-Yildirim, and R.M. Leahy, *Mapping human brain function with MEG and EEG: Methods and validation*. NeuroImage, 2004. **23**(SUPPL. 1).

Summary: We survey the field of magnetoencephalography (MEG) and electroencephalography (EEG) source estimation. These modalities offer the potential for functional brain mapping with temporal resolution in the millisecond range. However, the limited number of spatial measurements and the ill-posedness of the inverse problem present significant limits to our ability to produce accurate spatial maps from these data without imposing major restrictions on the form of the inverse solution. Here we describe approaches to solving the forward problem of computing the mapping from putative inverse solutions into the data space. We then describe the inverse problem in terms of low dimensional solutions, based on the equivalent current dipole (ECD), and

high dimensional solutions, in which images of neural activation are constrained to the cerebral cortex. We also address the issue of objective assessment of the relative performance of inverse procedures by the free-response receiver operating characteristic (FROC) curve. We conclude with a discussion of methods for assessing statistical significance of experimental results through use of the bootstrap for determining confidence regions in dipole-fitting methods, and random field (RF) and permutation methods for detecting significant activation in cortically constrained imaging studies. © 2004 Elsevier Inc. All rights reserved.

520. Congedo, M., J.F. Lubar, and D. Joffe, *Low-resolution electromagnetic tomography neurofeedback*. IEEE Transactions on Neural Systems and Rehabilitation Engineering, 2004. **12**(4): p. 387-397.

Summary: Through continuous feedback of the electroencephalogram (EEG) humans can learn how to shape their brain electrical activity in a desired direction. The technique is known as EEG biofeedback, or neurofeedback, and has been used since the late 1960s in research and clinical applications. A major limitation of neurofeedback relates to the limited information provided by a single or small number of electrodes placed on the scalp. We establish a method for extracting and feeding back intracranial current density and we carry out an experimental study to ascertain the ability of the participants to drive their own EEG power in a desired direction. To derive current density within the brain volume, we used the low-resolution electromagnetic tomography (LORETA). Six undergraduate students (three males, three females) underwent tomographic neurofeedback (based on 19 electrodes placed according to the 10-20 system) to enhance the current density power ratio between the frequency bands β (16-20 Hz) and a (8-10 Hz). According to LORETA modeling, the region of interest corresponded to the Anterior Cingulate (cognitive division). The protocol was designed to improve the performance of the subjects on the dimension of sustained attention. Two hypotheses were tested: 1) that the β/α current density power ratio increased over sessions and 2) that by the end of the training subjects acquired the ability of increasing that ratio at will. Both hypotheses received substantial experimental support in this study. This is the first application of an EEG inverse solution to neurofeedback. Possible applications of the technique include the treatment of epileptic foci, the rehabilitation of specific brain regions damaged as a consequence of traumatic brain injury and, in general, the training of any spatial specific cortical electrical activity. These findings may also have relevant consequences for the development of brain-computer interfaces.

521. Carretié, L., M. Tapia, F. Mercado, J. Albert, S. López-Martín, and J.M. De La Serna, *Voltage-based versus factor score-based source localization analyses of electrophysiological brain activity: A comparison*. Brain Topography, 2004. **17**(2): p. 109-115.

Summary: Summary: Though, traditionally, electrophysiological recordings have been limited to provide temporal information on neural activity, the development of mathematical algorithms capable of solving the inverse problem is facilitating, in recent years, the access to spatial information (i.e., on the origin of neural activation). This study explored a new strategy in order to increase the reliability of inverse problem solutions: applying these algorithms on factor scores (and not on voltages), a parameter that can be defined as "clean amplitude". Factor scores derive from Principal Component Analysis (PCA) applied to event-related potentials (ERPs). The main advantage of PCA is its capability to extract and quantify ERP components free of the influence of adjacent or subjacent components. The LORETA algorithm for source localization was applied on peak voltage, average voltage and factor scores for the motor potential recorded from 25 subjects, who had to repeatedly press a button with their right hand. The solutions given by LORETA in these three modalities were compared. The motor potential, a negative wave that begins just before any voluntary movement and is centrally distributed in the scalp, is particularly useful to the scope of this study, since its origin is known: contralateral motor cortex. Results show that the three modalities (peak voltage, mean voltage and factor scores) provided the same main focus (left motor cortex), though the "cleanest" solution (i.e., the main focus was more salient with respect to other secondary, noisy foci) was achieved by the factor score-based LORETA.

522. Carretié, L., J.A. Hinojosa, M. Martín-Loeches, F. Mercado, and M. Tapia, *Automatic attention to emotional stimuli: Neural correlates*. Human Brain Mapping, 2004. **22**(4): p. 290-299.

Summary: We investigated the capability of emotional and nonemotional visual stimulation to capture automatic attention, an aspect of the interaction between cognitive and emotional processes that has received scant attention from researchers. Event-related potentials were recorded from 37 subjects using a 60-electrode array, and were submitted to temporal and spatial principal component analyses to detect and quantify the main components, and to source localization software (LORETA) to determine their spatial origin. Stimuli capturing automatic attention were of three types: emotionally positive, emotionally negative, and nonemotional pictures. Results suggest that initially (P1: 105 msec after stimulus), automatic attention is captured by negative pictures, and not by positive or nonemotional ones. Later (P2: 180 msec), automatic attention remains captured by negative pictures, but also by positive ones. Finally (N2: 240 msec), attention is captured only by positive and nonemotional stimuli. Anatomically, this sequence is characterized by decreasing activation of the visual association cortex (VAC) and by the growing involvement, from dorsal to ventral areas, of the anterior cingulate cortex (ACC). Analyses suggest that the ACC and not the VAC is responsible for experimental effects described above. Intensity, latency, and location of neural activity related to automatic attention thus depend clearly on the stimulus emotional content and on its associated biological importance. © 2004 Wiley-Liss, Inc.

523. Carbonell, F., L. Galán, P. Valdés, K. Worsley, R.J. Biscay, L. Díaz-Comas, M.A. Bobes, and M. Parra, *Random Field-Union Intersection tests for EEG/MEG imaging*. NeuroImage, 2004. **22**(1): p. 268-276.

Summary: Electrophysiological (EEG/MEG) imaging challenges statistics by providing two views of the same spatiotemporal data: topographic and tomographic. Until now, statistical tests for these two situations have developed separately. This work introduces statistical tests for assessing simultaneously the significance of spatiotemporal event-related potential/event-related field (ERP/ERF) components and that of their sources. The test for detecting a component at a given time instant is provided by a Hotelling's T2 statistic. This statistic is constructed in such a manner to be invariant to any choice of reference and is based upon a generalized version of the average reference transform of the data. As a consequence, the proposed test is a generalization of the well-known Global Field Power statistic. Consideration of tests at all time instants leads to a multiple comparison problem addressed by the use of Random Field Theory (RFT). The Union-Intersection (UI) principle is the basis for testing hypotheses about the topographic and tomographic distributions of such ERP/ERF components. The performance of the method is illustrated with actual EEG recordings obtained from a visual experiment of pattern reversal stimuli. © 2004 Elsevier Inc. All rights reserved.

524. Cannon, R., J. Lubar, K. Thornton, S. Wilson, and M. Congedo, *Limbic beta activation and LORETA: Can hippocampal and related limbic activity be recorded and changes visualized using LORETA in an affective memory condition?* Journal of Neurotherapy, 2004. **8**(4): p. 5-24.

Summary: Background. The purpose of this study was to determine the validity of Low Resolution Electromagnetic Tomography (LORETA) in visualizing limbic structures and possibly identifying electroencephalographic (EEG) frequencies in the limbic region during an anger memory recall process. Method. This study was conducted with twelve subjects, non-clinical students at the University of Tennessee, Knoxville. A pre-study screening was conducted. Eyes-open baselines were obtained employing 300 epochs, or five minutes, using a 19-channel quantitative electroencephalographic (qEEG) acquisition system with linked ear reference. The experimental condition recording directly followed an eyes-open baseline. The experimental condition was to allocate a memory that created intense anger and retain the state as long as possible. All files were no less than 100 total epochs upon editing. The data were analyzed in both individual and group conditions with LORETA imaging software. Statistical differences between conditions were evaluated for significance, then computed and transformed into LORETA images. Results. The data revealed significant differences between the anger condition and baseline recordings in limbic structures and frontal regions. The data suggests that limbic lobe and hippocampal activity can be recorded and visualized using LORETA during affective memory recall. There are several notable differences between the baseline and condition images. One of the more interesting of these differences is possible activation of the amygdala, uncinate

gyrus and surrounding structures in the beta (12-32 Hz) frequencies. The hemispheric asymmetries during anger memory recall offer further support for the lateralization of hemispheric activity relating to affective states. Conclusion. LORETA may be an effective method used to differentiate and visualize limbic lobe, hippocampal formation and other related structures during affective anger memory recall. © 2004 by The Haworth Press, Inc. All rights reserved.

525. Caldara, R., F. Jermann, G. López Arango, and M. Van Der Linden, *Is the N400 category-specific? A face and language processing study*. NeuroReport, 2004. **15**(17): p. 2589-2593.

Summary: N400 event-related potential (ERP) components have been observed during semantic incongruity detection in language, face identity and/or expression. However, it is still unclear whether semantic processing is functionally equivalent, since no study has directly investigated within the same participants the occurrence of the N400s for language and faces. We recorded ERPs while subjects performed incongruity detection on words, facial identities and facial expressions, with conditions matched to involve context integration. N400s were identified on central-parietal electrodes only for language and face identity processing. Scalp topographies of these N400s differed but a LORETA inverse solution identified a common functional generator in the left lateral frontal cortex, suggesting a general role of this brain region in selecting and contextually integrating semantic information. © 2004 Lippincott Williams & Wilkins.

526. Bücker, H.M. and R. Beucker, *Using automatic differentiation for the solution of the minimum p-norm estimation problem in magnetoencephalography*. Simulation Modelling Practice and Theory, 2004. **12**(2): p. 105-116.

Summary: The minimum-norm estimate is a popular reconstruction technique to localize the electrical activity on the human cortex for given measurements of a magnetic field outside the head. The standard approach minimizes the Euclidean norm of the current density distribution of the underlying dipole moments. However, for certain magnetic fields whose current density distribution is known to be focal, the traditional approach based on the Euclidean norm tends to over-smooth the reconstructions. To overcome these difficulties, a minimum p-norm approach with $1<p<2$ is taken to increase the focality when p approaches unity. A Newton-type optimization algorithm is investigated in order to avoid potential numerical instabilities caused by reweighted least-squares algorithms. The reverse mode of automatic differentiation is used to efficiently evaluate the underlying gradient of the cost function. © 2004 Elsevier B.V. All rights reserved.

527. Breznitz, Z., R. Oren, and S. Shaul, *Brain activity of regular and dyslexic readers while reading Hebrew as compared to English sentences*. Reading and Writing, 2004. **17**(7-8): p. 707-737.

Summary: The aim of the present study was to examine differences among 'regular' and dyslexic adult bilingual readers when processing reading and reading related skills in their first (L1 Hebrew) and second (L2 English) languages. Brain activity during reading Hebrew and English unexpected sentence endings was also studied. Behavioral and electrophysiological measures including event-related potentials (ERP) and low resolution electromagnetic tomography (LORETA) methodology were employed. Results indicated discrepancies in the processing profiles of dyslexic and regular bilingual readers in both first and second languages. In general, the amplitudes of the evoked potentials were higher and the latencies longer among dyslexic readers during processing of information in first and second languages (L1 and L2), but were more pronounced in English (L2). LORETA analysis indicated evidence that the source of brain activity measured by current density of brain activation is different when reading Hebrew as compared to English sentences mainly among dyslexies and not among regular readers. The data from the present study supports the 'dominanat bilingual' hypothesis for defining bilinguals. A discrepancy between achievement in performing various L1 and L2 tasks was consistent across groups. Both groups were better in there mother tongue, which was Hebrew as compared to English.

528. Anderer, P., B. Saletu, G. Saletu-Zyhlarz, D. Gruber, M. Metka, J. Huber, and R.D. Pascual-Marqui, *Brain regions activated during an auditory discrimination task in insomniac postmenopausal patients before and after hormone replacement therapy: Low-resolution brain electromagnetic tomography applied to event-related potentials*. Neuropsychobiology, 2004. **49**(3): p. 134-153.

Summary: Electrical sources of auditory event-related potentials (ERPs) determined by means of low-resolution brain electromagnetic tomography (LORETA) in 48 unmedicated insomniac postmenopausal patients aged between 46 and 67 years were compared with those obtained in 48 age-matched normal female controls. Subsequently, the patients were included in a double-blind, placebo-controlled, comparative, randomized 3-arm trial phase - Climodien 2/3 [estradiol valerate (EV) 2 mg + the progestin dienogest 3 mg] was compared with EV 2 mg and placebo - followed by an open-label phase in which all of them received Climodien 2/2 (EV 2 mg + dienogest 2 mg). The double-blind and the open-label phase lasted 2 months. ERPs were recorded from 19 EEG leads in a two-tone oddball paradigm and electrical sources of standard N1 and P2 as well as target N2 and P300 components were estimated. In both patients and controls, LORETA revealed an activation of the superior temporal gyrus [auditory cortex, Brodmann areas (BA) 41, 42, 22] for all four components. For standard P2, an additional activation was observed medially parietally in the precuneus (BA 7, 5). For target N2, also a medial frontal source (BA 9, 10, 32) was identified. Finally, for the target P300 component - in addition to the aforementioned sources - activations in the prefrontal cortex (BA 9, 10, 46, 47), the inferior parietal cortex (supramarginal gyrus, BA 40, 39) and the posterior cingulum (BA 31) were found. Thus, patients and controls did not differ in the structural

processes engaged in these fundamental aspects of information processing. However, patients demonstrated significantly reduced source strength - for standard ERP components predominantly in the temporal lobe and for target components predominantly in the frontal lobe, indicating reduced energetic resources available for perceptual and cognitive demands of the discrimination task. While, as compared with placebo, estrogen alone had only minor effects on ERP source strength, Climodien generally increased the impressed current density at the ERP peak latencies, predominantly in the temporal lobe, indicating an increased stimulus-induced cortical arousal in the primary and higher-order auditory cortex. Specifically, Climodien enhanced P300 source strength in the left middle temporal gyrus and in the left superior frontal gyrus, brain regions that on the one hand have been shown to be affected by hormone therapy in positron emission tomography and functional magnetic resonance neuroimaging studies and that on the other hand are among those critical for encoding and memory processes. Copyright © 2004 S. Karger AG, Basel.

529. Amblard, C., E. Lapalme, and J.M. Lina, *Biomagnetic Source Detection by Maximum Entropy and Graphical Models*. IEEE Transactions on Biomedical Engineering, 2004. **51**(3): p. 427-442.

Summary: This article presents a new approach for detecting active sources in the cortex from magnetic field measurements on the scalp in magnetoencephalography (MEG). The solution of this ill-posed inverse problem is addressed within the framework of maximum entropy on the mean (MEM) principle introduced by Clarke and Janday. The main ingredient of this regularization technique is a reference probability measure on the random variables of interest. These variables are the intensity of current sources distributed on the cortical surface for which this measure encompasses all available prior information that could help to regularize the inverse problem. This measure introduces hidden Markov random variables associated with the activation state of predefined cortical regions. MEM approach is applied within this particular probabilistic framework and simulations show that the present methodology leads to a practical detection of cerebral activity from MEG data.

530. Alonso-Prieto, E., E. Palmero-Soler, C. Trujillo-Matienzo, E. Cuspineda-Bravo, and I. Suárez-Luis, *Event-related potentials and the diagnosis of short-term verbal memory disorders in cerebrovascular disease*. Potenciales relacionados con eventos y diagnóstico de las alteraciones de la memoria verbal a corto plazo en la enfermedad cerebrovascular, 2004. **39**(6): p. 521-524.

Summary: Introduction. Cerebrovascular disease can cause different memory disorders depending on the area of the brain involved. More specifically, ischemic lesions in the frontal region can be associated to short-term verbal memory disorders. Patients and methods. Two groups of subjects were studied, 10 of whom were patients who presented a frontal cerebral infarction and 10 healthy controls. They were administered a memory task involving word recognition. While they were performing the task the electrical activity of their brains was recorded in order to examine event-related potentials (ERP). Results. The patients' performance of the task was poorer than that of the healthy control subjects. Likewise, while the latter displayed a predominantly frontal distribution of ERPs, in the patients the frontal activity diminished and was seen to be chiefly temporoparietooccipital. Conclusions. These findings allow important conclusions to be drawn about the characteristics of the memory disorder presented by these patients.

531. Alonso-Prieto, E., E. Palmero-Soler, E. Cuspineda-Bravo, A. Cordero-Eiriz, N. Trujillo-Barreto, C. Trujillo-Matienzo, O. Fernández-Concepción, and A. Jiménez-Conde, *Cognitive diagnosis of cerebrovascular disease by event-related potentials: Anatomical sources that generate P300.* Diagnóstico cognitivo en la enfermedad cerebrovascular mediante potenciales relacionados con eventos: Fuentes anatómicas generadoras de la P300, 2004. **38**(3): p. 229-233.

Summary: Introduction. Cerebrovascular disease causes different cognitive alterations. There is a need to develop tools that are capable of diagnosing them. One of them could be event-related potentials. These provide an indicator of cognitive processing in real time. Patients and methods. A study was conducted of 10 patients with cerebral infarction in the frontal region and 10 paired healthy controls. Evaluation of the patients was performed a week after the stroke. A continuous performance test was applied to both groups together with the recording of the electrical activity in the brain in order to obtain the P300 component. The results were submitted to the non-parametric Student's t test, and the Bayesian model averaging method (BMAM) was employed to calculate the sources generating the electrical activity recorded on the electroencephalogram. Results. Patients displayed significantly poorer performances compared to the healthy controls in the attention test. The BMAM showed that the P300 component was related to the right-hand temporal structures in healthy controls, whereas the left temporoparietal regions were also involved in the patients. Conclusions. These findings indicate the existence of subclinical disorders affecting sustained attention and that they can only be detected by very sensitive tools; furthermore, they also have implications for the brain circuits regulating sustained attention and the P300 component.

532. Alecu, T.I., S. Voloshynovskiy, and T. Pun, *Regularized two-step brain activity reconstruction from spatiotemporal EEG data.* Proceedings of SPIE - The International Society for Optical Engineering, 2004. **5562**: p. 109-120.

Summary: We are aiming at using EEG source localization in the framework of a Brain Computer Interface project. We propose here a new reconstruction procedure, targeting source (or equivalently mental task) differentiation. EEG data can be thought of as a collection of time continuous streams from sparse locations. The measured electric potential on one electrode is the result of the superposition of synchronized synaptic activity from sources in all the brain volume. Consequently, the EEG inverse problem is a highly underdetermined (and ill-posed) problem. Moreover, each source contribution is linear with respect to its amplitude but non-linear with respect to its localization and orientation. In order to overcome these drawbacks we propose a novel two-step inversion procedure. The solution is based on a double scale division of the solution space. The first step uses a coarse discretization and has the sole purpose of globally identifying the active regions, via a sparse approximation algorithm. The second step is applied only on the retained regions and makes use of a fine discretization of the space, aiming at detailing the brain activity. The local configuration of sources is recovered using an iterative stochastic estimator with adaptive joint minimum energy and directional consistency constraints.

533. Ahlfors, S.P. and G.V. Simpson, *Geometrical interpretation of fMRI-guided MEG/EEG inverse estimates*. NeuroImage, 2004. **22**(1): p. 323-332.

Summary: Magneto- and electroencephalography (MEG/EEG) and functional magnetic resonance imaging (fMRI) provide complementary information about the functional organization of the human brain. An important advantage of MEG/EEG is the millisecond time resolution in detecting electrical activity in the cerebral cortex. The interpretation of MEG/EEG signals, however, is limited by the difficulty of determining the spatial distribution of the neural activity. Functional MRI can help in the MEG/EEG source analysis by suggesting likely locations of activity. We present a geometric interpretation of fMRI-guided inverse solutions in which the MEG/EEG source estimate minimizes a distance to a subspace defined by the fMRI data. In this subspace regularization (SSR) approach, the fMRI bias does not assume preferred amplitudes for MEG/EEG sources, only locations. Characteristic dependence of the source estimates on the regularization parameters is illustrated with simulations. When the fMRI locations match the true MEG/EEG source locations, they serve to bias the underdetermined MEG/EEG inverse solution toward the fMRI loci. Importantly, when the fMRI loci do not match the true MEG/EEG loci, the solution is insensitive to those fMRI loci. © 2004 Elsevier Inc. All rights reserved.

534. Zhang, X., W. van Drongelen, K. Hecox, V.L. Towle, D.M. Frim, A. McGee, J. Lian, and B. He, *Localization of epileptic foci by means of cortical imaging using a spherical head model*. Neurocomputing, 2003. **52-54**: p. 977-982.

Summary: We have applied a cortical imaging technique (CIT) with a three-sphere head model to estimate cortical potentials from scalp electroencephalogram (EEG) recordings during interictal spikes in a pediatric epilepsy patient. The CIT analysis was performed during the ascending limb of interictal spikes and localized areas of activity were observed, overlying the epileptogenic zone, as being confirmed by the electrocorticography recordings and neurosurgical resections of the patient. The present study suggests that CIT may become a useful alternative for noninvasive localization of intracranial sources generating epileptiform activity from pre-operative scalp EEG recordings. © 2002 Elsevier Science B.V. All rights reserved.

535. Zhang, X., W. Van Drongelen, K. Hecox, V.L. Towle, D.M. Frim, A. McGee, and B. He, *Cortical imaging of epileptiform activity by means of a realistic geometry head model*. Annual International Conference of the IEEE Engineering in Medicine and Biology - Proceedings, 2003. **3**: p. 2091-2094.

Summary: A cortical potential imaging technique (CPI) was used to estimate the cortical potentials from scalp EEG recordings in two pediatric epilepsy patients. The pre-operative interictal spikes for 2 patients were applied to CPI by using realistic geometry head models built from individual MRI data. The localized areas of activity were revealed by CPI, as confirmed by neurosurgical resections and subdural ECoG recordings. The present study suggests that CPI may become a useful alternative for noninvasive imaging of epileptiform activity from pre-operative EEG recordings.

536. Zhang, Q., H. Nagashino, and Y. Kinouchi, *Accuracy of Single Dipole Source Localization by BP Neural Networks from 18-Channel EEGs*. IEICE Transactions on Information and Systems, 2003. **E86-D**(8): p. 1447-1455.

Summary: A problem of estimating biopotential sources in the brain based on EEG signals observed on the scalp is known as an important inverse problem of electrophysiology. Usually there is no closed-form solution for this problem and it requires iterative techniques such as the Levenberg-Marquardt algorithm. Considering the nonlinear properties of inverse problem, and signal to noise ratio inherent in EEG signals, a back propagation neural network has been recently proposed as a solution. In this paper, we investigated the properties of neural networks and its localization accuracy for single dipole source localization. Based on the results of extensive studies, we concluded the neural networks are highly feasible in single-source localization with a small number of electrodes (18 electrodes), also examined the usefulness of this method for clinical application with a case of epilepsy.

537. White, J.N., *Comparison of QEEG reference databases in basic signal analysis and in the evaluation of adult ADHD*. Journal of Neurotherapy, 2003. **7**(3-4): p. 123-169.

Summary: Introduction. Despite the relatively widespread investigation of potential quantitative electroencephalographic (QEEG) characteristics of childhood attention deficit hyperactivity disorder (ADHD), relatively little is known about the possible QEEG characteristics of adult ADHD. In addition to general magnitude or power measures, or ratios of these measures, the additional analyses and comparisons provided by QEEG reference databases may prove useful in providing unique markers for adult ADHD. Method. This investigation reports the findings of evaluations using three QEEG reference databases for a sample of ten adults previously diagnosed with ADHD. The packages used in the current investigation included the NeuroRep QEEG Analysis and Report System, the SKIL Topometric QEEG software package, and the NovaTech EEG EureKa3! QEEG analysis package. Results. As compared with the respective databases,

adults with ADHD appear to demonstrate higher levels of 8-10 Hz activity during both eyes-closed and eyes-open resting baselines. They also appear to demonstrate frontal involvement as evidenced by hypercoherence and hypercomodulation in frontal areas. Conclusions. Each of the three QEEG reference databases appears to offer unique markers for adult ADHD. However, other apparent differences were found to be attributable to specific analysis packages rather than the clinical group itself. An investigation of basic signal analyses also revealed differences between the three packages. Results of the respective analyses and possible implications are discussed. © 2003 by The Haworth Press, Inc. All rights reserved.

538. Wang, J., K.I. Hiramatsu, H. Hokama, H. Miyazato, and C. Ogura, *Abnormalities of auditory P300 cortical current density in patients with schizophrenia using high density recording*. International Journal of Psychophysiology, 2003. **47**(3): p. 243-253.

Summary: While P300 current density analysis has been performed in schizophrenic patients, the event-related potential data have never been obtained using a high density recording, nor have their cortical images been well demonstrated. In this study, the auditory P300 elicited by an oddball paradigm was recorded using a high density recording system of 128 channels. Thirteen male patients who met DSM-IV criteria for schizophrenia were compared with 20 healthy male controls. The cortical current density analysis of low resolution electromagnetic tomography (LORETA) was applied to the P300 component, and this resulted in the values of 6222 current density points over the surface of a cortex model. The inter-group difference of P300 current density was assessed using a point-by-point comparison by t-test. While the normal controls demonstrated the cortical activation of bilateral frontal, temporal and parietal cortex during the oddball paradigm, visual inspection suggested that in the schizophrenic patients these areas were less activated. The inter-group significance of P300 current density was dominant over the left hemisphere, and particularly over the left prefrontal area. It is concluded that the LORETA current density analysis localizes the neural activity from the cortical fronto-temporo-parietal network as the neural substrates of the scalp recorded P300. The dysfunction of such a network, especially over the left hemisphere, possibly subserves the scalp recorded P300 abnormality in schizophrenia. © 2002 Elsevier Science B.V. All rights reserved.

539. Veiga, H., A. Deslandes, M. Cagy, A. Fiszman, R.A.M. Piedade, and P. Ribeiro, *Neurocortical electrical activity tomography in chronic schizophrenics*. Arquivos de Neuro-Psiquiatria, 2003. **61**(3 B): p. 712-717.

Summary: Functional imaging of brain electrical activity was performed in 25 chronic medicated schizophrenics and 40 controls, analyzing the classical frequency bands (delta, theta, alpha, and beta) of 19-channel EEG during resting state to identify brain regions with deviant activity of different functional significances, using LORETA (Low Resolution Tomography) and SPM99

(Statistical Parametric Mapping). Patients differed from controls due to an excess of slow activity comprising delta + theta frequency bands (inhibitory pattern) located at the right middle frontal gyrus, right inferior frontal gyrus, and right insula, as well as at the bilateral anterior cingulum with a left preponderance. The high temporal resolution of EEG enables the specification of the deviations not only as an excess or a deficit of brain electrical activity, but also as inhibitory (delta, theta), normal (alpha), and excitatory (beta) activities. These deviations point out to an impaired functional brain state consisting of inhibited frontal and prefrontal areas that may result in inadequate treatment of externally or internally generated information.

540. Tanaka, H., M. Harada, M. Arai, and K. Hirata, *Cognitive dysfunction in cortical cerebellar atrophy correlates with impairment of the inhibitory system*. Neuropsychobiology, 2003. **47**(4): p. 206-211.

Summary: The aim of the present study was to evaluate the profile of cognitive impairment in patients with cortical cerebellar atrophy (CCA) by measurement of event-related potentials (ERP) and neuropsychological tests. We studied 13 CCA patients and 13 age-, sex- and education-matched normal controls. For ERP recording, we used the conventional auditory oddball task as well as the continuous performance task, which evaluates the attentional performance and ability to control a motor response, i.e., to execute ('Go') or inhibit a motor reaction ('No Go'). Brain electric activity was recorded using 20 scalp electrodes and computed into series of potential distribution maps. For components of ERP, reference-independent measures [global field power (GFP)] were determined, and low-resolution brain electromagnetic tomography (LORETA) was used to compute the three-dimensional intracerebral distribution of electric activity of the P3 component of Go and No Go responses. A comprehensive neuropsychological test battery was also assessed. GFP peak latency was prolonged and GFP peak was attenuated under the No Go condition in patients with CCA, although there were no differences in the auditory oddball task and in the Go condition between the two groups. LORETA showed low activation of frontal source in CCA patients in No Go P3 compared with the controls. However, neuropsychological tests revealed no differences between the two groups. Our results indicate that degeneration of the cerebellum contributes to frontal dysfunction, and suggest this dysfunction is characterized by an impairment of the inhibitory system. Copyright © 2003 S. Karger AG, Basel.

541. Somersalo, E., A. Voutilainen, and J.P. Kaipio, *Non-stationary magnetoencephalography by Bayesian filtering of dipole models*. Inverse Problems, 2003. **19**(5): p. 1047-1063.

Summary: In this paper, we consider the biomagnetic inverse problem of estimating a time-varying source current from magnetic field measurements. It is assumed that the data are severely corrupted by measurement noise. This setting is a model for magnetoencephalography (MEG) when the dynamic nature of the source prevents us from effecting noise reduction by averaging over consecutive

measurements. Thus, the potential applications of this approach include the single trial estimation of the brain activity, in particular from the spontaneous MEG data. Our approach is based on non-stationary Bayesian estimation, and we propose the use of particle filters. The source model in this work is either a single dipole or multiple dipole model. Part of the problem consists of the model determination. Numerical simulations are presented.

542. Sittiprapaporn, W., C. Chindaduangratn, M. Tervaniemi, and N. Khotchabhakdi, *Preattentive Processing of Lexical Tone Perception by the Human Brain as Indexed by the Mismatch Negativity Paradigm*. Annals of the New York Academy of Sciences, 2003. **999**: p. 199-203.

Summary: Mismatch negativity (MMN) was used to investigate the processing of the discrimination between native and non-native CV syllables in tonal languages. MMN elicited by the native word was greater than that elicited by the non-native word. Hearing a native-language deviant significantly altered the elicited MMN in both amplitude and scalp voltage field distribution, reflecting the presence of a long-term memory trace for spoken words in tonal languages.

543. Sinai, A. and H. Pratt, *High-resolution time course of hemispheric dominance revealed by low-resolution electromagnetic tomography*. Clinical Neurophysiology, 2003. **114**(7): p. 1181-1188.

Summary: Objective: Auditory event-related brain potentials (ERPs) were recorded during a lexical decision task in response to linguistic and non-linguistic stimuli, to assess the detailed time course of language processing in general, and hemispheric dominance in particular. Methods: Young adults (n=17) were presented with pairs of auditory stimuli consisting of words, pseudowords and words played backwards in a lexical decision task. ERPs were recorded from 21 scalp electrodes. Current densities were calculated using low-resolution electromagnetic tomography (LORETA). Statistic non-parametric maps of activity were derived from the calculated current densities and the number of active brain voxels in the left and right hemispheres was compared throughout the processing of each stimulus. Results: Our results show that hemispheric dominance is highly time dependent, alternating between the right and left hemispheres at different times, and that the right hemisphere's role in language processing follows a different time course for first and second language. The time course of hemispheric dominance for non-linguistic stimuli was highly variable. Conclusions: The time course of hemispheric dominance is dynamic, alternating between left and right homologous regions, with different time courses for different stimulus classes. © 2003 International Federation of Clinical Neurophysiology. Published by Elsevier Science Ireland Ltd. All rights reserved.

544. Silva-Pereyra, J., M. Rivera-Gaxiola, E. Aubert, J. Bosch, L. Galán, and A. Salazar, *N400 during lexical decision tasks: A current source localization study*. Clinical Neurophysiology, 2003. **114**(12): p. 2469-2486.

Summary: Objective: Our primary aim in the present study was to establish the anatomic and psychophysiological correlates of automatic and controlled semantic priming. Methods: Current sources were calculated on N400 component data from a previous study on lexical decision tasks [Clin Neurophysiol 1999;110:813] using the variable resolution electromagnetic tomography method (VARETA). In this study, two experiments were carried out, one using directly related pairs and the other one using mediated related pairs. Each experiment consisted of 3 tasks that required different levels of contribution from controlled processes. Results: Average source localization images showed the brain structures involved in lexical decision tasks. The automatic component of the N400 effect was related to activation of occipitotemporal and parahippocampal gyri and anterior temporal lobes bilaterally. The expectancy strategy was related to activation of the right posterior temporal and right frontal areas. The postlexical strategy was associated with activation of right frontal, anterior cingulate and bilateral superior parietal areas. Conclusions: The findings indicated that the current sources of the N400 varied according to the relative contributions of automatic and controlled mechanisms. Moreover, the sources of the N400 effect depended on the type of strategy used. © 2003 International Federation of Clinical Neurophysiology. Published by Elsevier Ireland Ltd. All rights reserved.

545. Ricamato, A.L., Y.Y. Dhaher, and J.P.A. Dewald, *Estimation of Active Cortical Current Source Regions Using a Vector Representation Scanning Approach*. Journal of Clinical Neurophysiology, 2003. **20**(5): p. 326-344.

Summary: The objective of this article is to present a framework for cortical current source reconstruction that extracts a center and magnitude of electrical brain activity from EEG signals. High-resolution EEG recordings, a subject-specific MRI-based electromagnetic boundary element method (BEM) model, and a channel reduction technique are used. This new geometric measure combines the magnitude and spatial location of electrical brain activity of each of the identified subsets of channels into a three-dimensional resultant vector. The combination of the two approaches constitutes a source reconstruction scanning technique that provides a real-time estimation of cortical centers that can be tracked over time. Simulations demonstrate that the ability of this method to find the best-fit cortical location is more robust both in terms of accuracy and precision than traditional approaches for single-source conditions. Experimental validation demonstrates its ability to localize and separate cortical activity in plausible sites for two different motor tasks. Finally, this method provides a statistical measure to compare electrical brain activity associated with different motor tasks.

546. Pizzagalli, D.A., T.R. Oakes, and R.J. Davidson, *Coupling of theta activity and glucose metabolism in the human rostral anterior cingulate cortex: An EEG/PET study of normal and depressed subjects*. Psychophysiology, 2003. **40**(6): p. 939-949.

Summary: In rodents, theta rhythm has been linked to the hippocampal formation, as well as other regions, including the anterior cingulate cortex (ACC). To test the role of the ACC in theta rhythm, concurrent measurements of brain electrical activity (EEG) and glucose metabolism (PET) were performed in 29 subjects at baseline. EEG data were analyzed with a source localization technique that enabled voxelwise correlations of EEG and PET data. For theta, but not other bands, the rostral ACC (Brodmann areas 24/32) was the largest cluster with positive correlations between current density and glucose metabolism. Positive correlations were also found in right fronto-temporal regions. In control but not depressed subjects, theta within ACC and prefrontal/orbitofrontal regions was positively correlated. The results reveal a link between theta and cerebral metabolism in the ACC as well as disruption of functional connectivity within frontocingulate pathways in depression.

547. Pizzagalli, D.A., L.L. Greischar, and R.J. Davidson, *Spatio-temporal dynamics of brain mechanisms in aversive classical conditioning: High-density event-related potential and brain electrical tomography analyses.* Neuropsychologia, 2003. **41**(2): p. 184-194.

Summary: Social cognition, including complex social judgments and attitudes, is shaped by individual learning experiences, where affect often plays a critical role. Aversive classical conditioning - a form of associative learning involving a relationship between a neutral event (conditioned stimulus, CS) and an aversive event (unconditioned stimulus, US) - represents a well-controlled paradigm to study how the acquisition of socially relevant knowledge influences behavior and the brain. Unraveling the temporal unfolding of brain mechanisms involved appears critical for an initial understanding about how social cognition operates. Here, 128-channel ERPs were recorded in 50 subjects during the acquisition phase of a differential aversive classical conditioning paradigm. The CS+ (two fearful faces) were paired 50% of the time with an aversive noise (CS↑ + /Paired), whereas in the remaining 50% they were not (CS↑ + /Unpaired); the CS- (two different fearful faces) were never paired with the noise. Scalp ERP analyses revealed differences between CS↑ + /Unpaired and CS- as early as ~120ms post-stimulus. Tomographic source localization analyses revealed early activation modulated by the CS+ in the ventral visual pathway (e.g. fusiform gyrus, ~ 120ms), right middle frontal gyrus (~176ms), and precuneus (~240ms). At ~ 120ms, the CS- elicited increased activation in the left insula and left middle frontal gyrus. These findings not only confirm a critical role of prefrontal, insular, and precuneus regions in aversive conditioning, but they also suggest that biologically and socially salient information modulates activation at early stages of the information processing flow, and thus furnish initial insight about how affect and social judgments operate. © 2002 Elsevier Science Ltd. All rights reserved.

548. Perlstein, W.M., M.A. Cole, M. Larson, K. Kelly, P. Seignourel, and A. Keil, *Steady-state visual evoked potentials reveal frontally-mediated working memory activity in humans*. Neuroscience Letters, 2003. **342**(3): p. 191-195.

Summary: Steady-state visual evoked potentials (SSVEPs) reflect power changes at the stimulus driving frequency and have been used to assess brain activity reflecting cognitive processing. Only one study has demonstrated SSVEP modulation associated with working memory (WM), and none have compared the spatial localization of SSVEP modulations during WM performance with other brain imaging methods. Here we examined WM-related activity recorded with dense-array SSVEPs, analyzed using low resolution electromagnetic tomography, and compared the results to our previous findings using functional magnetic resonance imaging (fMRI). WM was associated with increased SSVEP activity over the right dorsolateral prefrontal cortex, paralleling our previous fMRI findings. Frontal WM-related SSVEP power correlated selectively with task performance. These results demonstrate the utility of SSVEPs for studying representational aspects of cognition. © 2003 Elsevier Science Ireland Ltd. All rights reserved.

549. Pae, J.S., J.S. Kwon, T. Youn, H.J. Park, M.S. Kim, B. Lee, and K.S. Park, *LORETA imaging of P300 in schizophrenia with individual MRI and 128-channel EEG*. NeuroImage, 2003. **20**(3): p. 1552-1560.

Summary: We investigated the characteristics of P300 generators in schizophrenics by using voxel-based statistical parametric mapping of current density images. P300 generators, produced by a rare target tone of 1500 Hz (15%) under a frequent nontarget tone of 1000 Hz (85%), were measured in 20 right-handed schizophrenics and 21 controls. Low-resolution electromagnetic tomography (LORETA), using a realistic head model of the boundary element method based on individual MRI, was applied to the 128-channel EEG. Three-dimensional current density images were reconstructed from the LORETA intensity maps that covered the whole cortical gray matter. Spatial normalization and intensity normalization of the smoothed current density images were used to reduce anatomical variance and subject-specific global activity and statistical parametric mapping (SPM) was applied for the statistical analysis. We found that the sources of P300 were consistently localized at the left superior parietal area in normal subjects, while those of schizophrenics were diversely distributed. Upon statistical comparison, schizophrenics, with globally reduced current densities, showed a significant P300 current density reduction in the left medial temporal area and in the left inferior parietal area, while both left prefrontal and right orbitofrontal areas were relatively activated. The left parietotemporal area was found to correlate negatively with Positive and Negative Syndrome Scale total scores of schizophrenic patients. In conclusion, the reduced and increased areas of current density in schizophrenic patients suggest that the medial temporal and frontal areas contribute to the pathophysiology of schizophrenia, the frontotemporal circuitry abnormality. © 2003 Elsevier Inc. All rights reserved.

550. Nixon, J.B., P.E. Rasser, M.D. Teubner, C.R. Clark, and M.J. Bottema, *Numerical model of electrical potential within the human head*. International Journal for Numerical Methods in Engineering, 2003. **56**(15): p. 2353-2366.

Summary: A realistic subject-specific human head model was constructed based on structural magnetic resonance imaging (sMRI) data. Electrical conductivities were assigned inhomogeneously according to tissue type and variability within each head segment. A three-dimensional (3D) finite-difference method (FDM) was used to compute the evolution of the electrical potential from a single electrical dipole within the brain. The Douglas-Rachford FDM and three versions of iterative FDM were tested on a three-layer concentric sphere model. The successive over-relaxation (SOR) iterative method showed the best convergence properties and hence was used to compute the electrical potential within a realistic head model. The effect of using inhomogeneous rather than homogeneous conductivities within head segments of this model was shown to be important. © 2003 John Wiley and Sons, Ltd.

551. Maurer, U., K. Bucher, S. Brem, and D. Brandeis, *Development of the automatic mismatch response: From frontal positivity in kindergarten children to the mismatch negativity*. Clinical Neurophysiology, 2003. **114**(5): p. 808-817.

Summary: Objective: The automatic event-related potential (ERP) response to auditory deviance typically consists of a frontocentral mismatch negativity (MMN), which has been shown to be quite stable during development. Whereas in some infant studies, positive frontal mismatch responses have been reported instead of a MMN; to date, such positivities have not been reported for older children. Methods: Oddball sequences with small frequency and phoneme deviance (standard: 1000Hz, 'ba'; larger deviance: 1060Hz, 'ta'; smaller deviance: 1030Hz, 'da') and short intervals (every 0.38s) were presented to 6-7-year-old children and adults during 43-channel ERP recordings. Results: Children showed a consistent frontal positive mismatch response with posterior negativity (179-207ms), and adults a frontocentral MMN with mastoid positivity (129-199ms). This map polarity reversal was reflected by significantly different 3D centroid distributions. Low-resolution electromagnetic tomography (LORETA) revealed temporal mismatch response sources for both age groups and conditions. Conclusions: Major developmental changes characterise the automatic mismatch response for the small deviances and short intervals used. Source localisation suggests that children's and adults' mismatch responses originated from superior temporal plane generators with similar localisation but opposite polarity. This indicates qualitatively different neurophysiological functioning of the automatic bi-temporal auditory change detectors in children and adults. © 2003 International Federation of Clinical Neurophysiology. Published by Elsevier Science Ireland Ltd. All rights reserved.

552. Lubar, J.F., M. Congedo, and J.H. Askew, *Low-resolution electromagnetic tomography (LORETA) of cerebral activity in chronic depressive disorder*. International Journal of Psychophysiology, 2003. **49**(3): p. 175-185.

Summary: In this study we compared the current density power and power asymmetry in 15 right-handed, medication-free chronically depressed females (of the unipolar type) and age-matched non-clinical female controls. We used frequency domain LORETA (Low-Resolution Electromagnetic Tomography). In the interhemispheric asymmetry analysis, compared with the control group, the depression group exhibited a left-to-right Alpha2 (10-12 Hz) current density dominance in the left postcentral gyrus. The pattern of left-to-right dominance included frontal (especially medial and middle frontal gyri) and temporal locations. The between groups comparison of spectral power revealed decreased activity in the right middle temporal gyrus in the depressed group. The decrease emerged in the whole frequency spectrum analyzed (2-32 Hz), although it reached significance in the Delta (2-3.5 Hz) band only. These findings are discussed in terms of the existing literature on affect using EEG, PET and SPECT.
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553. Liu, Y., C.A. Perfetti, and L. Hart, *ERP Evidence for the Time Course of Graphic, Phonological, and Semantic Information in Chinese Meaning and Pronunciation Decisions*. Journal of Experimental Psychology: Learning Memory and Cognition, 2003. **29**(6): p. 1231-1247.

Summary: Two words that varied in their relationship were presented sequentially to Chinese readers who made meaning and pronunciation decisions. In the meaning task, they decided whether the words had the same meaning. In the pronunciation task, they decided whether the words had the same pronunciation. In both tasks, the word pairs represented 1 of 4 relationships: graphically similar, homophonic, semantically related, or unrelated. Event related potentials (ERP) recordings made from the onset of the 2nd word suggested a temporal unfolding of graphic, phonological, and semantic effects. Specifically, graphically related pairs produced a smaller P200 in the pronunciation task and a smaller N400 in the meaning task. Homophones produced reduced N400 component with bilateral sources in the meaning task.

554. Liu, Y. and C.A. Perfetti, *The time course of brain activity in reading English and Chinese: An ERP study of Chinese bilinguals*. Human Brain Mapping, 2003. **18**(3): p. 167-175.

Summary: Chinese bilinguals performed a delayed naming task, reading both Chinese characters and English words, while EEGs were recorded by a 128-channel system. Principle component analysis (PCA) of Event Related Potentials (ERP) from the onset of the stimulus suggested a temporal unfolding of graphic, phonological, and semantic processing that depended on both language and word frequency. At 150 msec, Chinese produced an earlier and higher amplitude shift (N150) than English. At 250 msec, frequency effects were significant for both Chinese and English, but at 450 msec, only the English frequency effect was reliable. Source localization analysis by Low Resolution Electromagnetic Tomography (LORETA) showed bilateral occipital (left BA 17, right BA 18) visual processing of Chinese characters with left occipital only (left BA 17) for English

high-frequency words. Low-frequency English words showed activation bilaterally, but with a more diffused and extended temporal pattern. Right prefrontal area (BA 10) was found to be strongly activated in the mid latency (300-400 msec) period of Chinese character naming, whereas English word naming showed more medial frontal (BA 8, and 10) activation. A post 450-msec visual verification was found to be general for both writing systems. © 2003 Wiley-Liss, Inc.

555. Laufer, I. and H. Pratt, *The electrophysiological net response ('F-complex') to spatial fusion of speech elements forming an auditory object*. Clinical Neurophysiology, 2003. **114**(5): p. 818-834.

Summary: Objective: The purpose of this study was to define and analyze the brain activity associated with fusion of speech elements to form an auditory object and to study the effects of presenting the elements at different spatial locations (duplex stimulus). Methods: Stimuli were formant transitions (presented to the front, left or right of the subject) and base (presented to the front), that fused to result in V-C-V sequences /aga/ and /ada/. Ten right-handed, adult, native Hebrew speakers discriminated each fused stimulus, and the brain potentials associated with performance of the task were recorded from 21 electrodes. The net-fusion response, the 'F(fusion)-complex', was extracted by subtracting the sum of potentials to the base and formant transitions from the potentials to the fused sound. Low resolution electromagnetic tomography analysis (LORETA) was performed to assess the timing and brain location of the fusion process. Results: The 'F-complex', comprising of the difference N1, P2, N2b (FN1, FP2, FN2b) components could be identified for each of the stimuli and reflected a process indicating inhibition, occlusion or both, with right ear advantage in fusion. LORETA analyses indicate sequential processing of speech fusion in the temporal lobes, beginning with right prominence in FN1 and FP2 shifting to a more symmetrical pattern in FN2. Conclusions: The electrophysiological correlates of speech fusion highlight the uniqueness of speech perception and the brain areas involved in its analysis. © 2003 International Federation of Clinical Neurophysiology. Published by Elsevier Science Ireland Ltd. All rights reserved.

556. Laufer, I. and H. Pratt, *Evoked potentials to auditory movement sensation in duplex perception*. Clinical Neurophysiology, 2003. **114**(7): p. 1316-1331.

Summary: Objective: The purpose of this study was to examine the processing of auditory movement sensation accompanying duplex perception in binaural hearing. Methods: Stimuli were formant transitions (presented to the front, left or right of the subject) and base (presented to the front), that fused to result in vowel-consonant-vowel (V-C-V) sequences /aga/ and /ada/. An illusion of auditory movement (duplex sensation) accompanied the fusion of these V-C-V sequences when the spatial locations of the formant transitions and base were different. Ten right-handed, adult, native Hebrew speakers discriminated each fused stimulus, and the brain potentials associated with performance of the task were recorded from 21 electrodes. The processing of auditory movement was studied by a factorial design (ANOVA) and statistical non-parametric mapping (SnPM) of low resolution electromagnetic tomography (LORETA) images of the net-fusion response. Brain regions implicated in auditory movement processing were expected to be associated with the lateralized formant location, which gave rise to duplex perception. In addition, the time-course of significant activation in brain areas that differentiated between fusion conditions was determined. Results: The posterior parietal, anterior cingulate and premotor cortices were found to be implicated in duplex processing. Auditory cortex involvement was also evident, and together with the latter two brain regions was affected by right-ear advantage. Conclusions: Duplex perception resulting from fusion of spatially separate sounds forming an auditory object results in activation of a network of brain regions reflecting enhanced allocation of attention and the effect of language processing. © 2003 International Federation of Clinical Neurophysiology. Published by Elsevier Science Ireland Ltd. All rights reserved.

557. Kincses, W.E., C. Braun, S. Kaiser, W. Grodd, H. Ackermann, and K. Mathiak, *Reconstruction of extended cortical sources for EEG and MEG based on a Monte-Carlo-Markov-Chain estimator*. Human Brain Mapping, 2003. **18**(2): p. 100-110.

Summary: A new procedure to model extended cortical sources from EEG and MEG recordings based on a probabilistic approach is presented. The method (SPMECS) was implemented within the framework of maximum likelihood estimators. Neuronal activity generating EEG or MEG signals was characterized by the number of sources and their location and extension. Based on the noise distribution of the measured data, source configurations were associated with the according value of the likelihood function. To find the most likely source, i.e., the maximum likelihood estimator, and its level of confidence, a stochastic solver (Metropolis algorithm) was applied. The method presented supports the incorporation of virtually any constraint, e.g., based on physiological and anatomical a priori knowledge. Thus, ambiguity of the ill-posed inverse problem was reduced considerably by confining sources to the cortical surface extracted from individual MR images. The influence of different levels and types of noise on the outcome was investigated by means of simulations. Somatosensory evoked magnetic fields analyzed by the method presented suggest that larger extended cortical areas are involved in the processing of combined finger stimulation as compared to single finger stimulation. © 2002 Wiley-Liss, Inc.

558. Im, C.H., K.O. An, H.K. Jung, H. Kwon, and Y.H. Lee, *Assessment criteria for MEG/EEG cortical patch tests*. Physics in Medicine and Biology, 2003. **48**(15): p. 2561-2573.

Summary: To validate newly developed methods or implemented software for magnetoencephalography/electroencephalography (MEG/EEG) source localization problems, many researchers have used human skull phantom experiments or artificially constructed forward data sets. Between the two

methods, the use of an artificial data set constructed with forward calculation attains superiority over the use of a human skull phantom in that it is simple to implement, adjust and control various conditions. Nowadays, for the forward calculation, especially for the cortically distributed source models, generating artificial activation patches on a brain cortical surface has been popularized instead of activating some point dipole sources. However, no well-established assessment criterion to validate the reconstructed results quantitatively has yet been introduced. In this paper, we suggest some assessment criteria to compare and validate the various MEG/EEG source localization techniques or implemented software applied to the cortically distributed source model. Four different criteria can be used to measure accuracy, degrees of focalization, noise-robustness, existence of spurious sources and so on. To verify the usefulness of the proposed criteria, four different results from two different noise conditions and two different reconstruction techniques were compared for several patches. The simulated results show that the new criteria can provide us with a reliable index to validate the MEG/EEG source localization techniques.

559. Hori, J. and B. He, *EEG Cortical Potential Imaging of Brain Electrical Activity by means of Parametric Projection Filters*. IEICE Transactions on Information and Systems, 2003. **E86-D**(9): p. 1909-1920.

Summary: The objective of this study was to explore suitable spatial filters for inverse estimation of cortical potentials from the scalp electroencephalogram. The effect of incorporating noise covariance into inverse procedures was examined by computer simulations. The parametric projection filter, which allows inverse estimation with the presence of information on the noise covariance, was applied to an inhomogeneous three-concentric-sphere model under various noise conditions in order to estimate the cortical potentials from the scalp potentials. The present simulation results suggest that incorporation of information on the noise covariance allows better estimation of cortical potentials, than inverse solutions without knowledge about the noise covariance, when the correlation between the signal and noise is low. The method for determining the optimum regularization parameter, which can be applied for parametric inverse techniques, is also discussed.

560. Holliday, I.E., G.R. Barnes, A. Hillebrand, and K.D. Singh, *Accuracy and Applications of Group MEG Studies Using Cortical Source Locations Estimated From Participants' Scalp Surfaces*. Human Brain Mapping, 2003. **20**(3): p. 142-147.

Summary: We contend that powerful group studies can be conducted using magnetoencephalography (MEG), which can provide useful insights into the approximate distribution of the neural activity detected with MEG without requiring magnetic resonance imaging (MRI) for each participant. Instead, a participant's MRI is approximated with one chosen as a best match on the basis of the scalp surface from a database of available MRIs. Because large inter-individual variability in sulcal and gyral patterns is an inherent source of blurring in studies using grouped functional activity, the additional error introduced by this approximation procedure has little effect on the group results, and offers a sufficiently close approximation to that of the participants to yield a good indication of the true distribution of the grouped neural activity. T1-weighted MRIs of 28 adults were acquired in a variety of MR systems. An artificial functional image was prepared for each person in which eight 5 × 5 × 5 mm regions of brain activation were simulated. Spatial normalisation was applied to each image using transformations calculated using SPM99 with (1) the participant's actual MRI, and (2) the best matched MRI substituted from those of the other 27 participants. The distribution of distances between the locations of points using real and substituted MRIs had a modal value of 6 mm with 90% of cases falling below 12.5 mm. The effects of this -approach on real grouped SAM source imaging of MEG data in a verbal fluency task are also shown. The distribution of MEG activity in the estimated average response is very similar to that produced when using the real MRIs. © 2003 Wiley-Liss, Inc.

561. Halford, J.J., *Neurophysiologic correlates of psychiatric disorders and potential applications in epilepsy*. Epilepsy and Behavior, 2003. **4**(4): p. 375-385.

Summary: There is increasing interest in psychiatric assessment using neurophysiologic tools such as electroencephalography (EEG), magnetoencephalography (MEG), and transcranial magnetic stimulation (TMS). This is because these technologies have good temporal resolution, are relatively noninvasive, and (with the exception of MEG) are economical. Many different experimental paradigms and analysis techniques for the assessment of psychiatric patients involving these technologies are reviewed including conventional quantitative electroencephalography (QEEG), EEG cordance, low-resolution electromagnetic tomography (LORETA), frontal midline theta, midlatency auditory evoked potentials (P50, N100, P300), loudness dependency of the auditory evoked potential (LDAEP), mismatch negativity (MMN), contingent negative variation (CNV), and transcranial magnetic stimulation (TMS). Many of these neurophysiologic stimulus paradigms hold the promise of improving psychiatric patient care by improving diagnostic precision, predicting treatment response, and providing new phenotypes for genetic studies. Large cooperative multisite studies need to be designed to test and validate a few of these paradigms so that they might find use in routine clinical practice. © 2003 Elsevier Science (USA). All rights reserved.

562. Gómez, C.M., J. Marco, and C. Grau, *Preparatory visuo-motor cortical network of the contingent negative variation estimated by current density*. NeuroImage, 2003. **20**(1): p. 216-224.

Summary: The present report studied the intracerebral current density of the contingent negative variation (CNV) during a visuo-manual task using the gap paradigm. The CNV is usually obtained during preparatory periods for perception and action. In this experiment right-hand responses were required. The CNV

potential was obtained during the preparatory period from electrodes placed at 58 scalp sites. The CNV showed an early and a late phase. Scalp voltage and source current density maps showed that the early phase was focused on frontal midline sites. The late phase had two foci, one overlying the primary motor cortex and one over occipital sites. When analyzed by low-resolution tomography, the early phase of the CNV showed activations in the supplementary motor area (SMA), the anterior cingulate cortex (ACC), and some posterior areas. The late phase had anterior activations in the left prefrontal cortex, middle frontal cortex, primary motor cortex, ACC, and SMA; and several posterior activations including those in the medial occipital cortex, middle inferior occipital cortex, posterior cingulate cortex, and temporal and parietal areas. Results from the activated areas and their temporal dynamics during the preparatory period suggest that the ACC and the SMA areas recruit the action- and perception-related areas needed to process the expected subsequent imperative task. © 2003 Elsevier Inc. All rights reserved.

563. Fallgatter, A.J., A.J. Bartsch, J. Zielasek, and M.J. Herrmann, *Brain electrical dysfunction of the anterior cingulate in schizophrenic patients.* Psychiatry Research - Neuroimaging, 2003. **124**(1): p. 37-48.

Summary: The anterior cingulate cortex (ACC) is a key region within the human prefrontal cortex that has been shown to be dysfunctional in schizophrenic patients. Supporting evidence for this notion has been collected with neuroimaging methods during various cognitive activation tasks. Recently, electrophysiological ACC activity has been demonstrated by means of a three-dimensional source location with low resolution electromagnetic tomography (LORETA) in the event-related potentials elicited during the NoGo condition of the Continuous Performance Test (CPT) as compared to its Go condition. Thirty-one schizophrenic patients and 31 age- and gender-matched healthy volunteers were investigated with this newly developed electrophysiological method. LORETA analysis revealed a significantly diminished brain electrical activity in the ACC of schizophrenic patients as compared to controls during the NoGo condition of the CPT. This result supports the assumption of a functional deficit of the ACC during this cognitive task as a central feature in schizophrenias and, thereby, specifies the general concept of hypofrontality. Moreover, this investigation underscores the value of sophisticated electrophysiological methods in combination with unambiguously designed mental tasks for the evaluation of the pathophysiological processes underlying schizophrenic diseases. © 2003 Elsevier Ireland Ltd. All rights reserved.

564. Curtis, W.J. and D. Cicchetti, *Moving research on resilience into the 21st century: Theoretical and methodological considerations in examining the biological contributors to resilience.* Development and Psychopathology, 2003. **15**(3): p. 773-810.

Summary: Empirical investigations of resilience over the past 30 years have examined a wide range of psychosocial correlates of, and contributors to, this phenomenon. Thus far, theoretical treatments of resilience have focused almost exclusively on psychosocial levels of analysis to derive explanatory models. However, there have been no formal discussions of either theory or research that have examined the biological contributors to, or correlates of, competent functioning despite the experience of adversity. This paper seeks to fill this gap and sets forth a preliminary theoretical framework and outline of empirical strategies for studying the biological underpinnings of resilience. The initial sections of the paper discuss the particular suitability of a transactional organizational theoretical perspective as a conceptual foundation for including a biological level of analysis within the extant theoretical framework of resilience. Subsequently, other important theoretical considerations for the inclusion of a biological perspective on resilience are discussed, including the avoidance of an approach that would reduce resilience to merely a biological process, the application of the constructs of multifinality and equifinality to a biological perspective on resilience, as well as a general discussion of the potential for utilization of brain imaging and other technologies in the study of resilience. The possible relation between the mechanisms of neural plasticity and resilience are examined in some detail, with specific suggestions concerning research questions needed to examine this association. Sections of the paper discuss the likely relation of several areas of brain and biological functioning with resilience, including emotion, cognition, neuroendocrine and immune functioning, and genetics. The paper concludes with a discussion of the implications of a biological perspective on resilience for preventive interventions. Copyright © 2003 Cambridge University Press.

565. Coutin-Churchman, P. and A.P. De Freytez, *Vector analysis of visual evoked potentials in migraineurs with visual aura*. Clinical Neurophysiology, 2003. **114**(11): p. 2132-2137.

Summary: Objective: To assess the capability of vector analysis of visual evoked potentials (VEPs) for revealing alterations in posterior visual pathways in migraineurs with visual aura. Methods: VEPs to pattern reversal (PR) and LED goggle stimulation were obtained in 23 patients suffering from migraine with visual aura, in an orthogonal Fpz-Oz and T3-T4 montage and displayed as a two-channel Lissajous' trajectory. VEP latency and amplitude at Fpz-Oz, bc segment amplitude (V) and bc vector orientation angle (θ) were compared with a previously collected normative database for individual assessment, and group comparisons with the previously collected normal sample were made. Electrophysiological measures were also correlated with time from onset of disease and from the last crisis, and with the side of symptoms. Results: No individual alterations in VEP latency or amplitude were observed. However, 36. 4% of patients showed alterations in vector orientation to PR and 78% to LED goggles. Group differences with respect to normal subjects were found not only in vector orientation but also in midline VEP and V, only for PR stimulation. A significant relationship was found between the laterality of vector deviation and the laterality of symptoms. Conclusions: Vector analysis of VEP revealed alterations possibly corresponding to asymmetrical visual cortex activation in migraineurs with visual aura, mainly to diffuse light stimulation. Significance: An electrophysiological parameter of individual value for revealing asymmetric activation of visual cortex in migraineurs is proposed. © 2003 International Federation of Clinical Neurophysiology. Published by Elsevier Ireland Ltd. All rights reserved.

566. Coutin-Churchman, P., Y. Añez, M. Uzcátegui, L. Alvarez, F. Vergara, L. Mendez, and R. Fleitas, *Quantitative spectral analysis of EEG in psychiatry revisited: Drawing signs out of numbers in a clinical setting*. Clinical Neurophysiology, 2003. **114**(12): p. 2294-2306.

Summary: Objective: To evaluate the incidence, sensitivity and specificity of abnormal quantitative EEG (QEEG) measures in normal subjects and patients with mental disorders. Methods: Normalized QEEG measures were blindly assessed in 67 normal human beings and 340 psychiatric patients. QEEG results were correlated to subject condition or diagnosis and magnetic resonance imaging (MRI) findings. Results: QEEG was abnormal in 83% of patients, and 12% of normal subjects. The most frequent abnormality was a decrease in slow (delta and/or theta) bands, either alone, with beta increase, or with alpha decrease, followed by increase in beta band. No normal subject showed delta and/or theta decrease. Slow band decrease was more frequent in depression and mental disorders due to general medical condition, alcohol and drug dependence. However, no pattern was specific of any entity, and patients within the same diagnostic may present different patterns. Delta-theta decrease was correlated with cortical atrophy as seen in MRI. Beta increase was correlated with psychoactive medication. No association was found between any other QEEG pattern and MRI abnormalities, or medication. Conclusions: Decrease in the delta and theta bands of the QEEG can be regarded as a specific sign of brain dysfunction, and is correlated with cortical atrophy. However, this sign, as other QEEG abnormal patterns, can be found in many different disorders and none of them can be considered as pathognomonic of any specific disorder. Significance: This work attempted to circumvent the alleged lack of Class I evidence of QEEG utility in the study of psychiatric patients by means of a prospective, blinded study, searching for specific signs of physiopathology in individual patients. © 2003 International Federation of Clinical Neurophysiology. Published by Elsevier Ireland Ltd. All rights reserved.

567. Congedo, M. and J.F. Lubar, *Parametric and non-parametric analysis of QEEG: Normative database comparisons in electroencephalography, a simulation study on accuracy*. Journal of Neurotherapy, 2003. **7**(3-4): p. 1-29.

Summary: Quantitative electroencephalography (QEEG) as a tool for the diagnosis of neurological and psychiatric disorders is receiving increased interest. While QEEG analysis is restricted to the scalp, the recent development of electromagnetic tomography (ET) allows the study of the electrical activity of all cortical structures. Electrical measures from a patient can be compared with a normative database derived from a large sample of healthy individuals. The

deviance from the database norms provides a measure of the likelihood that the patient's electrical activity reflects abnormal brain functioning. The focus of this article is a method for estimating such deviance. The traditional method based on z-scores (parametric) is reviewed and a new method based on percentiles (non-parametric) is proposed. The parametric and the non-parametric methods are compared using simulated data. The accuracy of both methods is assessed as a function of normative sample size and gaussianity for three different alpha levels. Results suggest that the performance of the parametric method is unaffected by sample size, given that the sample size is large enough (N > 100), but that non-gaussianity jeopardizes accuracy even if the normative distribution is close to gaussianity. In contrast, the performance of the non-parametric method is unaffected by non-gaussianity, but is a function of sample size only. It is shown that with N > 160, the non-parametric method is always preferable. Results will be discussed taking into consideration technical issues related to the nature of QEEG and ET data. It will be suggested that the sample size is the only constant across EEG frequency bands, measurement locations, and kind of quantitative measures. As a consequence, for a given database, the error rate of the non-parametric database is homogeneous; however, the same is not true for the parametric method. © 2003 by The Haworth Press, Inc. All rights reserved.

568. Caldara, R., G. Thut, P. Servoir, C.M. Michel, P. Bovet, and B. Renault, *Face versus non-face object perception and the 'other-race' effect: A spatio-temporal event-related potential study*. Clinical Neurophysiology, 2003. **114**(3): p. 515-528.

Summary: Objective: To investigate a modulation of the N170 face-sensitive component related to the perception of other-race (OR) and same-race (SR) faces, as well as differences in face and non-face object processing, by combining different methods of event-related potential (ERP) signal analysis. Methods: Sixty-two channel ERPs were recorded in 12 Caucasian subjects presented with Caucasian and Asian faces along with non-face objects. Surface data were submitted to classical waveforms and ERP map topography analysis. Underlying brain sources were estimated with two inverse solutions (BESA and LORETA). Results: The N170 face component was identical for both race faces. This component and its topography revealed a face specific pattern regardless of race. However, in this time period OR faces evoked significantly stronger medial occipital activity than SR faces. Moreover, in terms of maps, at around 170 ms face-specific activity significantly preceded non-face object activity by 25 ms. These ERP maps were followed by similar activation patterns across conditions around 190-300 ms, most likely reflecting the activation of visually derived semantic information. Conclusions: The N170 was not sensitive to the race of the faces. However, a possible pre-attentive process associated to the relatively stronger unfamiliarity for OR faces was found in medial occipital area. Moreover, our data provide further information on the time-course of face and non-face object processing. © 2002 Elsevier Science Ireland Ltd. All rights reserved.

569. Begré, S., A. Federspiel, C. Kiefer, G. Schroth, T. Dierks, and W.K. Strik, *Reduced hippocampal anisotropy related to anteriorization of alpha EEG in schizophrenia*. NeuroReport, 2003. **14**(5): p. 739-742.

Summary: Dysfunctions of the hippocampus have been suggested to be related to schizophrenia, and reduced connectivity with other brain regions may be a key for the pathophysiology. The aim of this study was to investigate the effect of white matter anomalies in the hippocampus, as a sign of altered connectivity, on the brain electrical activity. We investigated seven first episode schizophrenic patients and seven age, gender and education-matched controls with diffusion tensor imaging and resting EEG. Fractional anisotropy was computed based on diffusion tensor imaging data for the right and left hippocampus for both groups. No group differences were found in hippocampal fractional anisotropy, EEG spectral power and topography. However a significant correlation was found between more anterior α activity and lower fractional anisotropy of both hippocampi in schizophrenics, but not in controls. More anterior α activity has been described in schizophrenia. We conclude that this feature might depict a group of schizophrenic patients with reduced hippocampal connectivity. © 2003 Lippincott Williams & Wilkins.

570. Bauer, H., J. Pripfl, C. Lamm, C. Prainsack, and N. Taylor, *Functional neuroanatomy of learned helplessness*. NeuroImage, 2003. **20**(2): p. 927-939.

Summary: In the experiments reported here, female subjects were presented with reasoning tasks that changed from solvable to unsolvable, evoking "learned helplessness" or "loss of control" reactions in some subjects. Significant differences in slow cortical potential (SCP) changes were found between emotionally highly and lowly reactive subjects (grouped according to responses in postexperimental questionnaires) when processing unsolvable tasks. Cortical LORETA (Pascual-Marqui, 1999) of SCP topographies (Bauer, 1998; Bauer et al., 2000) and subsequent statistical nonparametric mapping (SnPM; Nichols and Holmes, 2002) analysis indicate clear reduction of anterior cingulate activity only with emotionally highly reactive subjects. In these subjects a region of the brain that is indispensable for goal-directed handling of tasks was switched off, whereas regions that are primarily engaged in processing the task stimuli were even more active during loss of control, although not at a statistically significant level. According to Carter et al. (1999) the anterior cingulate monitors the conflicts among brain regions and issues calls for further processing to the PFC that then guides behavior toward a goal. Learned helplessness might then be seen a state in which the function of the anterior cingulate is no longer maintained, perhaps due to the inhibitory influence of the amygdala possibly mediated via the brainstem dopaminergic ventral tegmental area (Davis et al., 1994; Goldstein et al., 1996). © 2003 Elsevier Inc. All rights reserved.

571. Arai, M., H. Tanaka, R.D. Pascual-Marqui, and K. Hirata, *Reduced brain electric activities of frontal lobe in cortical cerebellar atrophy*. Clinical Neurophysiology, 2003. **114**(4): p. 740-747.

Summary: Objective: To assess the relationship between cerebellum and brain cortical activity without motor factors, we recorded the mid-latency auditory evoked responses (MLRs) with simultaneous recording of the electroencephalography (EEG) at rest in patients with 'pure cortical cerebellar atrophy (CCA)'. Methods: We studied 12 normal control subjects and non-demented 'pure CCA' patients determined by quantitative magnetic resonance imaging analysis. A comprehensive neuropsychological test battery assessed intelligence, frontal lobe function and word fluency. Spontaneous eyes-closed resting EEG and MLRs were recorded from 20 scalp electrodes and analysed with low-resolution electromagnetic tomography (LORETA) to compute the 3-dimensional intracerebral distribution of electric activity. Results: Neuropsychological tests revealed no differences between CCA and the control. Analysis of EEG and MLRs using classical methods also did not reveal any differences. LORETA analysis indicated significant decrease of alpha2 activity in the left inferior frontal gyrus in CCA. On MLRs, the most significant difference was observed at P1 component, and CCA patients showed significant decrease at the right superior frontal gyrus. Conclusions: Our results indicated that the frontal lobe and ascending reticular activating system are inhibited in CCA patients, and suggested the involvement of the cerebellum in cortical electric activities irrespective of motor adjunct. Significance: Quantitative EEG and MLR measurements with LORETA pointed out frontal lobe hypoactivities in pure CCA patients. © 2003 International Federation of Clinical Neurophysiology. Published by Elsevier Science Ireland Ltd. All rights reserved.

572. Arai, M., *The Involvement of the Cerebellum in Cortical Electric Activities: EEG and Midlatency Auditory Evoked Responses in Cortical Cerebellar Atrophy*. Dokkyo Journal of Medical Sciences, 2003. **30**(2): p. 185-199.

Summary:

573. Anderer, P., B. Saletu, H.V. Semlitsch, and R.D. Pascual-Marqui, *Non-invasive localization of P300 sources in normal aging and age-associated memory impairment*. Neurobiology of Aging, 2003. **24**(3): p. 463-479.

Summary: Cognitive event-related potentials were recorded from 17 EEG leads in an auditory two-tone paradigm in 43 patients aged 51-79 years with the diagnosis of age-associated memory impairment (AAMI), in age-and sex-matched normal controls and in a control group 10 years older than the AAMI patients. In addition to P300 latencies, amplitudes and topographies, three-dimensional current density distribution utilizing low-resolution brain electromagnetic tomography (LORETA) was computed. P300 latency was delayed and P300 amplitude was reduced in both AAMI and older subjects. Topographically this amplitude reduction was most pronounced frontally. LORETA revealed medial (frontal and parietal) and lateral (dorso- and ventrolateral prefrontal, middle/superior temporal, posterior superior temporal/inferior parietal) sources. Significant reductions in LORETA source strength in normal aging and in AAMI were found mainly medially frontally, right dorsolaterally prefrontally and right

inferiorly parietally. Since these anatomically highly interconnected brain regions in the right hemisphere are part of a network associated with sustained attention, the results speak for a decline in attentional resource capacity in AAMI patients and elderly subjects. © 2002 Elsevier Science Inc. All rights reserved.

574. Yao, D.Z., S.M. Fu, N.N. Rao, Y.C. Zhou, S.L. Fan, and L. Chen, *A computer simulation study of music algorithm for EEG inverse problem*. Chinese Journal of Biomedical Engineering, 2002. **21**(1).

Summary: By using computer simulation, effectiveness of multiple signal classification (MUSIC) was evaluated. The head model used was the concentric 3-spheres conductor model. The EEG time-course was reconstructed by the Total Least Squares (TLS). Two new parameters were proposed: Normalized Blurring Index (NBI) was used to indicate the spatial blurring level and Singular Value Ratio (SVR) was used to show the effectiveness of the signal-noise subspace decomposition in the MUSIC algorithm. The general Relative Error (RE) and Correlation Coefficient (CC) were used to express the temporal reconstruction precision. It was simulated by using the different level of Gaussian white noise and the different correlation sources that the spatial blurring seriousness, the temporal reconstruction precision and the ability to decompose the signal and the noise subspace of the MUSIC algorithm. The results showed that the MUSIC algorithm was robust to the Gaussian white noise and sensitive to the sources correlation.

575. Vitacco, D., D. Brandeis, R. Pascual-Marqui, and E. Martin, *Correspondence of event-related potential tomography and functional magnetic resonance imaging during language processing*. Human Brain Mapping, 2002. **17**(1): p. 4-12.

Summary: Combining event-related potentials (ERP) and functional magnetic resonance imaging (fMRI) may provide sufficient temporal and spatial resolution to clarify the functional connectivity of neural processes, provided both methods represent the same neural networks. The current study investigates the statistical correspondence of ERP tomography and fMRI within the common activity volume and time range in a complex visual language task. The results demonstrate that both methods represent similar neural networks within the bilateral occipital gyrus, lingual gyrus, precuneus and middle frontal gyrus, and the left inferior and superior parietal lobe, middle and superior temporal gyrus, cingulate gyrus, superior frontal gyrus and precentral gyrus. The mean correspondence of both methods over subjects was significant. On an individual basis, only half of the subjects showed significantly corresponding activity patterns, suggesting that a one-to-one correspondence between individual fMRI activation patterns and ERP source tomographies integrated over microstates cannot be assumed in all cases. © 2002 Wiley-Liss, Inc.

576. Saletu, B., P. Anderer, G.M. Saletu-Zyhlarz, and R.D. Pascual-Marqui, *EEG topography and tomography in diagnosis and treatment of mental disorders:*

Evidence for a key-lock principle. Methods and Findings in Experimental and Clinical Pharmacology, 2002. **24**(SUPPL. D): p. 97-106.

Summary: Clinically well-defined diagnostic subgroups of mental disorders, such as schizophrenia with predominantly plus and minus symptomatology, major depression, generalized anxiety disorder, agoraphobia, obsessive-compulsive disorder, multiinfarct dementia, senile dementia of the Alzheimer type and alcohol dependence, show electroencephalogram (EEG) maps that differ statistically both from each other and from normal controls. Representative drugs of the main psychopharmacological classes, such as sedative and nonsedative neuroleptics and antidepressants, tranquilizers, hypnotics, psychostimulants and cognition-enhancing drugs, induce significant and typical changes to normal human brain function compared with placebo, in which many variables are opposite to the above-mentioned differences between psychiatric patients and normal controls. Thus, by considering these differences between psychotropic drugs and placebo in normal subjects, as well as between mental disorder patients and normal controls, it may be possible to choose the optimum drug for a specific patient according to a key-lock principle, since the drug should normalize the deviant brain function. This is supported by low-resolution brain electromagnetic tomography (LORETA), which identifies brain regions affected by psychiatric disorders and psychotropic drugs. © 2002 Prous Science. All rights reserved.

577. Saletu, B., P. Anderer, G.M. Saletu-Zyhlarz, O. Arnold, and R.D. Pascual-Marqui, *Classification and evaluation of the pharmacodynamics of psychotropic drugs by single-lead pharmaco-EEG, EEG mapping and tomography (LORETA)*. Methods and Findings in Experimental and Clinical Pharmacology, 2002. **24**(SUPPL. C): p. 97-120.

Summary: Utilizing computer-assisted quantitative analyses of human scalp-recorded electroencephalogram (EEG) in combination with certain statistical procedures (quantitative pharmaco-EEG) and mapping techniques (pharmaco-EEG mapping), it is possible to classify psychotropic substances and objectively evaluate their bioavailability at the target organ: the human brain. Specifically, one may determine at an early stage of drug development whether a drug is effective on the central nervous system (CNS) compared with placebo, what its clinical efficacy will be like, at which dosage it acts, when it acts and the equipotent dosages of different galenic formulations. Pharmaco-EEG profiles and maps of neuroleptics, antidepressants, tranquilizers, hypnotics, psychostimulants and nootropics/cognition-enhancing drugs will be described in this paper. Methodological problems, as well as the relationships between acute and chronic drug effects, alterations in normal subjects and patients, CNS effects, therapeutic efficacy and pharmacokinetic and pharmacodynamic data will be discussed. In recent times, imaging of drug effects on the regional brain electrical activity of healthy subjects by means of EEG tomography such as low-resolution electromagnetic tomography (LORETA) has been used for identifying brain areas predominantly involved in psychopharmacological action. This will be

demonstrated for the representative drugs of the four main psychopharmacological classes, such as 3 mg haloperidol for neuroleptics, 20 mg citalopram for antidepressants, 2 mg lorazepam for tranquilizers and 20 mg methylphenidate for psychostimulants. LORETA demonstrates that these psychopharmacological classes effect brain structures differently. © 2002 Prous Science. All rights reserved.

578. Saletu, B., P. Anderer, L. Linzmayer, H.V. Semlitsch, E. Lindeck-Pozza, A. Assandri, C. Di Padova, and G.M. Saletu-Zyhlarz, *Pharmacodynamic studies on the central mode of action of S-adenosyl-L-methionine (SaMe) infusions in elderly subjects, utilizing EEG mapping and psychometry*. Journal of Neural Transmission, 2002. **109**(12): p. 1505-1526.

Summary: In a double-blind, placebo-controlled cross-over study, the acute and subacute effects of S-adenosyl-L-methionine (SAMe), or ademetionine, on brain function and behavior of 10 elderly normal healthy volunteers (5 males and 5 females, aged 56-71 years, mean: 59.3 years) were investigated by means of EEG mapping and psychometry. In random order they received infusions of 800mg SAMe and placebo, administered over 30 minutes for 7 days, with a wash-out period of 3 weeks in between. EEG recordings and psychometric tests were carried out 0, 1, 3 and 6 hours after drug administration on days 1 and 7. Multivariate analysis based on MANOVA/Hotelling T2 tests demonstrated significant central effects of SAMe as compared with placebo after acute, subacute and superimposed drug administration. Acute SAMe-induced changes were characterized by a decrease in total power, an increase in absolute delta and a decrease in absolute alpha power, further by an increase in relative delta and a decrease in relative alpha power, a slowing of the delta/theta centroid as well as a slowing of the centroid of the total power spectrum. These changes are typical of classical antidepressants of the thymoleptic type such as imipramine and amitriptyline. After one week of daily infusions there was a marked increase in total power, reminiscent of nootropic drug effects. One additional superimposed dosage mitigated these effects in the direction of an antidepressant profile, with the inter-drug differences waning in the 6th hour. Our pharmaco-EEG findings suggest both inhibitory and excitatory drug effects underlying the antidepressant properties of SAMe well-documented in clinical trials. Psychometric tests concerning noopsychic and thymopsychic measures as well as critical flicker frequency generally demonstrated a lack of differences between SAMe and placebo, which again reflects a good tolerability of the drug in elderly subjects.

579. Saletu, B., P. Anderer, C. Di Padova, A. Assandri, and G.M. Saletu-Zyhlarz, *Electrophysiological neuroimaging of the central effects of S-adenosyl-L-methionine by mapping of electroencephalograms and event-related potentials and low-resolution brain electromagnetic tomography*. American Journal of Clinical Nutrition, 2002. **76**(5).

Summary: Background: S-Adenosyl-L-methionine (SAMe, or ademetionine) is a naturally occurring molecule used as both a nutraceutical and a pharmaceutical to treat depression. Objective: The central mode of action of SAMe was investigated in 20 healthy volunteers by mapping of electroencephalograms (EEGs) and event-related potentials (ERPs) and low-resolution brain electromagnetic tomography (LORETA). Design: In an acute and subacute, double-blind, placebo-controlled, crossover study, subjects received in random order infusions of 800 mg SAMe and placebo for 7 d, with a washout period of 3 wk between the 2 treatment periods. EEG recordings were made 0, 1, 3, and 6 h after and ERP recordings were made 0 and 1 h after the drug infusions on days 1 and 7. Results: Multivariate analyses of variance and Hotelling T2 tests showed significant acute and subacute encephalotropic effects of SAMe compared with placebo. Acute pharmaco-EEG changes were typical of classic antidepressants of the thymoleptic type; subacute alterations were typical of cognition enhancers. Regarding ERPs, standard N1 and P2 latencies were shortened, and target P300 latencies were lengthened. N1 amplitudes increased after subacute treatment, and temporooccipital P300 amplitudes increased after the acute dose. Similar changes were described for antidepressants. LORETA showed that the N2 source strength increased in both the left and the right temporal lobes, whereas the P300 source strength increased in the dorsolateral prefrontal regions and decreased in the ventral limbic regions. Conclusion: EEG-ERP mapping identified SAMe as an antidepressant. LORETA targeted brain regions crucial in the therapeutic efficacy of antidepressants.

580. Pratt, H., A. Sinai, I. Laufer, and N. Horev, *Time course of auditory cortex activation during speech processing*. Journal of Basic and Clinical Physiology and Pharmacology, 2002. **13**(2): p. 135-149.

Summary: The purpose of the studies summarized in this report was to determine the time course of auditory cortex involvement in speech and language processing in the context of auditory object formation. Forty-one subjects took part in the three studies summarized in this report. In all three studies, subjects performed a choice-reaction task that required their pressing an appropriate button in response to auditory stimuli (speech/non-speech, good/worse fused phonemes, first/second language words) presented through earphones. Event-related potentials (ERPs) were recorded during performance of the task from 21 scalp electrodes, in addition to peri-ocular electrodes for monitoring eye movements. Current densities within the gray matter of the brain were estimated using the LORETA (low resolution electromagnetic tomography) method. In general, except for some periods, processing phonetic and linguistic information was associated with elevated activity in the left auditory cortex. Peaks in auditory cortex activation corresponded in time to scalp recorded peaks in the latencies of P1 and up to as late as P3. The adjacent posterior temporal areas showed a similar temporal pattern of activation, but tended to be less lateralized to the left, or even biased toward right hemisphere predominance, depending on the stimulus, particularly in the later time frames. The results indicate that the auditory cortex is engaged in auditory processing from its early stages and as long as a few hundreds of msec, even after cessation of the stimulus, defining sounds as distinct auditory objects and differentiating speech from non-speech material,

relying on acoustic cues. Hemispheric dominance fluctuates to include activity in the 'non-dominant' hemisphere depending on stimulus type and stage of processing.

581. Pizzagalli, D.A., J.B. Nitschke, T.R. Oakes, A.M. Hendrick, K.A. Horras, C.L. Larson, H.C. Abercrombie, S.M. Schaefer, J.V. Koger, R.M. Benca, R.D. Pascual-Marqui, and R.J. Davidson, *Brain electrical tomography in depression: The importance of symptom severity, anxiety, and melancholic features.* Biological Psychiatry, 2002. **52**(2): p. 73-85.

Summary: Background: The frontal lobe has been crucially involved in the neurobiology of major depression, but inconsistencies among studies exist, in part due to a failure of considering modulatory variables such as symptom severity, comorbidity with anxiety, and distinct subtypes, as codeterminants for patterns of brain activation in depression. Methods: Resting electroencephalogram was recorded in 38 unmedicated subjects with major depressive disorder and 18 normal comparison subjects, and analyzed with a tomographic source localization method that computes the cortical three-dimensional distribution of current density for standard electroencephalogram frequency bands. Symptom severity and anxiety were measured via self-report and melancholic features via clinical interview. Results: Depressed subjects showed more excitatory (beta3, 21.5-30.0 Hz) activity in the right superior and inferior frontal lobe (Brodmann's area 9/10/11) than comparison subjects. In melancholic subjects, this effect was particularly pronounced for severe depression, and right frontal activity correlated positively with anxiety. Depressed subjects showed posterior cingulate and precuneus hypoactivity. Conclusions: While confirming prior results implicating right frontal and posterior cingulate regions, this study highlights the importance of depression severity, anxiety, and melancholic features in patterns of brain activity accompanying depression. © 2002 Society of Biological Psychiatry.

582. Pizzagalli, D.A., D. Lehmann, A.M. Hendrick, M. Regard, R.D. Pascual-Marqui, and R.J. Davidson, *Affective judgments of faces modulate early activity (~160 ms) within the fusiform gyri.* NeuroImage, 2002. **16**(3 I): p. 663-677.

Summary: Functional neuroimaging studies have implicated the fusiform gyri (FG) in structural encoding of faces, while event-related potential (ERP) and magnetoencephalography studies have shown that such encoding occurs approximately 170 ms poststimulus. Behavioral and functional neuroimaging studies suggest that processes involved in face recognition may be strongly modulated by socially relevant information conveyed by faces. To test the hypothesis that affective information indeed modulates early stages of face processing, ERPs were recorded to individually assessed liked, neutral, and disliked faces and checkerboard-reversal stimuli. At the N170 latency, the cortical three-dimensional distribution of current density was computed in stereotactic space using a tomographic source localization technique. Mean activity was extracted from the FG, defined by structure-probability maps, and a meta-cluster delineated by the coordinates of the voxel with the strongest face-sensitive response from five published functional magnetic resonance imaging studies. In the FG, ~160 ms poststimulus, liked faces elicited stronger activation than disliked and neutral faces and checkerboard-reversal stimuli. Further, confirming recent results, affect-modulated brain electrical activity started very early in the human brain (~112 ms). These findings suggest that affective features conveyed by faces modulate structural face encoding. Behavioral results from an independent study revealed that the stimuli were not biased toward particular facial expressions and confirmed that liked faces were rated as more attractive. Increased FG activation for liked faces may thus be interpreted as reflecting enhanced attention due to their saliency. © 2002 Elsevier Science (USA).

583. Phillips, C., M.D. Rugg, and K.J. Friston, *Anatomically informed basis functions for EEG source localization: Combining functional and anatomical constraints*. NeuroImage, 2002. **16**(3 I): p. 678-695.

Summary: Distributed linear solutions have frequently been used to solve the source localization problem in EEG. Here we introduce an approach based on the weighted minimum norm (WMN) method that imposes constraints using anatomical and physiological information derived from other imaging modalities. The anatomical constraints are used to reduce the solution space a priori by modeling the spatial source distribution with a set of basis functions. These spatial basis functions are chosen in a principled way using information theory. The reduced problem is then solved with a classical WMN method. Further (functional) constraints can be introduced in the weighting of the solution using fMRI brain responses to augment spatial priors. We used simulated data to explore the behavior of the approach over a range of the model's hyperparameters. To assess the construct validity of our method we compared it with two established approaches to the source localization problem, a simple weighted minimum norm and a maximum smoothness (Loreta-like) solution. This involved simulations, using single and multiple sources that were analyzed under different levels of confidence in the priors. © 2002 Elsevier Science (USA).

584. Phillips, C., M.D. Rugg, and K.J. Friston, *Systematic regularization of linear inverse solutions of the EEG source localization problem*. NeuroImage, 2002. **17**(1): p. 287-301.

Summary: Distributed linear solutions of the EEG source localization problem are used routinely. Here we describe an approach based on the weighted minimum norm method that imposes constraints using anatomical and physiological information derived from other imaging modalities to regularize the solution. In this approach the hyperparameters controlling the degree of regularization are estimated using restricted maximum likelihood (ReML). EEG data are always contaminated by noise, e.g., exogenous noise and background brain activity. The conditional expectation of the source distribution, given the data, is attained by carefully balancing the minimization of the residuals induced by noise and the improbability of the estimates as determined by their priors.

This balance is specified by hyperparameters that control the relative importance of fitting and conforming to prior constraints. Here we introduce a systematic approach to this regularization problem, in the context of a linear observation model we have described previously. In this model, basis functions are extracted to reduce the solution space a priori in the spatial and temporal domains. The basis sets are motivated by knowledge of the evoked EEG response and information theory. In this paper we focus on an iterative "expectation-maximization" procedure to jointly estimate the conditional expectation of the source distribution and the ReML hyperparameters on which this solution rests. We used simulated data mixed with real EEG noise to explore the behavior of the approach with various source locations, priors, and noise levels. The results enabled us to conclude: (i) Solutions in the space of informed basis functions have a high face and construct validity, in relation to conventional analyses. (ii) The hyperparameters controlling the degree of regularization vary largely with source geometry and noise. The second conclusion speaks to the usefulness of using adaptative ReML hyperparameter estimates. © 2002 Elsevier Science (USA).

585. Pascual-Marqui, R.D., M. Esslen, K. Kochi, and D. Lehmann, *Functional imaging with low-resolution brain electromagnetic tomography (LORETA): A review*. Methods and Findings in Experimental and Clinical Pharmacology, 2002. **24**(SUPPL. C): p. 91-95.

Summary: This paper reviews several recent publications that have successfully used the functional brain imaging method known as LORETA. Emphasis is placed on the electrophysiological and neuroanatomical basis of the method, on the localization properties of the method, and on the validation of the method in real experimental human data. Papers that criticize LORETA are briefly discussed. LORETA publications in the 1994-1997 period based localization inference on images of raw electric neuronal activity. In 1998, a series of papers appeared that based localization inference on the statistical parametric mapping methodology applied to high-time resolution LORETA images. Starting in 1999, quantitative neuroanatomy was added to the methodology, based on the digitized Talairach atlas provided by the Brain Imaging Centre, Montreal Neurological Institute. The combination of these methodological developments has placed LORETA at a level that compares favorably to the more classical functional imaging methods, such as PET and fMRI. © 2002 Prous Science. All rights reserved.

586. Pascual-Marqui, R.D., *Standardized low-resolution brain electromagnetic tomography (sLORETA): Technical details*. Methods and Findings in Experimental and Clinical Pharmacology, 2002. **24**(SUPPL. D): p. 5-12.

Summary: Scalp electric potentials (electroencephalograms) and extracranial magnetic fields (magnetoencephalograms) are due to the primary (impressed) current density distribution that arises from neuronal postsynaptic processes. A solution to the inverse problem - the computation of images of electric neuronal activity based on extracranial measurements - would provide important information on the time-course and localization of brain function. In general, there is no unique solution to this problem. In particular, an instantaneous, distributed, discrete, linear solution capable of exact localization of point sources is of great interest, since the principles of linearity and superposition would guarantee its trustworthiness as a functional imaging method, given that brain activity occurs in the form of a finite number of distributed hot spots. Despite all previous efforts, linear solutions, at best, produced images with systematic nonzero localization errors. A solution reported here yields images of standardized current density with zero localization error: The purpose of this paper is to present the technical details of the method, allowing researchers to test, check, reproduce and validate the new method. © 2002 Prous Science. All rights reserved.

587. Park, H.J., J.S. Kwon, T. Youn, J.S. Pae, J.J. Kim, M.S. Kim, and K.S. Ha, *Statistical parametric mapping of LORETA using high density EEG and individual MRI: Application to mismatch negativities in schizophrenia*. Human Brain Mapping, 2002. **17**(3): p. 168-178.

Summary: We describe a method for the statistical parametric mapping of low resolution electromagnetic tomography (LORETA) using high-density electroencephalography (EEG) and individual magnetic resonance images (MRI) to investigate the characteristics of the mismatch negativity (MMN) generators in schizophrenia. LORETA, using a realistic head model of the boundary element method derived from the individual anatomy, estimated the current density maps from the scalp topography of the 128-channel EEG. From the current density maps that covered the whole cortical gray matter (up to 20,000 points), volumetric current density images were reconstructed. Intensity normalization of the smoothed current density images was used to reduce the confounding effect of subject specific global activity. After transforming each image into a standard stereotaxic space, we carried out statistical parametric mapping of the normalized current density images. We applied this method to the source localization of MMN in schizophrenia. The MMN generators, produced by a deviant tone of 1,200 Hz (5% of 1,600 trials) under the standard tone of 1,000 Hz, 80 dB binaural stimuli with 300 msec of inter-stimulus interval, were measured in 14 right-handed schizophrenic subjects and 14 age-, gender-, and handedness-matched controls. We found that the schizophrenic group exhibited significant current density reductions of MMN in the left superior temporal gyrus and the left inferior parietal gyrus ($P < 0.0005$). This study is the first voxel-by-voxel statistical mapping of current density using individual MRI and high-density EEG. © 2002 Wiley-Liss, Inc.

588. Oostenveld, R. and T.F. Oostendorp, *Validating the boundary element method for forward and inverse EEG computations in the presence of a hole in the skull*. Human Brain Mapping, 2002. **17**(3): p. 179-192.

Summary: Holes in the skull may have a large influence on the EEG and ERP. Inverse source modeling techniques such as dipole fitting require an accurate volume conductor model. This model should incorporate holes if present, especially when either a neuronal generator or the electrodes are close to the hole, e.g., in case of a trephine hole in the upper part of the skull. The boundary element method (BEM) is at present the preferred method for inverse computations using a realistic head model, because of its efficiency and availability. Using a simulation approach, we have studied the accuracy of the BEM by comparing it to the analytical solution for a volume conductor without a hole, and to the finite difference method (FDM) for one with a hole. Furthermore, we have evaluated the influence of holes on the results of forward and inverse computations using the BEM. Without a hole and compared to the analytical model, a three-sphere BEM model was accurate up to 5-10%, while the corresponding FDM model had an error <0.5%. In the presence of a hole, the difference between the BEM and the FDM was, on average, 4% (1.3-11.4%). The FDM turned out to be very accurate if no hole is present. We believe that the difference between the BEM and the FDM represents the inaccuracy of the BEM. This inaccuracy in the BEM is very small compared to the effect that holes can have on the scalp potential (up to 450%). In regard to the large influence of holes on forward and inverse computations, we conclude that holes in the skull can be treated reliably by means of the BEM and should be incorporated in forward and inverse modeling. © 2002 Wiley-Liss, Inc.

589. Noesselt, T., S.A. Hillyard, M.G. Woldorff, A. Schoenfeld, T. Hagner, L. Jäncke, C. Tempelmann, H. Hinrichs, and H.J. Heinze, *Delayed striate cortical activation during spatial attention*. Neuron, 2002. **35**(3): p. 575-587.

Summary: Recordings of event-related potentials (ERPs) and event-related magnetic fields (ERMFs) were combined with functional magnetic resonance imaging (fMRI) to study visual cortical activity in humans during spatial attention. While subjects attended selectively to stimulus arrays in one visual field, fMRI revealed stimulus-related activations in the contralateral primary visual cortex and in multiple extrastriate areas. ERP and ERMF recordings showed that attention did not affect the initial evoked response at 60-90 ms poststimulus that was localized to primary cortex, but a similarly localized late response at 140-250 ms was enhanced to attended stimuli. These findings provide evidence that the primary visual cortex participates in the selective processing of attended stimuli by means of delayed feedback from higher visual-cortical areas.

590. Mulert, C., G. Juckel, H. Augustin, and U. Hegerl, *Comparison between the analysis of the loudness dependency of the auditory N1/P2 component with LORETA and dipole source analysis in the prediction of treatment response to the selective serotonin reuptake inhibitor citalopram in major depression*. Clinical Neurophysiology, 2002. **113**(10): p. 1566-1572.

Summary: Objectives: The loudness dependency of the auditory evoked potentials (LDAEP) is used as an indicator of the central serotonergic system and predicts clinical response to serotonin agonists. So far, LDAEP has been typically investigated with dipole source analysis, because with this method the primary and secondary auditory cortex (with a high versus low serotonergic innervation) can be separated at least in parts. Methods: We have developed a new analysis procedure that uses an MRI probabilistic map of the primary auditory cortex in Talairach space and analyzed the current density in this region of interest with low resolution electromagnetic tomography (LORETA). LORETA is a tomographic localization method that calculates the current density distribution in Talairach space. Results: In a group of patients with major depression (n=15), this new method can predict the response to an selective serotonin reuptake inhibitor (citalopram) at least to the same degree than the traditional dipole source analysis method (P=0.019 vs. P=0.028). The correlation of the improvement in the Hamilton Scale is significant with the LORETA-LDAEP-values (0.56; P=0.031) but not with the dipole source analysis LDAEP-values (0.43; P=0.11). Conclusions: The new tomographic LDAEP analysis is a promising tool in the analysis of the central serotonergic system. © 2002 Elsevier Science Ireland Ltd. All rights reserved.

591. Mientus, S., J. Gallinat, Y. Wuebben, R.D. Pascual-Marqui, C. Mulert, K. Frick, H. Dorn, W.M. Herrmann, and G. Winterer, *Cortical hypoactivation during resting EEG in schizophrenics but not in depressives and schizotypal subjects as revealed by low resolution electromagnetic tomography (LORETA).* Psychiatry Research - Neuroimaging, 2002. **116**(1-2): p. 95-111.

Summary: This study was performed in order to address the question whether the newly introduced technique of low-resolution electromagnetic tomography (LORETA) is able to detect hypofrontality in schizophrenic patients. We investigated resting EEGs of 19 unmedicated schizophrenics and 20 normal subjects. For comparison, we also investigated 19 subjects with schizotypal personality and 30 unmedicated depressive patients. A significant increase of delta activity was found in schizophrenic patients over the whole cortex, most strongly in the anterior cingulate gyrus and temporal lobe (fusiform gyrus). Both schizotypal subjects and depressive subjects showed significantly less delta, theta and beta activity in the anterior cingulum, a decrease of alpha1 activity in the right temporal lobe and a decrease of alpha2 activity in the left temporal lobe. The results suggest general cortical hypoactivation, most pronounced in the anterior cingulate and temporal lobe in schizophrenics, whereas there is evidence for a complex, frequency-dependent spatial pattern of hyperactivation in schizotypal subjects and depressive patients. The results are discussed within a neurophysiological and methodological framework. © 2002 Elsevier Science Ireland Ltd. All rights reserved.

592. Liu, A.K., A.M. Dale, and J.W. Belliveau, *Monte Carlo simulation studies of EEG and MEG localization accuracy.* Human Brain Mapping, 2002. **16**(1): p. 47-62.

Summary: Both electroencephalography (EEG) and magnetoencephalography (MEG) are currently used to localize brain activity. The accuracy of source localization depends on numerous factors, including the specific inverse approach and source model, fundamental differences in EEG and MEG data, and the accuracy of the volume conductor model of the head (i.e., the forward model). Using Monte Carlo simulations, this study removes the effect of forward model errors and theoretically compares the use of EEG alone, MEG alone, and combined EEG/MEG data sets for source localization. Here, we use a linear estimation inverse approach with a distributed source model and a realistic forward head model. We evaluated its accuracy using the crosstalk and point spread metrics. The crosstalk metric for a specified location on the cortex describes the amount of activity incorrectly localized onto that location from other locations. The point spread metric provides the complementary measure: for that same location, the point spread describes the mis-localization of activity from that specified location to other locations in the brain. We also propose and examine the utility of a "noise sensitivity normalized" inverse operator. Given our particular forward and inverse models, our results show that 1) surprisingly, EEG localization is more accurate than MEG localization for the same number of sensors averaged over many source locations and orientations; 2) as expected, combining EEG with MEG produces the best accuracy for the same total number of sensors; 3) the noise sensitivity normalized inverse operator improves the spatial resolution relative to the standard linear estimation operator; and 4) use of an a priori fMRI constraint universally reduces both crosstalk and point spread. © 2002 Wiley-Liss, Inc.

593. Lecumberri, P., M. Gómez, A. Malanda, J. Artieda, M. Alegre, I.G. De Gurtubay, M. Valencia, and M. Colino, *Estimation and localization of electrical dipoles in somatosensory evoked potentials*. Annual International Conference of the IEEE Engineering in Medicine and Biology - Proceedings, 2002. **1**: p. 275-276.

Summary: Neuronal currents in the brain produce external magnetic fields and scalp surface potentials that can be measured using magnetoencefalography (MEG) and electroencefalography (EEG), respectively. In the context of the localization of neuronal sources, the forward problem is to determinate the potentials and magnetic fields that result from primary current sources. The inverse problem is to estimate the location of these primary current sources. Several algorithms have been applied to solve it. There are two kinds of such algorithms: Imaging methods, e.g. see [1], and parametric approaches. Here we present a revision of the MUSIC [2] parametric algorithm and we analyze the effectiveness of this method with real EEG signals.

594. Khateb, A., A.J. Pegna, C.M. Michel, T. Landis, and J.M. Annoni, *Dynamics of brain activation during an explicit word and image recognition task: An electrophysiological study*. Brain Topography, 2002. **14**(3): p. 197-213.

Summary: Recent brain imaging studies suggest that semantic processing of words and images may share a common neural network, although modality-specific activation can also be observed. Other studies using event-related potentials (ERPs) report that brain responses to words and images may already differ at ~150 ms following stimulus presentation. The question thus remains, which differences are due to perceptual categorization processes and which differences are due to the semantic ones? Using ERP recordings and spatio-temporal source localization analysis, we investigated the dynamics of brain activation during a recognition task. The stimuli consisted of a randomized set of verbal (words vs. non-words) and pictorial items (line drawings of objects vs. scrambled drawings). After each stimulus, subjects had to decide whether it corresponds to a recognizable word or objects. ERP map series were first analyzed in terms of segments of quasi-stable map topography using a cluster analysis. This showed that verbal and pictorial stimuli elicited different field patterns in two time segments between ~190-400 ms. Before and after this period, map patterns were similar between verbal and pictorial conditions indicating that the same brain structures were engaged during the early and late steps of processing. Source localization analysis of map segments corresponding to the P100 and the N150 components first showed activation of posterior bilateral regions and then of left temporo-posterior areas. During the period differentiating conditions, other patterns of activation, involving mainly left anterior and posterior regions for words and bilateral posterior regions for images, were observed. These findings suggest that, while sharing an initial common network, recognition of verbal and pictorial stimuli subsequently engage different brain regions during time periods generally allocated to the semantic processing of stimuli.

595. Keil, A., M.M. Bradley, O. Hauk, B. Rockstroh, T. Elbert, and P.J. Lang, *Large-scale neural correlates of affective picture processing*. Psychophysiology, 2002. **39**(5): p. 641-649.

Summary: Hemodynamic and electrophysiological studies indicate differential brain response to emotionally arousing, compared to neutral, pictures. The time course and source distribution of electrocortical potentials in response to emotional stimuli, using a high-density electrode (129-sensor) array were examined here. Event-related potentials (ERPs) were recorded while participants viewed pleasant, neutral, and unpleasant pictures. ERP voltages were examined in six time intervals, roughly corresponding to P1, N1, early P3, late P3 and a slow wave window. Differential activity was found for emotional, compared to neutral, pictures at both of the P3 intervals, as well as enhancement of later posterior positivity. Source space projection was performed using a minimum norm procedure that estimates the source currents generating the extracranially measured electrical gradient. Sources of slow wave modulation were located in occipital and posterior parietal cortex, with a right-hemispheric dominance.

596. Kasai, K., H. Yamada, S. Kamio, K. Nakagome, A. Iwanami, M. Fukuda, M. Yumoto, K. Itoh, I. Koshida, O. Abe, and N. Kato, *Do high or low doses of*

anxiolytics and hypnotics affect mismatch negativity in schizophrenic subjects? An EEG and MEG study. Clinical Neurophysiology, 2002. **113**(1): p. 141-150.

Summary: Objective: Many studies have demonstrated mismatch negativity (MMN) attenuation in schizophrenia. Recently, investigators have shown that GABAergic inhibitory neurons may regulate MMN generation. Considering that a substantial proportion of schizophrenic patients receive anxiolytics and hypnotics that have affinity to GABAA receptors to reduce their comorbid symptoms of anxiety and sleep disturbances, we need to assess whether anxiolytics/hypnotics might affect their MMN generation. The aim of this study is to assess the possibility that high or low doses of anxiolytics/hypnotics received by schizophrenic subjects affect their mismatch negativity (MMN), using event-related potentials (ERPs) and magnetoencephalography (MEG). Methods: Twenty-three and 16 patients with schizophrenia participated in the ERP and MEG studies, respectively. Three types of MMN (MMN in response to a duration change of pure-tone stimuli, within-category vowel change (Japanese vowel /a/ with short versus long duration), and across-category vowel change (vowel /a/ versus /o/)) were recorded. Results: High or low doses of benzodiazepine had no significant effects on MMN amplitude/magnetic MMN power, topography/laterality, or latency under any conditions of the ERP or MEG study. Conclusions: These results suggest that chronic administration of anxiolytics/hypnotics does not significantly affect MMN in schizophrenia. © 2002 Elsevier Science Ireland Ltd. All rights reserved.

597. Kasai, K., K. Nakagome, A. Iwanami, M. Fukuda, K. Itoh, I. Koshida, and N. Kato, *No effect of gender on tonal and phonetic mismatch negativity in normal adults assessed by a high-resolution EEG recording*. Cognitive Brain Research, 2002. **13**(3): p. 305-312.

Summary: The auditory mismatch negativity (MMN) of event-related potential components has been widely used to assess the ability of auditory automatic change discrimination of verbal and nonverbal stimuli in healthy individuals and patients with various illnesses. To clarify the role of gender differences in the MMN, we compared the amplitude, latency, and topography of tonal and phonetic MMN between healthy males and females, using a high-density (128 channel) electroencephalography montage. The MMN was evaluated in 18 right-handed male and ten age-matched female adults. The MMN in response to a duration change of pure tone and that in response to a phonetic change (Japanese vowel /a/ versus /o/ with 150-ms duration) were recorded. There were no significant differences in amplitude, latency, or laterality for either tonal or phonetic MMN between male and female subjects. This lack of evidence for effects of gender on MMN in response to duration change of tones or that in response to changes of phonemes with a short duration in normal adults may be of relevance to a growing number of researchers who are studying the MMN in healthy individuals and various clinical groups. © 2002 Elsevier Science B.V. All rights reserved.

598. Kasai, K., A. Iwanami, H. Yamasue, N. Kuroki, K. Nakagome, and M. Fukuda, *Neuroanatomy and neurophysiology in schizophrenia*. Neuroscience Research, 2002. **43**(2): p. 93-110.

Summary: Schizophrenia is a major mental disorder, characterized by their set of symptoms, including hallucinatory-delusional symptoms, thought disorder, emotional flattening, and social withdrawal. Since 1980s, advances in neuroimaging and neurophysiological techniques have provided tremendous merits for investigations into schizophrenia as a brain disorder. In this article, we first overviewed neuroanatomical studies using structural magnetic resonance imaging (s-MRI), MR spectroscopy (MRS), and postmortem brains, followed by neurophysiological studies using event-related potentials (ERPs) and magnetoencephalography (MEG), in patients with schizophrenia. Evidences from these studies suggest that schizophrenia is a chronic brain disorder, structurally and functionally affecting various cortical and subcortical regions involved in cognitive, emotional, and motivational aspects of human behavior. Second, we reviewed recent investigations into neurobiological basis for schizophrenic symptoms (auditory hallucinations and thought disorder) using these indices as well as hemodynamic assessments such as positron emission tomography (PET) and functional MRI (f-MRI). Finally, we addressed the issue of the heterogeneity of schizophrenia from the neurobiological perspective, in relation to the neuroanatomical and neurophysiological measures. © 2002 Elsevier Science Ireland Ltd and the Japan Neuroscience Society. All rights reserved.

599. John, E.R., *The neurophysics of consciousness*. Brain Research Reviews, 2002. **39**(1): p. 1-28.

Summary: Consciousness combines information about attributes of the present multimodal sensory environment with relevant elements of the past. Information from each modality is continuously fractionated into distinct features, processed locally by different brain regions relatively specialized for extracting these disparate components and globally by interactions among these regions. Information is represented by levels of synchronization within neuronal populations and of coherence among multiple brain regions that deviate from random fluctuations. Significant deviations constitute local and global negative entropy, or information. Local field potentials reflect the degree of synchronization among the neurons of the local ensembles. Large-scale integration, or 'binding', is proposed to involve oscillations of local field potentials that play an important role in facilitating synchronization and coherence, assessed by neuronal coincidence detectors, and parsed into perceptual frames by cortico-thalamo-cortical loops. The most probable baseline levels of local synchrony, coherent interactions among brain regions, and frame durations have been quantitatively described in large studies of their age-appropriate normative distributions and are considered as an approximation to a conscious 'ground state'. The level of consciousness during anesthesia can be accurately predicted by the magnitude and direction of reversible multivariate deviations from this ground state. An invariant set of changes takes place during

anesthesia, independent of the particular anesthetic agent. Evidence from a variety of neuroscience areas supporting these propositions, together with the invariant reversible electrophysiological changes observed with loss and return of consciousness, are used to provide a foundation for this theory of consciousness. This paper illustrates the increasingly recognized need to consider global as well as local processes in the search for better explanations of how the brain accomplishes the transformation from synchronous and distributed neuronal discharges to seamless global subjective awareness. © 2002 Elsevier Science B.V. All rights reserved.

600. Isotani, T., T. Kinoshita, D. Lehmann, R.D. Pascual-Marqui, and J. Wackermann, *Spatial configuration of brain electric activity during positive, neutral and negative emotions*. Methods and Findings in Experimental and Clinical Pharmacology, 2002. **24**(SUPPL. D): p. 109-110.

Summary:

601. Horwitz, B. and D. Poeppel, *How can EEG/MEG and fMRI/PET data be combined?* Human Brain Mapping, 2002. **17**(1): p. 1-3.

Summary:

602. He, B., X. Zhang, J. Lian, H. Sasaki, D. Wu, and V.L. Towle, *Boundary element method-based cortical potential imaging of somatosensory evoked potentials using subjects' magnetic resonance images*. NeuroImage, 2002. **16**(3 I): p. 564-576.

Summary: A boundary element method-based cortical potential imaging technique has been developed to directly link the scalp potentials with the cortical potentials with the aid of magnetic resonance images of the subjects. First, computer simulations were conducted to evaluate the new approach in a concentric three-sphere inhomogeneous head model. Second, the corresponding cortical potentials were estimated from the patients' preoperative scalp somatosensory evoked potentials (SEPs) based on the boundary element models constructed from subjects' magnetic resonance images and compared to the postoperative direct cortical potential recordings in the same patients. Simulation results demonstrated that the cortical potentials can be estimated from the scalp potentials using different scalp electrode configurations and are robust against measurement noise. The cortical imaging analysis of the preoperative scalp SEPs recorded from patients using the present approach showed high consistency in spatial pattern with the postoperative direct cortical potential recordings. Quantitative comparison between the estimated and the directly recorded subdural grid potentials resulted in reasonably high correlation coefficients in cases studied. Amplitude difference between the estimated and the recorded potentials was also observed as indexed by the relative error, and the possible underlying reasons are discussed. The present numerical and experimental results validate the boundary element method-based cortical potential imaging approach and demonstrate the feasibility of the new approach in noninvasive high-resolution imaging of brain electric activities from scalp potential measurement and magnetic resonance images. © 2002 Elsevier Science (USA).

603. He, B., D. Yao, J. Lian, and D. Wu, *An equivalent current source model and Laplacian weighted minimum norm current estimates of brain electrical activity*. IEEE Transactions on Biomedical Engineering, 2002. **49**(4): p. 277-288.

Summary: We have developed a method for estimating the three-dimensional distribution of equivalent current sources inside the brain from scalp potentials. Laplacian weighted minimum norm algorithm has been used in the present study to estimate the inverse solutions. A three-concentric-sphere inhomogeneous head model was used to represent the head volume conductor. A closed-form solution of the electrical potential over the scalp and inside the brain due to a point current source was developed for the three-concentric-sphere inhomogeneous head model. Computer simulation studies were conducted to validate the proposed equivalent current source imaging. Assuming source configurations as either multiple dipoles or point current sources/sinks, in computer simulations we used our method to reconstruct these sources, and compared with the equivalent dipole source imaging. Human experimental studies were also conducted and the equivalent current source imaging was performed on the visual evoked potential data. These results highlight the advantages of the equivalent current source imaging and suggest that it may become an alternative approach to imaging spatially distributed current sources-sinks in the brain and other organ systems.

604. He, B., D. Yao, and J. Lian, *High-resolution EEG: On the cortical equivalent dipole layer imaging*. Clinical Neurophysiology, 2002. **113**(2): p. 227-235.

Summary: Background: Brain electrical activity is a spatio-temporally distributed process. Cortical imaging techniques have been developed to reconstruct cortical activity from the scalp electroencephalographic or magnetoencephalographic measurements. Several cortical imaging approaches, such as the epicortical potentials and a dipole layer accounting for the cortical activity, have been used to represent brain electrical activity. Methods: A closed cortical dipole layer source model is used to equivalently represent brain electrical activity. The relationship between the primary brain electrical sources and the cortical equivalent dipole layer is derived from the theory of electromagnetics. Computer simulation studies were conducted using a 3-concentric-sphere head model to validate the proposed theory. The cortical equivalent dipole layer imaging approach was tested in both computer simulation and human visual evoked potential (VEP) experiments. Results: The strength of the cortical equivalent dipole layer is shown to be proportional to the electrical potential over the same surface generated by primary electrical sources, had the outer medium been replaced by air. The proposed theory was validated by computer simulation in a discrete system. Simulation and VEP experimental studies suggest the feasibility

of applying the cortical equivalent dipole layer imaging approach for brain imaging. Conclusions: The cortical equivalent dipole layer model can equivalently represent the primary brain electrical sources throughout the entire brain surrounded by the dipole layer. The strength of the cortical equivalent dipole layer due to primary sources can be directly calculated according to the theory developed in the present study. © 2002 Elsevier Science Ireland Ltd. All rights reserved.

605. He, B. and J. Lian, *High-resolution spatio-temporal functional neuroimaging of brain activity*. Critical Reviews in Biomedical Engineering, 2002. **30**(4-6): p. 283-306.

Summary: The past decades have shown extraordinary progress in our ability to noninvasively image the functions of the human brain. Of particular interest is the recent trend in combining information from electrophysiological and magnetic resonance imaging, which we termed eMRI, to achieve high-resolution functional neuroimaging in both space and time domains. In this article, we review the recent progress in high-resolution functional neuroimaging, in particular the multimodal integration of electroencephalography (EEG) and magnetic resonance imaging (MRI). The state-of-the-art EEG inverse solutions based on different brain electric source models and various approaches to integrate the information from MRI are reviewed. The remaining challenges, future trends, and potential applications of the high-resolution functional neuroimaging research are discussed.

606. He, B. and J. Lian, *Electrophysiological neuroimaging of brain activity*. Annual International Conference of the IEEE Engineering in Medicine and Biology - Proceedings, 2002. **3**: p. 1970-1971.

Summary: We review the recent development in electrophysiological neuroimaging of brain activity by solving the inverse problem of electroencephalography (EEG). Different approaches to solve the EEG inverse problem have been reviewed, and the recent trend of multimodel integration for high-resolution neuroimaging has been discussed. Examples on electrophysiological neuroimaging are also be provided.

607. Hauk, O., A. Keil, T. Elbert, and M.M. Müller, *Comparison of data transformation procedures to enhance topographical accuracy in time-series analysis of the human EEG*. Journal of Neuroscience Methods, 2002. **113**(2): p. 111-122.

Summary: We describe a methodology to apply current source density (CSD) and minimum norm (MN) estimation as pre-processing tools for time-series analysis of single trial EEG data. The performance of these methods is compared for the case of wavelet time-frequency analysis of simulated gamma-band activity. A reasonable comparison of CSD and MN on the single trial level requires regularization such that the corresponding transformed data sets have similar signal-to-noise ratios (SNRs). For region-of-interest approaches, it should be possible to optimize the SNR for single estimates rather than for the whole distributed solution. An effective implementation of the MN method is described. Simulated data sets were created by modulating the strengths of a radial and a tangential test dipole with wavelets in the frequency range of the gamma band, superimposed with simulated spatially uncorrelated noise. The MN and CSD transformed data sets as well as the average reference (AR) representation were subjected to wavelet frequency-domain analysis, and power spectra were mapped for relevant frequency bands. For both CSD and MN, the influence of noise can be sufficiently suppressed by regularization to yield meaningful information, but only MN represents both radial and tangential dipole sources appropriately as single peaks. Therefore, when relating wavelet power spectrum topographies to their neuronal generators, MN should be preferred. © 2002 Elsevier Science B.V. All rights reserved.

608. Hamm, J.P., B.W. Johnson, and I.J. Kirk, *Comparison of the N300 and N400 ERPs to picture stimuli in congruent and incongruent contexts*. Clinical Neurophysiology, 2002. **113**(8): p. 1339-1350.

Summary: Objectives: The aim of this study was to examine the N300 and N400 effect to pictures that were semantically incongruous to a prior object name. Based upon theories of object identification, the semantic incongruity was manipulated to occur early or late in the object processing stream. Methods: High-density visual event-related potentials were measured in response to passively viewed black and white line drawings of common objects. Pictures were preceded with an object name at either the basic (categorical) or subordinate (specific) level. The object either matched or mismatched with the name. With subordinate level names, mismatches could be within- or between-category. Results: The N400 effect was found for both basic and subordinate level mismatches. The N400 was found for both the subordinate-within and subordinate-between. Comparison of the scalp distributions between these N400 effects suggested a common effect was found for all conditions. The N300 effect, however, was only found for between-category mismatches, and only when semantic expectations were high in the match baseline (subordinate matches). Conclusions: The findings are consistent with theories of object identification that suggest that objects are initially categorized prior to being identified at more specific levels. The N300 appears to reflect the categorisation while the N400 effect appears to be responsive to all semantic mismatches. Comparison of scalp topographies, functional differences, and different estimated cortical source locations suggest that the N300 and N400 are two distinct semantic effects that reflect aspects of object identification. © 2002 Elsevier Science Ireland Ltd. All rights reserved.

609. Gallinat, J., C. Mulert, M. Bajbouj, W.M. Herrmann, J. Schunter, D. Senkowski, R. Moukhtieva, D. Kronfeldt, and G. Winterer, *Frontal and temporal dysfunction of auditory stimulus processing in schizophrenia*. NeuroImage, 2002. **17**(1): p. 110-127.

Summary: Attention deficits have been consistently described in schizophrenia. Functional neuroimaging and electrophysiological studies have focused on anterior cingulate cortex (ACC) dysfunction as a possible mediator. However, recent basic research has suggested that the effect of attention is also observed as a relative amplification of activity in modality-associated cortical areas. In the present study, the question was addressed whether an amplification deficit is seen in the auditory cortex of schizophrenic patients during an attention-requiring choice reaction task. Twenty-one drug-free schizophrenic patients and 21 age- and sex-matched healthy controls were studied (32-channel EEG). The underlying generators of the event-related N1 component were separated in neuroanatomic space using a minimum-norm (LORETA) and a multiple dipole (BESA) approach. Both methods revealed activation in the primary auditory cortex (peak latency ≈ 100 ms) and in the area of the ACC (peak latency ≈ 130 ms). In addition, the adapted multiple dipole model also showed a temporal-radial source activation in nonprimary auditory areas (peak latency ≈ 140 ms). In schizophrenic patients, significant activation deficits were found in the ACC as well as in the left nonprimary auditory areas that differentially correlated with negative and positive symptoms. The results suggest that (1) the source in the nonprimary auditory cortex is detected only with a multiple dipole approach and (2) that the N1 generators in the ACC and in the nonprimary auditory cortex are dysfunctional in schizophrenia. This would be in line with the notion that attention deficits in schizophrenia involve an extended cortical network. © 2002 Elsevier Science (USA).

610. Fallgatter, A.J., A.J. Bartsch, and M.J. Herrmann, *Electrophysiological measurements of anterior cingulate function*. Journal of Neural Transmission, 2002. **109**(5-6): p. 977-988.

Summary: Summary. Based on recent findings from various areas of brain research the anterior cingulate cortex (ACC) within the prefrontal cortex is increasingly considered as a brain region activated during tasks requiring conflict-monitoring and allocation of attention. In the present study with event-related potentials (ERPs) the question has been addressed, whether the NoGo-condition of the Continuous Performance Test is associated with enough conflict-monitoring and allocation of attention in order to activate the ACC in healthy controls. Low Resolution Electromagnetic Tomography (LORETA), a new three-dimensional source localization method, revealed significantly increased brain electrical activity during the NoGo-ERP as compared to the Go-ERP with its maximum located exactly within the ACC in four independent samples of healthy subjects. These results relate the conflict-monitoring requirements associated with inhibition of a prepared motor response (NoGo-condition) to a powerful brain electrical ACC-activity. This non-invasive, easy to perform and inexpensive electrophysiological measurement, therefore, provides a new method for the assessment of ACC-function in healthy subjects.

611. Fallgatter, A.J., D.R. Aranda, A.J. Bartsch, and M.J. Herrmann, *Long-term reliability of electrophysiologic response control parameters*. Journal of Clinical Neurophysiology, 2002. **19**(1): p. 61-66.

Summary: The execution (Go) and the inhibition (NoGo) of a motor response are basic cognitive processes that can be assessed by means of a simple neuropsychological Go-NoGo task: the Continuous Performance Test (CPT). Simultaneous electrophysiologic investigations revealed that the NoGo condition of the CPT is associated with a clearly more anterior brain electrical activity compared with the Go condition. Recently, it has been shown that this NoGo anteriorization effect during a response control paradigm can be measured quantitatively with the electrophysiologic centroid method. The objective of the current study, therefore, was to determine the long-term reliability of the topographic measures of cognitive response control (i.e., location of the Go and the NoGo centroid and the NoGo anteriorization). For this purpose, a 21-channel EEG was recorded twice from 13 healthy volunteers during their execution of a cued CPT (O-X version). The time interval between test and retest was 2.74 years (range, 2.41 to 2.97 years). Statistical analysis of the event-related Go and NoGo potentials revealed an excellent test-retest reliability, as expressed by Pearson's product moment correlation coefficients of more than 0.85 ($P \leq 0.0005$) and intraclass correlation coefficients of more than 0.90 ($P \leq 0.0005$) for all three topographic measures. These results indicate that these electrophysiologic parameters present with superior long-term reliability and that they may be applied as electrophysiologic trait markers of response control mechanisms in the human brain.

612. Falkenstein, M., J. Hoormann, and J. Hohnsbein, *Inhibition-related ERP components: Variation with modality, age, and time-on-task*. Journal of Psychophysiology, 2002. **16**(3): p. 167-175.

Summary: In Go/Nogo tasks, ERP after Nogo stimuli generally reveals a negativity (Nogo-)N2 and a subsequent positivity (Nogo-)P3 over fronto-central scalp regions. These components are probably related to different subprocesses serving response inhibition, namely, modality-specific and general inhibition, respectively. In the present study we investigate whether aging or prolonged work ("time-on-task") have an effect on N2 and P3. Twelve young and 12 elderly subjects performed simple Go/Nogo tasks to visual or auditory letter stimuli. Reaction times were longer after visual than after auditory stimuli, and longer in the elderly than in the young. The ERP results reveal a slight impairment of modality-specific inhibition (N2) in the elderly after visual, but not after auditory, stimuli. General inhibition (P3) was delayed in the elderly for both modalities, as was Go-P3 and RT. Hence, it appears that the response slowing of the elderly is the result of a slowing of the decision process whether to respond or to inhibit. Moreover, age appears to affect both aspects of inhibition in a different manner. No effects of time-on-task were found, which suggests that the inhibitory processes are fairly robust against mental fatigue.

613. David, O., L. Garnero, D. Cosmelli, and F.J. Varela, *Estimation of neural dynamics from MEG/EEG cortical current density maps: Application to the reconstruction of large-scale cortical synchrony*. IEEE Transactions on Biomedical Engineering, 2002. **49**(9): p. 975-987.

Summary: There is a growing interest in elucidating the role of specific patterns of neural dynamics-such as transient synchronization between distant cell assemblies-in brain functions. Magnetoencephalography (MEG)/electroencephalography (EEG) recordings consist in the spatial integration of the activity from large and multiple remotely located populations of neurons. Massive diffusive effects and poor signal-to-noise ratio (SNR) preclude the proper estimation of indices related to cortical dynamics from nonaveraged MEG/EEG surface recordings. Source localization from MEG/EEG surface recordings with its excellent time resolution could contribute to a better understanding of the working brain. We propose a robust and original approach to the MEG/EEG distributed inverse problem to better estimate neural dynamics of cortical sources. For this, the surrogate data method is introduced in the MEG/EEG inverse problem framework. We apply this approach on nonaveraged data with poor SNR using the minimum norm estimator and find source localization results weakly sensitive to noise. Surrogates allow the reduction of the source space in order to reconstruct MEG/EEG data with reduced biases in both source localization and time-series dynamics. Monte Carlo simulations and results obtained from real MEG data indicate it is possible to estimate non invasively an important part of cortical source locations and dynamic and, therefore, to reveal brain functional networks.

614. Croft, R.J., J.D. Williams, C. Haenschel, and J.H. Gruzelier, *Pain perception, hypnosis and 40 Hz oscillations*. International Journal of Psychophysiology, 2002. **46**(2): p. 101-108.

Summary: A number of brain regions are associated with the subjective experience of pain. This study adds to our understanding of the neural mechanisms involved in pain by considering the relation between cortical oscillations in response to pain, with and without hypnosis and hypnotic analgesia, and the subjective experience of pain. Thirty-three subjects' neural responses (EEG) were measured during the 40-540 ms period following phasic electrical stimulations to the right hand, under control and hypnosis conditions. Resultant FFT amplitudes for frequencies ranging from 8 to 100 Hz were computed. These were grouped into 7 scalp topographies, and for each frequency, relations between these topographies and pain ratings, performance and stimulus intensity measures were assessed. Gamma activity (32-100 Hz) over prefrontal scalp sites predicted subject pain ratings in the control condition ($r=0.50$, $P=0.004$), and no other frequency/topography combination did. This relation was present in both high and low hypnotisable subjects and was independent of performance and stimulus intensity measures. This relation was unchanged by hypnosis in the low hypnotisable subjects but was not present in the highs during hypnosis, suggesting that hypnosis interferes with this pain/gamma relation. This

study provides evidence for the role of gamma oscillations in the subjective experience of pain. Further, it is in keeping with the view that hypnosis involves the dissociation of prefrontal cortex from other neural functions. © 2002 Elsevier Science B.V. All rights reserved.

615. Coatanhay, A., L. Soufflet, L. Staner, and P. Boeijinga, *EEG source identification: Frequency analysis during sleep*. Comptes Rendus - Biologies, 2002. **325**(4): p. 273-282.

Summary: This article deals with a new approach in sleep characterization that combines EEG source localisation methods with standard frequency analysis of multielectrode EEGs. First, we describe the theoretical methodology and the benefits that we get from a three-dimensional image (LORETA) of the cerebral activity related to a frequency band. Then, this new application is used as signal-processing technique on sleep EEG recordings obtained from young male adults using four frequency bands (δ 0.5-3.5 Hz, θ 4.0-7.5 Hz, and α 8.0-12.5 Hz and β 13.0-32.0 Hz) in different sleep stages. Finally, we show that the obtained results are highly consistent with other physiological assessments (standard EEG mapping, functional magnetic resonance imaging, etc.), but give us more realistic additional information on the generators of electromagnetic cerebral activity. © 2002 Académie des sciences / Éditions scientifiques et médicales Elsevier SAS.

616. Brandeis, D., T. Banaschewski, L. Baving, P. Georgiewa, B. Blanz, M.H. Schmidt, A. Warnke, H.C. Steinhausen, A. Rothenberger, and P. Scheuerpflug, *Multicenter P300 Brain Mapping of Impaired Attention to Cues in Hyperkinetic Children*. Journal of the American Academy of Child and Adolescent Psychiatry, 2002. **41**(8): p. 990-998.

Summary: Objective: To measure specific neurophysiological attention deficits in children with hyperkinetic disorders (HD; the ICD-10 diagnosis for severe and pervasive attention-deficit/hyperactivity disorder [ADHD]). Method: In a multicenter sample of 148 children with HD and control children aged 8 to 14 years, event-related potential maps were recorded during a cued continuous performance test (A-X/O-X). Maps to cues (requiring attention but no response) and distractors and performance were tested for differences between age- and sex-matched HD and control groups (n = 57 each), as well as between clinics (n = 5). Results: The N1, P3a, and P3b maps revealed reliable attention effects, with larger amplitudes after cues than after distractors, and only minor differences across clinics. Children with HD missed more targets, made more false alarms, and had larger N1 followed by smaller P3b amplitudes after cues than did controls. Cue-P3b amplitude correlated with detecting subsequent targets. Cue-P3b tomography indicated posterior sources that were attenuated in children with HD. Conclusions: Brain mapping indicates that children with HD attend to cues (preceding potential targets) with increased initial orienting (N1) followed by insufficient resource allocation (P3b). These multiple, condition-specific attention deficits in HD within 300 msec extend previous results on ADHD and

underline the importance of high temporal resolution in mapping severe attention deficits.

617. Barbanoj, M.J., J. Riba, A. Morte, R.M. Antonijoan, and F. Jané, *Basics of PK-PD using QEEG: Acute/repetitive administration, interactions. Focus on anxiolytics with different neurochemical mechanisms as examples*. Methods and Findings in Experimental and Clinical Pharmacology, 2002. **24**(SUPPL. C): p. 67-83.

Summary: Utilizing computer-assisted quantitative analysis of the electroencephalogram (EEG) in combination with certain statistical procedures and under specific design conditions, it is possible to objectively evaluate the functional bioavailability of psychotropic substances in the target organ: the human brain. Specifically, one may determine whether a drug is active in the central nervous system (CNS) compared with placebo in humans, the dose effect (including nonmonotonic drug effects along the continuum range of concentrations) and the time effect (including time-dependent pharmacodynamic phenomena as tolerance and sensitization), as well as its activity in relation to the formulation and route of application. Methodological aspects are introduced, discussing the usefulness of evaluating different treatments, doses, time points, states, target variables, electrodes and even different groups. Several issues are raised in relation to acute vs. repetitive administration, particularly those dealing with statistical comparisons when making conclusions about acute, repetitive or superimposed effects, and in relation to human psychotropic interactions, such as mechanistic drug-drug interaction descriptions, drug metabolites and enantiomers, as well as the importance of acquiring drug plasma concentrations, elapse of time and topographic distributions to accurately identify its occurrence. PK-PD modeling is introduced as a tool to enlarge the scope of inferences that can be derived when using pharmaco-EEG. The examples presented in order to develop the arguments are mainly focused on anxiolytic compounds belonging to the different neurochemical groups, benzodiazepines and azaspirones. Questions that have yet to been resolved are also addressed. © 2002 Prous Science. All rights reserved.

618. Babiloni, F., C. Babiloni, F. Carducci, C. Del Gratta, G.L. Romani, P.M. Rossini, and F. Cincotti, *Cortical source estimate of combined high resolution EEG and fMRI data related to voluntary movements*. Methods of Information in Medicine, 2002. **41**(5): p. 443-450.

Summary: Objectives: In this paper, we employed advanced methods for the modeling of human cortical activity related to voluntary right one-digit movements from combined high-resolution electroencephalography (EEG) and functional magnetic resonance imaging (fMRI). Methods: Multimodal integration between EEG and fMRI data was performed by using realistic head models, a large number of scalp electrodes (128) and the estimation of current density strengths by linear inverse estimation. Results: Increasing of spatial details of the estimated cortical density distributions has been detected by using the proposed

integration method with respect to the estimation using EEG data alone. Conclusion: The proposed method of multimodal EEG-fMRI data is useful to increase spatial resolution of movement-related potentials and can also be applied to other kinds of event-related patentials.

619. Annoni, J.M., C.M. Michel, T. Landis, and A. Khateb, *Variability of right hemisphere activation during semantic word processing in aphasic patients: An electrophysiologic study in three patients*. Variabilité de l'activation hémisphérique droite lors du traitement sémantique des mots chez des patients aphasiques: Étude électrophysiologique de trois cas, 2002. **158**(3): p. 317-331.

Summary: After stroke, the interhemispheric reorganisation of the neural network implicated in language is hypothesized to be a function not only of the site of lesion but also of the residual impairment. With a multiple case approach, we tested this hypothesis in three chronic aphasic patients. Two patients, GE (capsulo-lenticular stroke) and JHN (fronto-temporal stroke) showed formal residual semantic difficulties, while the third patient (EG, large sylvian lesion) did not. Brain electric activity was analysed during a categorisation task of tachistoscopically presented words in the left and the right visual field. The temporal analysis of brain activity showed that both patients with semantic residual difficulties activated the right hemisphere (RH) during some steps of word processing. In the third patient, without semantic impairment, the RH was activated only during a short time period. Further more, RH activation was shown to be dependent on the visual field of word presentation. Phonological impairment was not predictive of RH activation. These results suggest that RH activation, particularly anterior regions, can occur during semantic processing of words as a function of semantic residual impairment.

620. Annoni, J.M., *Language and hemispheric specialization*. Langage et spécialisation hémisphérique, 2002. **12**(2): p. 275-317.

Summary: Language is a highly lateralized cognitive function and has been the scope of multiple studies on the different role of the left hemisphere (LH) and the right hemisphere (RH). Based on structural language's models, clinical, behavioral and imaging data confirm the advantage of the LH in nearly all aspects of language processing. On the other hand, dynamic models postulate the presence of hidden or latent right hemispheric competencies, which can appear in certain situations. In this chapter we confirm the existence of dominant phonological, graphemic and lexico-semantic processes in the LH, and discuss the potential role of some latent functions, particularly in the RH. Data from clinical, behavioral sciences and neuroimaging support the following statements: i) cortical representation of language are naturally lateralized in the left hemisphere, but some steps such as prosodic comprehension and expression, some reading strategies and some aspects of lexico-semantic processes can take advantage of complementary functions in both hemispheres. ii) A tonic inter-hemispheric interaction, excitatory and inhibitory, has been demonstrated at least in the lexico-semantic processing. iii) Despite these interactions, neural

networks involved in language are stable, and are barely modified by experimental changes in stimulus presentation. However, the pattern of activation of this network depends on the presentation. iv) Following focal lesion of the LH, compensatory homotopic areas of the RH can be used for language relearning. These compensatory areas do not seem to replicate the lost function but to use and adapt language functions anteriorly developed in this hemisphere. These compensatory activations vary according to the localization of the lesion.

621. Anderer, P., B. Saletu, H.V. Semlitsch, and R.D. Pascual-Marqui, *Perceptual and cognitive event-related potentials in neuropsychopharmacology: Methodological aspects and clinical applications (pharmaco-ERP topography and tomography)*. Methods and Findings in Experimental and Clinical Pharmacology, 2002. **24**(SUPPL. C): p. 121-137.

Summary: Middle latency and late components of event-related brain potentials (ERPs) are closely related to perceptual and cognitive information processing, respectively. In a double-blind, placebo-controlled study, the acute effects of lorazepam (2 mg), haloperidol (3 mg), methylphenidate (20 mg) and citalopram (20 mg) on ERP latencies, amplitudes, topographies and tomographies were investigated in 20 healthy subjects of 23-34 years of age. After automatic artifact minimization and rejection, standard N1 and P2 and target N2 and P300 components were determined. The tranquilizer lorazepam prolonged P300 latency, which indicates an impairment of stimulus evaluation time. Low-resolution brain electromagnetic tomography (LORETA) revealed decreases in N1 and P300 source strength in those brain regions with relevant generators of these components, which reflects impairments of attentional and cognitive processing resources. The neuroleptic haloperidol decreased N1 and P300 source strength predominantly in those brain regions not involved in the generation of these components, suggesting a shift of resources. The psychostimulant methylphenidate increased P300 source strength in brain regions with major P3b generators, indicating increases in energetic resources associated with stimulus encoding. The antidepressant citalopram increased N1 and P3b source strength in multiple brain regions specifically in the left prefrontal cortex, a brain region in which reduced blood flow and metabolism was found in depressed patients. © 2002 Prous Science. All rights reserved.

622. Anderer, P., G. Gruber, G. Klösch, W. Klimesch, B. Saletu, and J. Zeitlhofer, *Sleep and memory consolidation: The role of electrophysiological neuroimaging*. Somnologie, 2002. **6**(2): p. 54-62.

Summary: Memory consolidation involves a complex series of molecular, cellular and network-level processes that take place on time scales from millisecond to months. Evidence from a wide range of experimental observations supports the hypothesis that parts of these processes occur during sleep when the brain is not engaged in processing and encoding incoming information. Indeed, sleep seems to be favorable for brain plasticity. Experience-dependent cortical plasticity observed during sleep has been hypothesized to be part of the global process of

memory consolidation. Thus, studying task-dependent, regionally specific reactivation of neuronal assemblies during posttraining sleep may make important contributions to elucidating the role of sleep in memory trace processing. A new methodology - low-resolution brain electromagnetic tomography (LORETA) - offers the possibility of localizing electrical activity produced by cortical neuronal generators under normal (undisturbed) sleeping conditions. The high time resolution of brain electrical data can be exploited to produce neuroimages for specific EEG spectral frequency bands (e.g. delta, theta, or spindle bands). This makes it possible to investigate, dependent on the type of memory, when - in which sleep stages (S2 sleep, SWS, REM sleep) - and where - in which cortical brain regions (primary sensory cortex, higher association cortex) - experience-dependent reactivation occurs.

623. Ahmed, S., P.D. Mozley, and W.Z. Potter, *Biomarkers in psychotropic drug development*. American Journal of Geriatric Psychiatry, 2002. **10**(6): p. 678-686.

Summary: The authors review the use of biomarkers in the development of novel psychotropic agents. They briefly review clinical drug development, emphasizing the importance of incorporating biomarkers. For the development of psychotropic agents, biomarkers are particularly useful for assessing central nervous system exposure and effects and for serving as surrogate measures for safety and efficacy. Collectively, biomarkers allow for more accurate estimation of doses for clinical trials as drug development progresses. For drugs that target the pathophysiology of Alzheimer disease, several promising biomarkers are becoming available that may allow improved signal detection in clinical trials. Procedures for developing new drugs are evolving rapidly. Technical advances in the field are making it possible to shift from empirically-based methods to mechanistically-driven schemes. Biomarkers enhance the quality and safety of clinical drug development and reduce its cost and duration.

624. Yvert, B., A. Crouzeix-Cheylus, and J. Pernier, *Fast realistic modeling in bioelectromagnetism using lead-field interpolation*. Human Brain Mapping, 2001. **14**(1): p. 48-63.

Summary: The practical use of realistic models in bioelectromagnetism is limited by the time-consuming amount of numerical calculations. We propose a method leading to much higher speed than currently available, and compatible with any kind of numerical methods (boundary elements (BEM), finite elements, finite differences). Illustrated with the BEM for EEG and MEG, it applies to ECG and MCG as well. The principle is two-fold. First, a Lead-Field matrix is calculated (once for all) for a grid of dipoles covering the brain volume. Second, any forward solution is interpolated from the pre-calculated Lead-Fields corresponding to grid dipoles near the source. Extrapolation is used for shallow sources falling outside the grid. Three interpolation techniques were tested: trilinear, second-order Bézier (Bernstein polynomials), and 3D spline. The trilinear interpolation yielded the highest speed gain, with factors better than × 10,000 for a 9,000-triangle BEM model. More accurate results could be obtained with the Bézier interpolation (speed gain ~ 1,000), which, combined with a 8-mm step grid, lead to intrinsic localization and orientation errors of only 0.2 mm and 0.2 degrees. Further improvements in MEG could be obtained by interpolating only the contribution of secondary currents. Cropping grids by removing shallow points lead to a much better estimation of the dipole orientation in EEG than when solving the forward problem classically, providing an efficient alternative to locally refined models. This method would show special usefulness when combining realistic models with stochastic inverse procedures (simulated annealing, genetic algorithms) requiring many forward calculations. © 2001 Wiley-Liss, Inc.

625. Yao, D.Z., Y.C. Zhou, S.L. Fan, L. Chen, and X.Y. Ao, *Multi-dimensional delay-correlation MUSIC: a new method to extract multi-sources of EEGs*. Tien Tzu Hsueh Pao/Acta Electronica Sinica, 2001. **29**(4): p. 522-525.

Summary: The reported studies on EEG inverse by multiple signal classification (MUSIC) show the classical MUSIC algorithm suffers from two shortcomings: be sensitive to a color noise and fail in identifying synchronously active sources. Recent studies reveal that the MUSIC-based algorithm may be improved in depressing spatial coherent noise if the classical zero delay correlation matrix is replaced by a non-zero delay-correlation matrix, or by a high-order cumulant matrix, or by incorporating known noise covariance matrix in the zero-delay correlation matrix. And the MUSIC algorithm can be extended to identify synchronous actives through a recursive strategy. In this work, an iterative, multi-dimensional and delay-correlation MUSIC is proposed, where the color noise is depressed by the non-zero delay correlation and the synchronous active sources are identified by the iterative multi-dimensional MUSIC search. Simulation and VEP data tests show a good reconstruction is obtained.

626. Yao, D. and B. He, *A self-coherence enhancement algorithm and its application to enhancing three-dimensional source estimation from EEGs*. Annals of Biomedical Engineering, 2001. **29**(11): p. 1019-1027.

Summary: An algorithm was proposed to enhance the spatial resolution of solutions of the under determined electroencephalography (EEG) inverse problem. The self-coherence enhancement algorithm (SCEA) provides a self-coherence solution, which is a function of self-coherence estimate of the under determined EEG inverse solution. The high order self-coherence function was determined by the blurring level of the actual source distribution.

627. Winterer, G., C. Mulert, S. Mientus, J. Gallinat, P. Schlattmann, H. Dorn, and W.M. Herrmann, *P300 and LORETA: Comparison of normal subjects and schizophrenic patients*. Brain Topography, 2001. **13**(4): p. 299-313.

Summary: It was the aim of the present study 1) to investigate how many cortical activity maxima of scalp-recorded P300 are detected by Low Resolution Electromagentic Tomography (LORETA) when analyses are performed with high

time-resolution, 2) to see if the resulting LORETA-solution is in accordance with intracortical recordings as reported by others and 3) to compare the given pattern of cortical activation maxima in the P300-timeframe between schizophrenic patients and normal controls. Current density analysis was performed in 3-D Talairach space with high time resolution i.e. in 6 ms steps. This was done during an auditory choice reaction paradigm separately for normal subjects and schizophrenic patients with subsequent group comparisons. In normal subjects, a sequence of at least seven cortical activation maxima was found between 240-420ms poststimulus: the prefrontal cortex, anterior or medial cingulum, posterior cingulum, parietal cortex, temporal lobe, prefrontal cortex, medial or anterior cingulum. Within the given limits of spatial resolution, this sequential maxima distribution largely met the expectations from reports on intracranial recordings and functional neuroimaging studies. However, localization accuracy was higher near the central midline than at lateral aspects of the brain. Schizophrenic patients less activated their cortex in a widespread area mainly in the left hemisphere including the prefrontal cortex, posterior cingulum and the temporal lobe. From these analyses and comparsions with intracranial recordings as reported by others, it is concluded that LORETA correctly localizes P300-related cortical activity maxima on the basis of 19 electrodes except for lateral cortical aspects which is most likely an edge-phenomenon. The data further suggest that the P300-deficit in schizophrenics involves an extended cortical network of the left hemisphere at several steps in time during the information processing stream.

628. Waberski, T.D., I. Kreitschmann-Andermahr, W. Kawohl, F. Darvas, Y. Ryang, R. Gobbelé, and H. Buchner, *Spatio-temporal source imaging reveals subcomponents of the human auditory mismatch negativity in the cingulum and right inferior temporal gyrus*. Neuroscience Letters, 2001. **308**(2): p. 107-110.

Summary: We investigated the generators of the mismatch negativity by means of spatio-temporal source imaging on the basis of 64-channel electroencephalography data in order to study the time course and localization of proposed frontal sources. Results indicate that there are additional generators located both within the anterior cingulate gyrus and in the right inferior temporal gyrus, clearly separated from the supratemporal generators in space and time course. The cingulate generator is activated later than the temporal ones, which supports the hypothesis of a frontally located mechanism of involuntary switching of attention triggered by the temporal change detection system. Evidence for an additional right inferior temporal generator supports the hypothesis of right hemispheric dominance in early sound discrimination. © 2001 Elsevier Science Ireland Ltd. All rights reserved.

629. Veselis, R.A., *Anesthesia - A descent or a jump into the depths?* Consciousness and Cognition, 2001. **10**(2): p. 230-235.

Summary:

630. Uutela, K., S. Taulu, and M. Hämäläinen, *Detecting and correcting for head movements in neuromagnetic measurements*. NeuroImage, 2001. **14**(6): p. 1424-1431.

Summary: Head movements during neuromagnetic measurements may cause a significant error in the estimated locations of active brain areas. In this study we present a fast method for measuring the head position while neuromagnetic data are acquired. We then compare two methods for removing the effect of the movements in neuromagnetic source estimation and magnetic field alignment: minimum-norm estimate alignment and forward calculation correction. Simulations and a test measurement show that the proposed head position measurement method works with millimeter precision and that incorporating the effect of the head movements into the magnetic field forward calculations is an efficient and a sufficiently accurate method for correcting for the head movements. © 2001 Academic Press.

631. Thayer, Z.C., B.W. Johnson, M.C. Corballis, and J.P. Hamm, *Perceptual and motor mechanisms for mental rotation of human hands*. NeuroReport, 2001. **12**(16): p. 3433-3437.

Summary: We measured brain potentials from human subjects performing a mental rotation task requiring right-left judgments of misoriented hands, and a control task requiring palm-back judgments of the same stimuli. High-density, 128-channel event-related potentials (ERPs) were recorded from 16 normal, right-handed subiects. There was a main effect of task at five different latencies: 148 ms (occipital), 180 ms (parietal), 388 ms (vertex), 556 ms (central-parietal), and 900 ms (vertex). Source estimations derived from topographic data indicate that frontal brain regions were strongly activated after 300 ms in the control task, but not until about 900 ms in the rotation task. We conclude that the neural computations underlying mental hand rotation may be recruited from relatively early stages of visuo-perceptual analysis; these early computations influence subsequent processing within a parietal-prefrontal system for the integration of perception with action. © 2001 Lippincott Williams & Wilkins.

632. Szelenberger, W. and S. Niemcewicz, *Event-related current density in primary insomnia*. Acta Neurobiologiae Experimentalis, 2001. **61**(4): p. 299-308.

Summary: Using Low Resolution Electromagnetic Tomography (LORETA), event-related current density was investigated in 14 patients with primary insomnia and 14 controls matched for age, gender and education level. All subjects were rated on the Athens Insomnia Scale, the Hyperarousal Scale, the Hamilton Depression Rating Scale and the Beck Depression Inventory. They also completed the Selective Reminding Test and the Continuous Attention Test. Only minor elevations on depression scales were found in patients. The Continuous Attention Test did not reveal any between group differences. However, insomniacs required more trials before all the Selective Reminding Test items

were learned. Insomniacs showed less event-related current density in orbitofrontal, medial prefrontal and anterior cingulate cortex, i.e. brain regions of relevance for cognition and affect. Earliest group differences appeared in the P1 time range and then were observed at the N1, N2 and P3 stages of stimulus processing, These stimulus processing differences correlated most consistently with severity of insomnia. Neuropsychological impairment correlated most strongly with less current density in Brodmann area 10.

633. Steger, J., K. Imhof, J. Denoth, R.D. Pascual-MarquI, H.C. Steinhausen, and D. Brandeis, *Brain mapping of bilateral visual interactions in children*. Psychophysiology, 2001. **38**(2): p. 243-253.

Summary: Interhemispheric interactions were studied with functional brain mapping of visual processing. Children performed a reaction time task with uni- and bilateral targets and nontargets. The visual evoked potential (VEP) was segmented into P1a, P1b, and N1 microstates using map rather than channel features. Map latencies, amplitudes and sources were tested for bilateral interactions. Bilateral targets yielded shorter VEP map latencies but later response onsets than unilateral ones. Source analyses of the unilateral VEPs indicated a transition from contra- (P1a) to ipsilateral (P1b) visual cortex activation (interhemispheric transfer). Bilateral VEPs were smaller than the summed unilateral VEPs in all microstates, indicating that interhemispheric interactions both precede and follow interhemispheric transfer. Brain mapping of uni- and bilateral VEPs in children thus revealed several distinct forms of interhemispheric interactions in the same, early time range.

634. Sgouros, S., S. Seri, and K. Natarajan, *The clinical value of electroencephalogram/magnetic resonance imaging co-registration and three-dimensional reconstruction in the surgical treatment of epileptogenic lesions*. Child's Nervous System, 2001. **17**(3): p. 139-144.

Summary: With the rapid developments in image processing, new clinical applications of manipulation and three-dimensional (3-D) reconstruction of neuro-imaging are evolving. Combination with other non-invasive techniques aimed at localising electric sources in the brain is of particular interest. These techniques rely on the recording of brain electrical activity and/or the associated magnetic fields from multiple areas on the scalp. Data obtained from an electroencephalogram (EEG) or from magnetoencephalography (MEG) can be fused in 3-D arrangement with anatomical [magnetic resonance imaging/computerised tomography (MRI/CT)] and/or metabolic [positron emission tomography (PET)] data. Such techniques highlight information on the functional correlates of anatomical or space-occupying lesions and their role in the localisation of related symptomatic epilepsy. In the present study we report on methodological issues and preliminary clinical data on spectral EEG/MRI co-registration procedures, offering two examples of children presenting with hemispheric lesions, one frontal tumour and one temporal arterio-venous malformation. The EEG was acquired from 32/64 electrode location. The

electrode position and that of four reference points were measured with a dual sensor Polhemus 3D Isotrak digitiser. Sources of EEG activity were determined in 3-D space with the inverse solution method low resolution electromagnetic tomography (LORETA), providing for each frequency component, the topographic distribution of active electrical sources. The positions of the reference points were also measured on MRI, and co-registration of EEG and MRI was achieved using a transformation algorithm. The reconstructed 3-D images of co-registered EEG/MRI clearly demonstrate the relationship between the space-occupying lesion and the epileptic activity. Preliminary results show that in all the patients it was possible to identify with a remarkable accuracy the 3-D topographic relationship between lesion and cortical areas showing localised abnormalities on the EEG. The present method could further enhance the understanding of the effect of resective treatment of structural lesions on brain functioning. The new combined images can be used in combination with image-guided surgery equipment to modify effective surgical resection.

635. Sekihara, K., S.S. Nagarajan, D. Poeppel, A. Marantz, and Y. Miyashita, *Reconstructing spatio-temporal activities of neural sources using an MEG vector beamformer technique*. IEEE Transactions on Biomedical Engineering, 2001. **48**(7): p. 760-771.

Summary: We have developed a method suitable for reconstructing spatio-temporal activities of neural sources by using magnetoencephalogram (MEG) data. The method extends the adaptive beamformer technique originally proposed by Borgiotti and Kaplan to incorporate the vector beamformer formulation in which a set of three weight vectors are used to detect the source activity in three orthogonal directions. The weight vectors of the vector-extended version of the Borgiotti-Kaplan beamformer are then projected onto the signal subspace of the measurement covariance matrix to obtain the final form of the proposed beamformer's weight vectors. Our numerical experiments show that both spatial resolution and output signal-to-noise ratio of the proposed beamformer are significantly higher than those of the minimum-variance-based vector beamformer used in previous investigations. We also applied the proposed beamformer to two sets of auditory-evoked MEG data, and the results clearly demonstrated the method's capability of reconstructing spatio-temporal activities of neural sources.

636. Schmitt, U., A.K. Louis, F. Darvas, H. Buchner, and M. Fuchs, *Numerical aspects of spatio-temporal current density reconstruction from EEG-/MEG-data*. IEEE Transactions on Medical Imaging, 2001. **20**(4): p. 314-324.

Summary: The determination of the sources of electric activity inside the brain from electric and magnetic measurements on the surface of the head is known to be an ill-posed problem. In this paper, a new algorithm which takes temporal a priori information modeled by the smooth activation modell into account is described and compared with existing algorithms such as Tikhonov-Phillips.

637. Schairer, K.S., H.J. Gould, and M.A. Pousson, *Source generators of mismatch negativity to multiple deviant stimulus types*. Brain Topography, 2001. **14**(2): p. 117-130.

Summary: The purpose of the present study was to investigate auditory stimulus feature processing and how neural generators might differ among the mismatch negativity (MMN) responses to intensity, frequency, and duration deviant stimuli. Data collected from 72 electrodes in twelve adult female subjects were analyzed. For each subject, peak amplitude and latency values at Fz were compared among responses to the three deviant stimulus types presented in individual conditions with a probability of 0.10 and 0.30, and in the multiple deviant condition in which all three deviant types were presented (design based on Deacon et al. 1998). Further, equivalent current dipoles (ECD) for each deviant type, in each condition, and for each subject were calculated in three areas: right hemisphere, left hemisphere, and frontal. Peak amplitude and latency measured at Fz were consistent with previous findings by Deacon et al. (1998) and suggested parallel processing, perhaps by separate neural generators. However, ECD locations were not significantly different among the responses to the different deviant types. Further, the ECD magnitudes did not consistently reflect the differences in amplitude observed at the scalp among responses to the deviant types and conditions. The latter finding may indicate that the procedures were not sensitive enough to identify true differences among the generators. Alternatively, it was suggested that searching for separate neural generators at the cortical level may be too restrictive because the process may begin in subcortical areas, as indicated in animal models.

638. Radha Prabhu, V., B. Porjesz, D.B. Chorlian, K. Wang, A. Stimus, and H. Begleiter, *Visual P3 in female alcoholics*. Alcoholism: Clinical and Experimental Research, 2001. **25**(4): p. 531-539.

Summary: Background: The P300 (P3) component of the event related potential has been established as a sensitive risk marker of vulnerability to alcoholism. Most alcoholism studies have focused on men; recent studies indicate that women are equally vulnerable to developing alcoholism. Methods: Visual P3 recorded from 31 electrode positions was evaluated in 44 alcoholic and 60 control women, 24-50 years of age. P3 amplitudes and latencies of the two groups were statistically compared using Analysis of Variance; source localization of surface amplitude values from each group were plotted using a low-resolution brain electromagnetic tomography. Results: The results indicated that alcoholic women had significantly smaller P3 amplitudes in the frontal and central regions compared with controls. Source localization showed lowered activation in alcoholic women in right dorso-lateral prefrontal cortex and the ventro-medial fronto-central regions. Conclusions: The results suggest that P3 is an equally sensitive endophenotypic marker of vulnerability to alcoholism in women. The findings are discussed in terms of functional and physiologic significance of the P3 amplitude in alcoholic women and its relationship to drinking behaviors.

639. Prichep, L.S., E.R. John, and M. Tom, *Localization of deep white matter lymphoma using VARETA: A case study*. Clinical EEG Electroencephalography, 2001. **32**(2): p. 62-66.

Summary: Methods have recently been proposed for localization of multiple brain sources of particular EEG frequencies recorded from the scalp, to identify their most probable neuroanatomical generators. This paper reports the accurate localization of a deep white matter lymphoma, using Variable Resolution Electromagnetic Tomography (VARETA). The accuracy of this localization was confirmed by MRI studies. The patient was referred for a quantitative EEG evaluation, two weeks following an automobile accident, with no known loss of consciousness. There was marked excess and asymmetry of frontal slow wave activity, with highly significant hypocoherence. Significant gradient shifts within the left hemisphere were also seen. Visual inspection of the EEG tracings revealed theta paroxysms in left dorsolateral and mesial frontal regions. The MRI revealed a large space-occupying lesion deep within the white matter of the left frontal lobe, with evidence of subependymal spread and significant surrounding vasogenic edema. Localization of the sources of the maximal QEEG abnormalities using VARETA was consistent with the lesion location seen in the MRI images. This case demonstrates that VARETA can achieve highly sensitive and accurate localization of sources of QEEG abnormalities which lie in the deepest brain regions.

640. Pizzagalli, D., R.D. Pascual-Marqui, J.B. Nitschke, T.R. Oakes, C.L. Larson, H.C. Abercrombie, S.M. Schaefer, J.V. Koger, R.M. Benca, and R.J. Davidson, *Anterior cingulate activity as a predictor of degree of treatment response in major depression: Evidence from brain electrical tomography analysis*. American Journal of Psychiatry, 2001. **158**(3): p. 405-415.

Summary: Objective: The anterior cingulate cortex has been implicated in depression. Results are best interpreted by considering anatomic and cytoarchitectonic subdivisions. Evidence suggests depression is characterized by hypoactivity in the dorsal anterior cingulate, whereas hyperactivity in the rostral anterior cingulate is associated with good response to treatment. The authors tested the hypothesis that activity in the rostral anterior cingulate during the depressed state has prognostic value for the degree of eventual response to treatment. Whereas prior studies used hemodynamic imaging, this investigation used EEG. Method: The authors recorded 28-channel EEG data for 18 unmedicated patients with major depression and 18 matched comparison subjects. Clinical outcome was assessed after nortriptyline treatment. Of the 18 depressed patients, 16 were considered responders 4-6 months after initial assessment. A median split was used to classify response, and the pretreatment EEG data of patients showing better (N=9) and worse (N=9) responses were analyzed with low-resolution electromagnetic tomography, a new method to compute three-dimensional cortical current density for given EEG frequency bands according to a Talairach brain atlas. Results: The patients with better responses showed hyperactivity (higher theta activity) in the rostral anterior cingulate (Brodmann's area 24/32). Follow-up analyses demonstrated the specificity of this finding, which was not confounded by age or pretreatment depression severity. Conclusions: These results, based on electrophysiological imaging, not only support hemodynamic findings implicating activation of the anterior cingulate as a predictor of response in depression, but they also suggest that differential activity in the rostral anterior cingulate is associated with gradations of response.

641. O'Neill, N.S., M. Javidan, and Z.J. Koles, *Identification of the temporal components of seizure onset in the scalp EEG.* Canadian Journal of Neurological Sciences, 2001. **28**(3): p. 245-253.

Summary: Background: The identification of the earliest indication of rhythmical oscillations and paroxysmal events associated with an epileptic seizure is paramount in identifying the location of the seizure onset in the scalp EEG. In this work, data-dependent filters are designed that can help reveal obscure activity at the onset of seizures in problematic EEGs. Methods: Data-dependent filters were designed using temporal patterns common to selected segments from pre-ictal and ictal portions of the scalp EEG. Temporal patterns that accounted for more variance in the ictal segment than in the pre-ictal segment of the scalp EEG were used to form the filters. Results: Application of the filters to the scalp EEG revealed temporal components in the seizure onset in the scalp recording that were not obvious in the unfiltered EEG. Examination of the filtered EEG enabled the onset of the seizure to be recognized earlier in the recording. The utility of the filters was confirmed qualitatively by comparing the scalp recording to the intracranial recording and quantitatively by calculating correlation coefficients between the scalp and intracranial recordings before and after filtering. Conclusion: The data-dependent approach to EEG filter design allows automatic detection of the basic frequencies present in the seizure onset. This approach is more effective than narrow band-pass filtering for eliminating artifactual and other interference that can obscure the onset of a seizure. Therefore, temporal-pattern filtering facilitates the identification of seizure onsets in challenging scalp EEGs.

642. Mulert, C., J. Gallinat, R. Pascual-Marqui, H. Dorn, K. Frick, P. Schlattmann, S. Mientus, W.M. Herrmann, and G. Winterer, *Reduced event-related current density in the anterior cingulate cortex in schizophrenia.* NeuroImage, 2001. **13**(4): p. 589-600.

Summary: There is good evidence from neuroanatomic post-mortem and functional imaging studies that dysfunction of the anterior cingulate cortex plays a prominent role in the pathophysiology of schizophrenia. So far, no electrophysiological localization study has been performed to investigate this deficit. We investigated 18 drug-free schizophrenic patients and 25 normal subjects with an auditory choice reaction task and measured event-related activity with 19 electrodes. Estimation of the current source density distribution in Talairach space was performed with low-resolution electromagnetic tomography (LORETA). In normals, we could differentiate between an early event-related potential peak of the N1 (90-100 ms) and a later N1 peak (120-130 ms). Subsequent current-density LORETA analysis in Talairach space showed increased activity in the auditory cortex area during the first N1 peak and increased activity in the anterior cingulate gyrus during the second N1 peak. No activation difference was observed in the auditory cortex between normals and patients with schizophrenia. However, schizophrenics showed significantly less anterior cingulate gyrus activation and slowed reaction times. Our results confirm previous findings of an electrical source in the anterior cingulate and an anterior cingulate dysfunction in schizophrenics. Our data also suggest that anterior cingulate function in schizophrenics is disturbed at a relatively early time point in the information-processing stream (100-140 ms poststimulus). © 2001 Academic Press.

643. Morales-Chacón, L., J. Bosch-Bayard, P. Valdés, and M. Zaldívar, *Cerebral electrical tomography in bilateral congenital peri-sylum syndrome*. Tomografía eléctrica cerebral en el síndrome perisilviano congénito bilateral, 2001. **32**(4): p. 397-399.

Summary:

644. Morales-Chacón, L., *Magnetic resonance spectroscopy and functional magnetic resonance images: Non-invasive alternatives for identification of the zone*. Espectroscopía por resonancia magnética e imágenes de resonancia magnética funcional: Alternativas no invasivas para la identificación de la zona epileptogénica, 2001. **32**(3): p. 234-236.

Summary: Magnetic resonance spectroscopy and functional magnetic resonance images are new non-invasive techniques which have the potential for localization of the epileptogenic focus in patients with refractory focal epilepsy, who are candidates for surgery. Determination of patterns of asymmetry of the N-acetyl-aspartic acid (NAA) between homologous regions of the temporal lobes, using magnetic resonance spectroscopy contributes to preoperative lateralization in patients with temporal lobe epilepsy. This technique may become a method for localization if its usefulness in the differentiation of mesial temporal lobe epilepsy from neocortical epilepsy is validated. Functional magnetic resonance images triggered by epileptiform discharges on the EEG, when combined with methods for localizing the source, permit the site of the epileptogenic focus to be found. This would particularly benefit patients with non-lesional extra-temporal epilepsy who are potential candidates for invasive recordings. The use of magnetic resonance spectroscopy and junctional magnetic resonance images in the preoperative evaluation of patients with refractory focal epilepsy, especially if it is used together with the relevant clinical data and that from other structural and functional imaging techniques, will reduce invasive monitoring and increase the accessibility to surgical treatment for this condition.

645. Michel, C.M., G. Thut, S. Morand, A. Khateb, A.J. Pegna, R. Grave de Peralta, S. Gonzalez, M. Seeck, and T. Landis, *Electric source imaging of human brain functions*. Brain Research Reviews, 2001. **36**(2-3): p. 108-118.

Summary: We review recent methodological advances in electromagnetic source imaging and present EEG data from our laboratory obtained by application of these methods. There are two principal steps in our analysis of multichannel electromagnetic recordings: (i) the determination of functionally relevant time periods in the ongoing electric activity and (ii) the localization of the sources in the brain that generate these activities recorded on the scalp. We propose a temporal segmentation of the time-varying activity, which is based on determination of changes in the topography of the electric fields, as an approach to the first step, and a distributed linear inverse solution based on realistic head models as an approach to the second step. Data from studies of visual motion perception, visuo-motor transfer, mental imagery, semantic decision, and cognitive interference illustrate that this analysis allows us to define the patterns of electric activity that are present at given time periods after stimulus presentation, as well as those time periods where significantly different patterns appear between different stimuli and tasks. The presented data show rapid and parallel activation of different areas within complex neuronal networks, including early activity of brain regions remote from the primary sensory areas. In addition, the data indicate information exchange between homologous areas of the two hemispheres in cases where unilateral stimulus presentation requires interhemispheric transfer. © 2001 Elsevier Science B.V. All rights reserved.

646. Lian, J. and B. He, *A minimal product method and its application to cortical imaging*. Brain Topography, 2001. **13**(3): p. 209-217.

Summary: In order to reduce the spatial blurring effect due to the head volume conductor, cortical imaging technique (CIT) can be used to reconstruct the cortical potential distribution from the scalp potential measurement with enhanced spatial resolution. To overcome the ill-posed nature of the inverse problem, Tikhonov regularization (TIK) and truncated Singular Value Decomposition (TSVD) are commonly used by choosing the appropriate regularization parameter and truncation parameter, respectively. We have developed a minimal product method (MINP) to determine the regularization and truncation parameters. The present computer simulation and experimental results indicate that the MINP can be easily implemented in both TIK and TSVD with satisfactory performance, and suggest the potential applications of the MINP method in determining the corner of the L-curve.

647. Lehmann, D., P.L. Faber, P. Achermann, D. Jeanmonod, L.R.R. Gianotti, and D. Pizzagalli, *Brain sources of EEG gamma frequency during volitionally meditation-induced, altered states of consciousness, and experience of the self.* Psychiatry Research - Neuroimaging, 2001. **108**(2): p. 111-121.

Summary: Multichannel EEG of an advanced meditator was recorded during four different, repeated meditations. Locations of intracerebral source gravity centers as well as Low Resolution Electromagnetic Tomography (LORETA) functional images of the EEG 'gamma' (35-44 Hz) frequency band activity differed significantly between meditations. Thus, during volitionally self-initiated, altered states of consciousness that were associated with different subjective meditation states, different brain neuronal populations were active. The brain areas predominantly involved during the self-induced meditation states aiming at visualization (right posterior) and verbalization (left central) agreed with known brain functional neuroanatomy. The brain areas involved in the self-induced, meditational dissolution and reconstitution of the experience of the self (right fronto-temporal) are discussed in the context of neural substrates implicated in normal self-representation and reality testing, as well as in depersonalization disorders and detachment from self after brain lesions. © 2001 Elsevier Science Ireland Ltd. All rights reserved.

648. Leder, U., J. Haueisen, P. Pohl, F.M. Malur, J.P. Heyne, V. Baier, and H.R. Figulla, *Methods for the computational localization of atrio-ventricular pre-excitation syndromes*. International Journal of Cardiac Imaging, 2001. **17**(2): p. 153-160.

Summary: Background: The site of atrioventricular pre-excitation can roughly be estimated with the help of schemes basing on a few number of electrocardiogram (ECG) leads. Computer algorithms have been developed which utilize the body surface mapping of the pre-excitation signal for the localization purpose. We tested several new algorithms. Method: A patient suffering from Wolff-Parkinson-White syndrome was investigated prior the catheter ablation. The body surface mapping was performed with a 62-lead magnetocardiograph. The site of pre-excitation was calculated by using different methods: the dipole method with fixed and moving dipoles, the dipole scan on the endocardium, and different current density methods (L1 norm method, L2 norm method, low resolution electromagnetic tomography (LORETA) method, and maximum entropy method). Three-dimensional (3D) magnetic resonance imagings (MRIs) of the heart were used to visualize the results. The source positions were compared to the site of catheter ablation. Results: The accessory pathway was successfully ablated left laterally. This site was correctly identified by the conventional dipole method. By scanning the entire endocardial surface of the heart with the dipole method we found a circumscribed source area. This area too, was located at the lateral segment of the atrio-ventricular grove. The current density methods performed differently. Whereas the L1 norm identified the site of pre-excitation, the L2 norm, the LORETA method and the maximum entropy method resulted in extended source areas and therefore were not suited for the localization purpose. Conclusion: The dipole scan and the L1 norm current density method seem to be useful additions in the computational localization of pre-excitation syndromes. In our single case study they confirmed the localization results obtained with the dipole method, and they estimated the size of the suspected source region.

649. Lavric, A., D. Pizzagalli, S. Forstmeier, and G. Rippon, *Mapping dissociations in verb morphology*. Trends in Cognitive Sciences, 2001. **5**(7): p. 301-308.

Summary: Substantial behavioural and neuropsychological evidence has been amassed to support the dual-route model of morphological processing, which distinguishes between a rule-based system for regular items (walk-walked, call-called) and an associative system for the irregular items (go-went). Some neural-network models attempt to explain the neuropsychological and brain-mapping dissociations in terms of single-system associative processing. We show that there are problems in the accounts of homogeneous networks in the light of recent brain-mapping evidence of systematic double-dissociation. We also examine the superior capabilities of more internally differentiated connectionist models, which, under certain conditions, display systematic double-dissociations. It appears that the more differentiation models show, the more easily they account for dissociation patterns, yet without implementing symbolic computations. Copyright © 2001 Elsevier Science Ltd.

650. Lavric, A., D. Pizzagalli, S. Forstmeier, and G. Rippon, *A double-dissociation of English past-tense production revealed by event-related potentials and low-resolution electromagnetic tomography (LORETA)*. Clinical Neurophysiology, 2001. **112**(10): p. 1833-1849.

Summary: Objectives: Evidence of systematic double-dissociations of neural activity associated with the generation of regular and irregular past tense in healthy individuals may prove decisive in distinguishing between single- and dual-route models of morphological processing, because the former (connectionist models of morphological processing) have only been able to simulate double-dissociations of past-tense morphology as low-probability phenomena. Methods: Twenty-eight channel event-related potentials (ERPs) were recorded in response to past-tense production and subsequently analyzed using a 3-stage strategy. Results: A data-driven algorithm temporally segmented the ERPs into 16 distinct epochs of stable field configuration (microstates). A space-oriented brain electric field analysis determined that one of those epochs, 288-321 ms after the verb stem presentation, showed significant differences between the regular and irregular verb conditions. As a further test of these results, a novel source localization technique that computes 3-dimensional distribution of cortical current density in the Talairach brain atlas - low-resolution electromagnetic tomography - found in the above microstate more activity for regulars in the right prefrontal and right temporal areas and for irregulars in the left temporal areas and the anterior cingulate cortex, which can be taken as evidence of systematic double-dissociation. Conclusions: The present results achieved with a source localization technique provide evidence of a two-way compartmentalization of neural activity corresponding to regular and irregular past tense, thus corroborating the dual-mechanism character of verb morphology. © 2001 Elsevier Science Ireland Ltd. All rights reserved.

651. Lantz, G., L. Spinelli, C.M. Michel, R.G. De Peralta Menendez, and M. Seeck, *Localization of distributed sources and comparison with functional MRI.* Localisation de sources distribuées et comparaison avec l'IRM fonctionnelle, 2001. **3**(SPEC. ISS. 1).

Summary: Functional mapping of the human brain has made tremendous progress in the past years thanks to new technical developments. Imaging methods are now available; they allow to study brain functions with high spatial and temporal resolution. Single photon emission computer tomography (SPECT), positron emission tomography (PET), functional magnetic resonance imaging (fMRI) and high resolution electro- and magnetoencephalography (EEG and MEG) are currently intensively applied techniques to functional studies, each one having specific properties concerning spatial and temporal resolution. The success of these methods in basic neuroscience research has led to the demand for applying them to clinical questions. Diseases of the central nervous system that lead to brain dysfunction can be ideally explored using these techniques. Of particular importance are those diseases in which a focal neuronal dysfunction is the primary cause and where surgical resection of this focus might be the cure. This is often the case for epilepsy, where a discrete primary focus might exist from which pathological rhythms evolve and propagate throughout the brain, leading to seizures that severely handicap the patient. Surgical resection of the primary focus is only possible if the focus can be exactly localized and adequately separated from functionally important areas. This is where these new functional imaging tools become important. The use of SPECT and PET for focus localization has been most extensively studied and their specificity and sensitivity are intensively discussed. In the last few years functional MRI has evolved as a new interesting tool in epileptic focus localization. The most important limitation of these techniques, however, is the temporal resolution. Since epileptic activity can propagate very fast, several hyper- or hypoactive regions are seen in the images and primary areas cannot be distinguished from regions of propagation. The only methods that have sufficient temporal resolution to follow neuronal activity in real time are the electrophysiological measures, i.e. the EEG and the MEG. Localization of the sources in the brain that produced a given surface electromagnetic field has become possible through algorithms that solve the so-called "inverse problem". Several different algorithms exist and many groups begun to apply them to epileptic data with the aim to localize the focus of the pathological electrical discharges. This review article discusses the use of distributed EEG source localization procedures in the presurgical evaluation of patients with intractable focal epilepsy. In contrast to equivalent dipole models, distributed localization methods do not localize one active point in the brain but rather assume extended active areas, which is generally the case in epileptic activity. The methods shown here are based on linear numerical methods and are therefore less prone to errors when working with scattered solution spaces such as the one defined by anatomical constraints. Solutions constraint to the gray matter determined in the individual MRI are shown here. We illustrate three methods to increase the spatial resolution of the source localization procedures: One is to increase the number of recording channels to more than 100, the

second to use linear methods of high precision to detect focal sources (EPIFOCUS), and the third to combine EEG source localization with EEG-triggered functional magnetic resonance imaging. The importance of EEG source localization for the interpretation of fMRI data will be particularly discussed in view of the important difference of the temporal resolution by the two methods. The localization methods can be applied to interictal as well as to ictal activity. In case of analysis of ictal EEG we propose to use full scalp frequency analysis to determine the time period of seizure onset and to localize the sources of the initial dominant frequency.

652. Lantz, G., R.G.D.P. Menendez, S.G. Andino, and C.M. Michel, *Noninvasive localization of electromagnetic epileptic activity. II. Demonstration of sublobar accuracy in patients with simultaneous surface and depth recordings*. Brain Topography, 2001. **14**(2): p. 139-147.

Summary: Seven patients with complex partial epileptic seizures undergoing invasive video/EEG-monitoring were investigated with a combination of 10 subdural strip electrode contacts (subtemporal + lateral temporal), and 22 extracranial recording sites. In each patient spikes with different intracranial distributions were identified, and for those with similar distributions the extracranial activity was averaged. A new inverse solution method called EPIFOCUS (Grave et al. 2001, this issue) was used to reconstruct the sources of both single and averaged spikes in a standard 3D-MRI, and a statistical analysis was performed in order to demonstrate location differences between spikes with different intracranial distributions. The results revealed significantly more anterior and ventral source locations for subtemporal compared to lateral temporal spikes. Within the subtemporal group, medial spikes had more mesial and dorsal locations compared to lateral ones. In the lateral temporal group, more anterior and ventral locations were obtained for anterior compared to posterior spikes. The results demonstrate the applicability of EPIFOCUS in the localization of sources in the temporal lobe with sublobar accuracy. This possibility may bb2ecome important in the future, for instance in identifying cases where amygdalo-hippocampectomy or other limited temporal lobe resections may replace the standard en bloc resections.

653. Kounios, J., R.W. Smith, W. Yang, P. Bachman, and M. D'Esposito, *Cognitive association formation in human memory revealed by spatiotemporal brain imaging*. Neuron, 2001. **29**(1): p. 297-306.

Summary: Cognitive theory posits association by juxtaposition or by fusion. We employed the measurement of event-related brain potentials (ERPs) to a concept fusion task in order to explore memory encoding of these two types of associations between word pairs, followed by a memory test for original pair order. Encoding processes were isolated by subtracting fusion task ERPs corresponding to pairs later retrieved quickly from ERPs corresponding to pairs later retrieved slowly, separately for pairs fused successfully and unsuccessfully (i.e., juxtaposed). Analyses revealed that the encoding of these two types of associations yields different ERP voltage polarities, scalp topographies, and brain sources extending over the entire time course of processing.

654. Koles, Z.J., P. Flor-Henry, and J.C. Lind, *Low-resolution electrical tomography of the brain during psychometrically matched verbal and spatial cognitive tasks*. Human Brain Mapping, 2001. **12**(3): p. 144-156.

Summary: EEGs were recorded from 75 normal, young, female subjects during psychometrically matched verbal (WF) and spatial (DL) cognitive tasks to elicit the differences in the electrical source distribution inside the brain. Recordings were obtained using 43 EEG and 3 guard electrodes then visually edited and spatially filtered to remove extracerebral artifacts. Twenty 1-sec artifact-free epochs were obtained and analyzed from 42 and 60 subjects during WF and DL respectively. Of these subjects, 20 were placed in a training set and the remainder into a test set. The baseline for the comparison of the two tasks was established by factoring the average cross-spectral matrices of the training-set EEGs, computed in the theta, alpha, and beta frequency bands into spatial patterns common to the two tasks. Only those spatial patterns that contributed to the correct classification of subjects in the test set were included in the source analysis. The source-current density distributions were obtained using the LORETA-KEY© algorithm. The results show that the source-current density distribution is related to the putative functional activity in the brain in all three frequency bands. The electrical effects of the tasks are both most highly localized and lateralized in the theta band. The effects in the alpha and beta bands are much more generalized and are strongly lateralized only during one and the other of the tasks respectively. The conclusion is that WF is mainly a left central and bilateral frontal cerebral process while DL is mainly a right central and bilateral posterior cerebral process. © 2001 Wiley-Liss, Inc.

655. Khateb, A., C.M. Michel, A.J. Pegna, G. Thut, T. Landis, and J.M. Annoni, *The time course of semantic category processing in the cerebral hemispheres: An electrophysiological study*. Cognitive Brain Research, 2001. **10**(3): p. 251-264.

Summary: Using visual half-field presentations of words to the right (RVF) and to the left visual field (LVF), this study investigated the time course of the hemispheric involvement in the processing of semantic category information. Multi-channel event related brain potentials (ERPs) were recorded from 15 healthy subjects during a categorisation task of sequentially presented word pairs. Subjects had to judge mentally after the appearance of the second word whether the words of a pair were semantically related (SR) or not (SU). ERPs were computed, from 100 ms before the onset of the second word to 600 ms, for SR and SU conditions in the LVF and in the RVF separately. The temporal segmentation of ERP map series into sequences of quasi-stable map configurations revealed a total of seven segments in each visual field of which only the first five (S1-S5, appearing between 70 and 400 ms) showed different map configurations as a function of visual field but presented a similar temporal

sequence in both visual fields. By contrast, of the last two segments (S6 and S7) which appeared between ~400 and ~600 ms, only S7 differentiated SR and SU conditions in terms of its duration. Source localisation analysis of the segments showed that following the initial activation of posterior brain regions as a function of the visual field of presentation, a common neural network was activated in the left hemisphere (LH) although the dynamics of activation varied as a function of visual field. Concerning the role of the right hemisphere (RH) in lexico-semantic processing, the results presented here appear to be compatible with a 'callosal relay model' and suggest that, in healthy subjects, information is transferred rapidly (~150 ms) from the RH to the language dominant-LH. © 2001 Elsevier Science B.V.

656. Jing, H., M. Takigawa, H. Okamura, W. Doi, and H. Fukuzako, *Comparisons of event-related potentials after repetitive transcranial magnetic stimulation.* Journal of Neurology, 2001. **248**(3): p. 184-192.

Summary: Effects of repetitive transcranial magnetic stimulation (rTMS) on the human cognitive process were investigated by examining auditory event-related potentials (ERPs) in 15 healthy subjects. Two rTMS trains were delivered over the left frontal area, with 30 pulses in each train. ERPs were recorded at 14 electrode sites on the scalp using a typical oddball protocol before and after rTMS. Tone stimuli (20% target and 80% standard) were delivered through earphones. Latency and amplitude of N100, P200, N200 and P300 were measured and compared during the study. To observe information flow between two electrode sites, directed coherence (DCOH) was calculated on the ERPs. Our results show that the effect of rTMS differs in the various ERPs components ($P < 0.001$). The latency of P300 significantly increased after stimulation, and the increase was more obvious in the frontal (18.6 ms) and central (15.8 ms) areas. The latency of P200 decreased in all areas. The amplitude of component N100 in the frontal and central areas decreased after rTMS. DCOH from the central area to the temporal area and DCOH from the parietal area to the temporal area were significantly higher than the DCOH between other areas ($P < 0.01$), and these properties were not affected by rTMS ($P > 0.05$). Information flow was driven from the frontal area to the parietal area after stimulation. Our results suggest that rTMS can suppress cognitive activities, showing an inhibitory effect on neurophysiological processes in the human brain. Since the temporal area is located at the terminus of the propagation pathways, it plays important roles in processing information in cognitive activities.

657. Jing, H., M. Takigawa, K. Hamada, H. Okamura, Y. Kawaika, T. Yonezawa, and H. Fukuzako, *Effects of high frequency repetitive transcranial magnetic stimulation on P300 event-related potentials.* Clinical Neurophysiology, 2001. **112**(2): p. 304-313.

Summary: Objective: Auditory event-related potentials (P300-ERPs) were analyzed before and after repetitive transcranial magnetic stimulation (rTMS). Methods: Two rTMS trains (10 Hz, 3 s, 100% motor threshold and 5 min interval) were delivered over the left frontal area in healthy subjects. P300-ERPs were recorded at 14 electrode sites on the scalp using a typical oddball paradigm before and after rTMS. The latencies and amplitudes of N100, P200, N200 and P300 were measured and compared. The directed coherence (DCOH) was estimated to demonstrate information flow between different cortical areas. Results: rTMS significantly influenced P300-ERPs. The effects differed on the different components ($P < 0.001$). The latency of P300 significantly increased after stimulation, which was more obvious in the frontal and central areas. The changes in P300 amplitude were not significant ($P > 0.05$). The DCOH from the frontal, central, parietal and occipital areas to the temporal area was significantly higher than the DCOH from the temporal area to the former 4 areas ($P < 0.01$). Conclusions: rTMS with the present parameters can affect P300-ERPs, leading to a delayed P300 component and changes in information connections around the stimulated site. Our data suggest that rTMS may postpone neuronal activities related to cognitive processing. © 2001 Elsevier Science Ireland Ltd.

658. Jaušovec, N. and K. Jaušovec, *Differences in EEG current density related to intelligence*. Cognitive Brain Research, 2001. **12**(1): p. 55-60.

Summary: Differences in current density between high intelligent (IQ = 127), and low intelligent individuals (IQ = 87), while solving two oddball tasks (auditive and visual) were analyzed with low resolution brain electromagnetic tomography (LORETA). In highly intelligent individuals a decrease in the volume of activated cortical gray matter between the P300 onset and the P300 peak amplitude was observed. The EEG of low intelligent individuals showed a reverse pattern of cortical activity. In the auditive oddball task the decrease in the activated cortical volume in high intelligent individuals was accompanied by an increase in current density, and a more left hemispheric source location at maximum current density. The results suggest that high intelligent individuals more efficiently distributed their cognitive resources needed to cope with the oddball tasks. © 2001 Elsevier Science B.V. All rights reserved.

659. Isotani, T., H. Tanaka, D. Lehmann, R.D. Pascual-Marqui, K. Kochi, N. Saito, T. Yagyu, T. Kinoshita, and K. Sasada, *Source localization of EEG activity during hypnotically induced anxiety and relaxation*. International Journal of Psychophysiology, 2001. **41**(2): p. 143-153.

Summary: The engagement of different brain regions which implement subjectively experienced emotional states in normals is not completely clarified. Emotional states can conveniently be induced by hypnosis-based suggestions. We studied brain electric activity during hypnotically induced anxiety and relaxation in 11 right-handed normals (5 males, 6 females, mean age 26.5±7.6 years). After induction of light hypnosis, anxiety and then relaxation was suggested using a standardized text (reverse sequence in half of the subjects). Nineteen-channel, eyes-closed EEG (20 artifact-free s/subject) was analyzed (source localization using FFT approximation and low resolution electromagnetic tomography, LORETA). Global tests revealed the strongest difference ($P<0.005$) between EEG source gravity center locations during the two emotional states in the excitatory beta-2 EEG frequency band (18.5-21 Hz). Post hoc tests showed that the sources were located more right during anxiety than during relaxation ($P=0.01$). LORETA specified that anxiety showed maximally stronger activity than relaxation in right Brodmann area 10, and relaxation showed maximally stronger activity than anxiety in left Brodmann area 22. Clearly, the two induced emotional states were associated with activity of different neural populations. Our results agree with reports on brain activity shifted to the right (especially fronto-temporal) during negative compared with positive emotions, and support the role of beta-2 EEG frequency in emotional states. Copyright © 2001 Elsevier Science B.V.

660. Isotani, T., D. Lehmann, R.D. Pascual-Marqui, K. Kochi, J. Wackermann, N. Saito, T. Yagyu, T. Kinoshita, and K. Sasada, *EEG source localization and global dimensional complexity in high- and low-hypnotizable subjects: A pilot study.* Neuropsychobiology, 2001. **44**(4): p. 192-198.

Summary: Individuals differ in hypnotizability. Information on hypnotizability-related EEG characteristics is controversial and incomplete, particularly on intracerebral source localization and EEG dimensionality. 19-channel, eyes-closed resting EEGs from right-handed, healthy, 8 high- and 4 low-hynotizable subjects (age: 26.7 ± 7.3 years) were analyzed. Hypnotizability was rated after the subjects' ability to attain a deep hypnotic stage (amnesia). FFT Dipole Approximation analysis in seven EEG frequency bands showed significant differences ($p < 0.04$) of source gravity center locations for theta (6.5-8 Hz, more posterior and more left for highs), beta-1 and beta-2 frequencies (12.5-18 and 18.5-21 Hz; both more posterior and more right for highs). Low Resolution Electromagnetic Tomography (LORETA) specified the cortical anteriorization of beta-1 and beta-2 in low hypnotizables. Power spectral analysis of Global Field Power time series (curves) showed no overall power differences in any band. Full-band Global Dimensional Complexity was higher in high-hypnotizable subjects ($p < 0.02$). Thus, before hypnosis, high and low hypnotizables were in different brain electric states, with more posterior brain activity gravity centers (excitatory right, routine or relaxation left) and higher dimensional complexity (higher arousal) in high than low hypnotizables. Copyright © 2001 S. Karger AG, Basel.

661. Idemen, M. and A. Alkumru, *New method for the source localization in sectionally homogeneous bounded domains involving finitely many inner interfaces of arbitrary shapes.* International Journal of Engineering Science, 2001. **39**(8): p. 851-872.

Summary: A new method to localize a static point source buried in a nonhomogeneous bounded domain composed of finitely many homogeneous parts separated by interfaces of arbitrary shapes was established. The source can be a simple point charge or current or a dipole of them. The method requires only the knowledge of the potential function $\Phi(x,y,z)$ at five or six points on the outermost interface depending on whether the source is simple or dipole. The new and basic feature of the method consists of determining the potential

function Φ0(x,y,z) which would be observed if the whole space was filled with a homogeneous material. Then, in the case of a simple source, the position P0 as well as the strength s can be determined, in general, by solving a system of three linear algebraic equations. When the source consists of a dipole, its position P0 and moment p can be found by solving a system of six nonlinear algebraic equations. The determination of Φ0, P0 and s (or p) is achieved iteratively by solving the above-mentioned algebraic equations along with a singular integral equation satisfied by Φ0. Some illustrative examples show the applicability and accuracy of the method. The method can have effective applications in heat conduction, matter diffusion, electrostatics, steady-state current flow, electroencephalography, electrocardiography, etc.

662. Huppertz, H.J., S. Hoegg, C. Sick, C.H. Lücking, J. Zentner, A. Schulze-Bonhage, and R. Kristeva-Feige, *Cortical current density reconstruction of interictal epileptiform activity in temporal lobe epilepsy*. Clinical Neurophysiology, 2001. **112**(9): p. 1761-1772.

Summary: Objective: To investigate the value of cortical current density (CCD) reconstruction in localizing intracranial generators of interictal epileptiform activity in mesial and lateral temporal lobe epilepsy (TLE). Methods: Non-linear minimum L1-norm CCD reconstruction (with current sources restricted to the individual cortical surface and a realistic boundary element method (BEM) head model) was used to localize and to study the propagation of interictal epileptiform EEG activity in 13 pre-surgical patients with TLE. Results: In all but one patient with mesial temporal lesions, an initial activation maximum corresponding to the ascending part of averaged sharp waves was found in the ipsilateral anterior basolateral temporal lobe, mostly extending up to the affected mesial structures whose resection rendered the patients seizure-free. In all 3 patients with lateral temporal lesions, the activation was initially confined to temporal neocortex immediately adjacent to the epileptogenic lesion. Towards the peak of sharp waves, two patients showed a propagation of interictal activity to anterior and posterior and partly contralateral temporal regions. A conventional EEG analysis based on amplitude maxima or phase reversal would have missed the initial onset zone. Conclusions: The findings demonstrate that CCD reconstruction can be a valuable additional non-invasive component in the multimodal pre-surgical evaluation of epilepsy patients. © 2001 Elsevier Science Ireland Ltd. All rights reserved.

663. Hirota, T., T. Yagyu, R.D. Pascual-Marqui, N. Saito, and T. Kinoshita, *Spatial structure of brain electric fields during intermittent photic stimulation*. Neuropsychobiology, 2001. **44**(2): p. 108-112.

Summary: EEG changes in 27 young healthy male right-handed volunteers on intermittent photic stimulation (IPS) were estimated using global field power (GFP), EEG micro-state modeling and analysis (EMMA), and low-resolution electromagnetic brain tomography (LORETA). The GFP significantly increased at flashing frequency and high harmonics. Three model maps were extracted with the EMMA procedure, from which high alternation rates of each microstate were observed. Moreover, two of the three model maps contributed very highly, occurring most frequently. LORETA imaging of the three model maps obtained from the EMMA procedure showed that both visual dominant cortical areas were activated, especially in the left hemisphere. These results suggest that IPS does not cause peculiar spatial configurations of the brain electric field, but does cause acceleration and deviation of the microstate alternation. Also, a functional laterality between hemispheres might be enhanced by symmetric IPS. Copyright © 2001 S. Karger AG, Basel.

664. Hinojosa, J.A., M. Martín-Loeches, P. Casado, F. Muoz, C. Fernández-Frías, and M.A. Pozo, *Studying semantics in the brain: The rapid stream stimulation paradigm*. Brain Research Protocols, 2001. **8**(3): p. 199-207.

Summary: Event-related potentials (ERPs) provide information about the temporal course of cognitive processes in the brain. They have proved to be a valuable tool in order to explore semantic aspects of word processing. However, to date, research in this field has been mostly concerned with the study of post-lexical features by means of the N400-paradigm. We introduce here the rapid stream stimulation paradigm, in which stimuli reflecting different levels of linguistic information are presented to subjects at a high rate of stimulation. The present protocol shows in detail how this paradigm can be applied. The application of the rapid stream stimulation paradigm evokes the recognition potential (RP), an ERP component that peaks at around 260 ms after stimuli onset and seems to be reflecting lexical selection processes. Results of studies that revealed the sensibility of the RP to visual-semantic aspects and the location of its neural generators within basal extrastriate areas are reported. Although some research has been conducted with the rapid stream stimulation paradigm much remains still to be done. Some of the possibilities that this paradigm offers are further discussed. © 2001 Elsevier Science B.V. All rights reserved.

665. He, B. and D. Wu, *Imaging and visualization of 3-D cardiac electric activity*. IEEE Transactions on Information Technology in Biomedicine, 2001. **5**(3): p. 181-186.

Summary: Noninvasive imaging of cardiac electric activity is of importance for better understanding the underlying mechanisms and for aiding clinical diagnosis and intervention of cardiac abnormalities. We propose to image the three-dimensional (3-D) cardiac bioelectric source distribution from body-surface electrocardiograms. Cardiac electrical sources were modeled by a current dipole distribution throughout the entire myocardium, and estimated by using the Laplacian weighted minimum norm (LWMN) algorithm from body-surface potentials. The estimated inverse solution of the current distribution was further improved by using a recursive weighting strategy for localized sources, such as origins of cardiac arrhythmias. Computer simulations were conducted to test the feasibility of the proposed approach by using a 3-D ventricle model embedded in a realistically shaped torso model. The boundary element method was used to solve the forward problem from assumed cardiac sources to the body-surface potentials. Two testing dipoles were placed in the left and right ventricles, simulating the early activation associated with ventricular arrhythmias. The LWMN inverse solution showed an equivalent source distribution over the entity of both ventricles, with spread areas of activity overlying the positions of the testing dipoles. The sharpened inverse image provides well-localized focal sources near the testing dipole positions. In summary, the present computer simulation suggests that the proposed 3-D cardiac current source imaging and localization approach appears to be a promising candidate for localizing J and imaging sites of origins of cardiac activation.

666. Harmony, T., T. Fernández, A. Fernández-Bouzas, J. Silva-Pereyra, J. Bosch, L. Díaz-Comas, and L. Galán, *EEG changes during word and figure categorization*. Clinical Neurophysiology, 2001. **112**(8): p. 1486-1498.

Summary: Objective: To analyze whether the EEG changes observed during figure and word categorization are compatible with either the dual, the common amodal, or the alternative model (modality-specific codes for words and pictures, where meaning is represented for both in a higher-order amodal system) for semantic knowledge. Methods: EEG was recorded during word and figure categorization of animals or non-animals in a group of 28 children 8-10 years old. Computation of EEG sources in the frequency domain using variable resolution electrical tomography (VARETA) and their statistical evaluation by statistical parametric mapping were carried out. Results: At all frequencies, there were significant changes between EEG segments prior to the presentation of the stimuli and EEG segments recorded after the stimuli. Post-segments showed more power from 1.56 to 7.02 Hz, and less power than pre-segments from 8 to 12.48 Hz. EEG changes were only observed in the word task at: 3.9 (left occipital), 4.68, 5.46, and 6.24 Hz (temporo-occipital regions). These changes may be associated with visual encoding of words. Frequencies 7.8 and 17.94 Hz increased in prefrontal, anterior cingulate, and anterior temporal regions only during figure categorization. The prefrontal region may be related to object working memory. Thus, these frequencies might be related to figure codification. No significant differences between tasks were observed at 3.12 and 7.02 Hz in very wide brain areas (all lobes except occipital), suggesting that the amodal semantic system storage could be the model compatible with figure and word categorization. Conclusions: Thus, our results support the modified amodal semantic hypothesis, which advocates that the meanings of both kinds of stimuli are represented in a conceptual memory that receives input from the logogen and iconogen systems. © 2001 Elsevier Science Ireland Ltd. All rights reserved.

667. Gratton, G., M.R. Goodman-Wood, and M. Fabiani, *Comparison of neuronal and hemodynamic measures of the brain response to visual stimulation: An optical imaging study*. Human Brain Mapping, 2001. **13**(1): p. 13-25.

Summary: The noninvasive mapping of hemodynamic brain activity has led to significant advances in neuroimaging. This approach is based in part on the assumption that hemodynamic changes are proportional to (and therefore constitute a linear measure of) neuronal activity. We report a study investigating the quantitative relationship between neuronal and hemodynamic measures, This study exploited the fact that optical imaging methods can simultaneously provide noninvasive measures of neuronal and hemodynamic activity from the same region of the brain. We manipulated visual stimulation frequency and measured responses from the medial occipital area of 8 young adults. The results were consistent with a model postulating a linear relationship between the neuronal activity integrated over time and the amplitude of the hemodynamic response. The hemodynamic response colocalized with the neuronal response. These data support the use of quantitative neuroimaging methods to infer the intensity and localization of neuronal activity in occipital areas. © 2001 Wiley-Liss, Inc.

668. Gomez, J.F. and R.W. Thatcher, *Frequency domain equivalence between potentials and currents using LORETA*. International Journal of Neuroscience, 2001. **107**(3-4): p. 161-171.

Summary: Analyzing the preferences of brain regions to oscillate at specific frequencies gives important functional information. Application of discrete inverse solutions for the EEG/ MEG inverse problem in the frequency domain usually involves the use of many current sources (sometimes 104 or more) restricted to gray matter points, as the solution space for the possible generators. This number can progressively increase with the level of detail of the MRI when it is used in co-registration with EEG/MEG. However, the computation of the Fourier transform to all these sources is computationally intensive. We illustrate with a simple example how this procedure can be simplified by applying the Fourier transform to the signals in the sensors using a popular inverse method (LORETA). We also suggest how the search space of current sources at specific frequencies of oscillation can be limited to some regions constrained by other technologies such as fMRI, PET and SPECT.

669. Gavit, L., S. Baillet, J.F. Mangin, J. Pescatore, and L. Garnero, *A multiresolution framework to MEG/EEG source imaging*. IEEE Transactions on Biomedical Engineering, 2001. **48**(10): p. 1080-1087.

Summary: A new method based on a multiresolution approach for solving the ill-posed problem of brain electrical activity reconstruction from electroencephaloram (EEG)/magnetoencephalogram (MEG) signals is proposed in a distributed source model. At each step of the algorithm, a regularized solution to the inverse problem is used to constrain the source space on the cortical surface to be scanned at higher spatial resolution. We present the iterative procedure together with an extension of the ST-maximum a posteriori method [1] that integrates spatial and temporal a priori information in an estimator of the brain electrical activity. Results from EEG in a phantom head

experiment with a real human skull and from real MEG data on a healthy human subject are presented. The performances of the multiresolution method combined with a nonquadratic estimator are compared with commonly used dipolar methods, and to minimum-norm method with and without multiresolution. In all cases, the proposed approach proved to be more efficient both in terms of computational load and result quality, for the identification of sparse focal patterns of cortical current density, than the fixed scale imaging approach.

670. Frei, E., A. Gamma, R. Pascual-Marqui, D. Lehmann, D. Hell, and F.X. Vollenweider, *Localization of MDMA-induced brain activity in healthy volunteers using low resolution brain electromagnetic tomography (LORETA)*, in *Human Brain Mapping*. 2001. p. 152-165.

671. Fallgatter, A.J. and T.J. Müller, *Electrophysiological signs of reduced prefrontal response control in schizophrenic patients.* Psychiatry Research - Neuroimaging, 2001. **107**(1): p. 19-28.

Summary: The prefrontal cortex is considered as a brain region important in the etiopathogenesis of schizophrenic disorders. Based on converging results from different research areas, the prefrontal cortex is regarded as the anatomical and functional representation of response control under physiological conditions. In previous studies, a robust electrophysiological marker for the investigation of response control in healthy control subjects was validated. This parameter was termed NoGo anteriorisation and consists of a more anterior peak of the event-related potentials during the inhibition of a prepared motor response (NoGo condition within the Continuous Performance Test) than during its execution (Go condition). The present study investigated these brain electrical correlates of response control in 19 schizophrenic patients and 19 age- and sex-matched healthy subjects. Compared to control subjects, the event-related potentials in schizophrenic patients were located more anterior in the Go condition and, as a trend, more posterior in the NoGo condition. The NoGo anteriorisation was strongly reduced in the schizophrenic group. On a qualitative level, the NoGo anteriorisation was present in all control subjects, but not in eight of the 19 patients. The results were interpreted as an indication of a disturbed prefrontal response control in schizophrenic patients. Further studies will clarify whether this method may be useful as a global test of hypofrontality in different groups of chronic schizophrenias, or as a quantifiable measure of an affected response control system, especially in catatonic subgroups. © 2001 Elsevier Science Ireland Ltd. All rights reserved.

672. Fallgatter, A.J. and M.J. Herrmann, *Electrophysiological assessment of impulsive behavior in healthy subjects.* Neuropsychologia, 2001. **39**(3): p. 328-333.

Summary: The different concepts of impulsivity cover a wide range of divergent behaviors. In clinical terms, aspects of impulsivity are both an important feature

in several psychiatric conditions related to a low central serotonergic neurotransmission like aggressive behavior and suicidality, and a core symptom of frontal lobe syndromes of various etiologies. Assessment of the different forms of impulsivity so far relies on clinical observations and self-rating questionnaires. Measurements of a distinct brain function associated with impulsive behavior are not available yet, however, electrophysiological parameters of cognitive response control elicited with the execution (Go-condition) and the inhibition (NoGo-condition) of a prepared motor response within the Continuous Performance Test (CPT) might be suitable candidates. By means of a spatial analysis method the centers of gravity (centroids) of the brain electrical fields evoked with Go- and NoGo-responses can be localized and quantified. In the present study, the Go- and NoGo-centroids and the impulsivity score in Eysenck's I7-scale were determined in 22 healthy subjects (10 women, 12 men, mean age 42.0±10.1 years). Impulsivity was correlated with both, a more anterior location of the Go- ($r=0.58$, $P<0.01$) and the NoGo-centroid ($r=0.53$, $P=0.01$). These results indicate, that in healthy subjects the amount of I7-impulsivity is associated with differences in the prefrontal brain activation pattern during cognitive response control. However, a replication study with a larger sample and an investigation of psychiatric patients with pathological levels of impulsivity are necessary to qualify these topographical ERP-parameters of cognitive response control as valid measures of the brain electrical basis of impulsive behavior. Copyright © 2001 Elsevier Science Ltd.

673. Fallgatter, A.J., A.J. Bartsch, W.K. Strik, T.J. Mueller, S.S. Eisenack, B. Neuhauser, D. Aranda, and M.J. Herrmann, *Test-retest reliability of electrophysiological parameters related to cognitive motor control.* Clinical Neurophysiology, 2001. **112**(1): p. 198-204.

Summary: Previously, the continuous performance test was demonstrated to elicit distinct electrophysiological correlates of cognitive response during execution (Go) and inhibition (NoGo) of an anticipated motor response. A robust method for topographical quantification of these brain electrical microstates has been established recently. Test reliability is crucial to allow application in the assessment of neuropsychiatric disorders. The present study evaluates the reliability of the Go and NoGo centroid locations as well as the NoGo anteriorisation (NGA) in 23 healthy individuals. Our results show supreme test-alternate retest reliabilities of Pearson's product moment correlations and intraclass correlation coefficients of $r\geq0.63$ ($P\leq0.001$) for these parameters which assert a quality well within the range reported for those of other electrophysiological standard paradigms. Go and NoGo centroid locations as well as the NGA are, therefore, reliable correlates of prefrontal motor control and may contribute to the understanding of disorders with allied impairments. © 2001 Elsevier Science Ireland Ltd.

674. Fallgatter, A.J., *Electrophysiology of the prefrontal cortex in healthy controls and schizophrenic patients: A review.* Journal of Neural Transmission, 2001. **108**(6): p. 679-694.

Summary: Prefrontal brain regions, in particular the anterior cingular gyrus (ACG), are altered in chronic schizophrenic patients and also play a pivotal role in physiological mechanisms of response control. A cued Continuous Performance Test (CPT) is a suitable paradigm for the investigation of response control, as it contains its fundamental mechanisms, i.e. the execution (Go) and the inhibition (NoGo) of an anticipated motor response. Previous electrophysiological investigations in healthy subjects during CPT execution revealed that the gravity center (centroid) of the event-related potential (ERP) elicited during the NoGo-condition is located more anterior as compared to the Go-condition in every single case. Moreover, by means of an electrophysiological source location method this NoGo-anteriorisation phenomenon (NGA) has been attributed to a strong brain electrical NoGo-hyperactivity located in prefrontal brain areas (ACG). Furthermore, the NGA has a superior test-retest reliability, a very high interindividual stability and is independent from age- and gender-effects. Systematic schizophrenic patients were characterized by a significantly diminished NGA indicating a dysfunction of prefrontal brain areas including the ACG. Based on these findings, the NGA has to be considered as a first electrophysiological measure for the quantitative assessment of ACG-function within a response control paradigm. Hopefully, this biological parameter will contribute to the elucidation of the etiopathogenetical background in different schizophrenic diseases.

675. Demiralp, T. and A. Ademoglu, *Decomposition of event-related brain potentials into multiple functional components using wavelet transform.* Clinical EEG Electroencephalography, 2001. **32**(3): p. 122-138.

Summary: Event related brain potential (ERP) waveforms consist of several components extending in time, frequency and topographical space. Therefore, an efficient processing of data which involves the time, frequency and space features of the signal, may facilitate understanding the plausible connections among the functions, the anatomical structures and neurophysiological mechanisms of the brain. Wavelet transform (WT) is a powerful signal processing tool for extracting the ERP components occurring at different time and frequency spots. A technical explanation of WT in ERP processing and its four distinct applications are presented here. The first two applications aim to identify and localize the functional oddball ERP components in terms of certain wavelet coefficients in delta, theta and alpha bands in a topographical recording. The third application performs a similar characterization that involves a three stimulus paradigm. The fourth application is a single sweep ERP processing to detect the P300 in single trials. The last case is an extension of ERP component identification by combining the WT with a source localization technique. The aim is to localize the time-frequency components in three dimensional brain structure instead of the scalp surface. The time-frequency analysis using WT helps isolate and describe sequential and/or overlapping functional processes during ERP generation, and provides a possibility for studying these cognitive processes and following their dynamics in single trials during an experimental session.

676. Del Gratta, C., V. Pizzella, F. Tecchio, and G.L. Romani, *Magnetoencephalography-a noninvasive brain imaging method with 1 ms time resolution*. Reports on Progress in Physics, 2001. **64**(12): p. 1759-1814.

Summary: The basics of magnetoencephalography (MEG), i.e. the measurement and the analysis of the tiny magnetic fields generated outside the scalp by the working human brain, are reviewed. Three main topics are discussed: (1) the relationship between the magnetic field and its generators, including on one hand the neurophysiological basis and the physical theory of magnetic field generation, and on the other hand the techniques for the estimation of the sources from the magnetic field measurements; (2) the instrumental techniques and the laboratory practice of neuromagnetic field measurement and (3) the main applications of MEG in basic neurophysiology as well as in clinical neurology.

677. Darvas, F., U. Schmitt, A.K. Louis, M. Fuchs, G. Knoll, and H. Buchner, *Spatio-temporal current density reconstruction (stCDR) from EEG/MEG-data*. Brain Topography, 2001. **13**(3): p. 195-207.

Summary: Among the different approaches to the bioelectromagnetic inverse problem, the current-density reconstruction methods (CDR) provide the most general solutions. Since the inverse problem does not have a unique solution, model assumptions have to be taken into account. Multi-channel measurements contain not only spatial, but also temporal information about the sources, so a naturally extension to existing methods leads to spatio-temporal model constraints. Spatio-temporal CDR's (stCDR) have been tested in simplified volume conductor models, assuming different spatial model constraints and a smooth temporal activation model. Comparison to existing spatial model constraints showed a significant improvement of spatial and temporal resolution of the reconstructed sources for the spatio-temporal models especial in noisy data.

678. Connemann, B.J., K. Mann, R.D. Pascual-Marqui, and J. Röschke, *Limbic activity in slow wave sleep in a healthy subject with alpha-delta sleep*. Psychiatry Research - Neuroimaging, 2001. **107**(3): p. 165-171.

Summary: All-night electroencephalographic (EEG) activity was recorded in a healthy subject with known alpha-delta sleep. Recordings were made from all 19 of the 10/20 system electrode sites, and low resolution electromagnetic tomography (LORETA) was used to estimate intracerebral current densities. Sleep stages were compared within classical frequency bands by statistical parametric mapping (SPM). With the onset of sleep, occipital alpha abated. With increasing depth of sleep, alpha power increased in a region comprising the left frontal lobe, the anterior and parietal cingulum, and the anterior and medial right front lobe. In slow wave sleep (SWS), frontal alpha power was much greater than in wakefulness. The maximum of frontal alpha power of SWS was localised symmetrically in the left and right anterior cingulum. The observed alpha activity was different from the occipital alpha characteristic of wakefulness; it was a

distinct activity of separate origin. The anterior limbic lobes seemed to play an active part in SWS in this healthy volunteer with an alpha-delta sleep pattern. © 2001 Elsevier Science Ireland Ltd. All rights reserved.

679. Carretié, L., M. Martín-Loeches, J.A. Hinojosa, and F. Mercado, *Emotion and attention interaction studied through event-related potentials*. Journal of Cognitive Neuroscience, 2001. **13**(8): p. 1109-1128.

Summary: Several studies on hemodynamic brain activity indicate that emotional visual stimuli elicit greater activation than neutral stimuli in attention-related areas such as the anterior cingulate cortex (ACC) and the visual association cortex (VAC). In order to explore the temporo-spatial characteristics of the interaction between attention and emotion, two processes characterized by involving short and rapid phases, event-related potentials (ERPs) were measured in 29 subjects using a 60-electrode array and the LORETA source localization software. A cue/target paradigm was employed in order to investigate both expectancy-related and input processing-related attention. Four categories of stimuli were presented to subjects: positive arousing, negative arousing, relaxing, and neutral. Three attention-related components were finally analyzed: N280pre (from pretarget ERPs), P200post and P340post (both from posttarget ERPs). N280pre had a prefrontal focus (ACC and/or medial prefrontal cortex) and presented significantly lower amplitudes in response to cues announcing negative targets. This result suggests a greater capacity of nonaversive stimuli to generate expectancy-related attention. P200post and P340post were both elicited in the VAC, and showed their highest amplitudes in response to negative- and to positive-arousing stimuli, respectively. The origin of P200post appears to be located dorsally with respect to the clear ventral-stream origin of P340post. The conjunction of temporal and spatial characteristics of P200post and P340post leads to the deduction that input processing-related attention associated with emotional visual stimulation involves an initial, rapid, and brief 'early' attentional response oriented to rapid motor action, being more prominent towards negative stimulation. This is followed by a slower but longer 'late' attentional response oriented to deeper processing, elicited to a greater extent by appetitive stimulation.

680. Bosch-Bayard, J., P. Valdés-Sosa, T. Virues-Alba, E. Aubert-Vázquez, E.R. John, T. Harmony, J. Riera-Díaz, and N. Trujillo-Barreto, *3D statistical parametric mapping of EEG source spectra by means of variable resolution electromagnetic tomography (VARETA)*. Clinical EEG Electroencephalography, 2001. **32**(2): p. 47-61.

Summary: This article describes a new method for 3D QEEG tomography in the frequency domain. A variant of Statistical Parametric Mapping is presented for source log spectra. Sources are estimated by means of a Discrete Spline EEG inverse solution known as Variable Resolution Electromagnetic Tomography (VARETA). Anatomical constraints are incorporated by the use of the Montreal Neurological Institute (MNI) probabilistic brain atlas. Efficient methods are

developed for frequency domain VARETA in order to estimate the source spectra for the set of 103-105 voxels that comprise an EEG/MEG inverse solution. High resolution source Z spectra are then defined with respect to the age dependent mean and standard deviations of each voxel, which are summarized as regression equations calculated from the Cuban EEG normative database. The statistical issues involved are addressed by the use of extreme value statistics. Examples are shown that illustrate the potential clinical utility of the methods herein developed.

681. Bokura, H., S. Yamaguchi, and S. Kobayashi, *Electrophysiological correlates for response inhibition in a Go/NoGo task*. Clinical Neurophysiology, 2001. **112**(12): p. 2224-2232.

Summary: Objective: Event-related brain potentials (ERPs) during a Go/NoGo task were investigated to elucidate the electrophysiological basis for executive and inhibitory control of responses. Methods: We studied Go/NoGo ERPs in 13 healthy subjects during a modified continuous performance test using high-density electroencephalogram (EEG) recording. We measured peak latency, amplitude, and topographic distribution of the components, and analyzed the neural sources using low-resolution electromagnetic tomography. Results: There were no differences between the Go and NoGo conditions in the latency, amplitude, scalp topography, or the electrical source localization of the P1 and N1 components. The N2 component was seen only in the NoGo ERP, and its source was located in the right lateral orbitofrontal and cingulate cortex. The NoGo-P3 component had larger amplitude and longer latency, and was more anteriorly localized than Go-P3; Go-P3 was located mainly in the medial part of the parietal cortex, whereas the NoGo-P3 activity was observed in the left lateral orbitofrontal cortex. Conclusions: These results suggest that the lateral orbitofrontal and anterior cingulate areas play critical roles in the inhibitory control of behavior and that both hemispheres are involved in inhibitory cognitive function. © 2001 Elsevier Science Ireland Ltd. All rights reserved.

682. Bidaut, L.M., *Model-based multi-constrained integration of invasive electrophysiology with other modalities*. Proceedings of SPIE - The International Society for Optical Engineering, 2001. **4319**: p. 681-692.

Summary: Following recent developments, most brain imaging modalities (MR, CT, SPECT, PET) can nowadays be registered and integrated in a manner almost simple enough for routine use. By design though, these modalities are still not able to match the principles and near real-time capabilities of the much simpler (but of lower spatial resolution) EEG, thus the need to integrate it as well, along with - for some patients - the more accurate invasive electrophysiology measurements taken directly in contact with brain structures. A standard control CT (or MR) is routinely performed after the implantation of invasive electrodes. After registration with the other modalities, the initial estimates of the electrodes' locations extracted from the CT (or MR) are iteratively improved by using a geometrical model of the etectrodes' arrangement (grids, strips, etc.) and other optional constraints (morphology, etc.). Unlike the direct 3D pointing of each electrode in the surgical suite - which can still act as a complementary approach this technique estimates the most likely location of the electrodes during monitoring and can also deal with non critical arrangements (internal strips, depth electrodes, etc.). Although not always applicable to normal volunteers because of its invasive components, this integration further opens the door towards an improved understanding of a very complex biological system.

683. Bertrand, C., M. Ohmi, R. Suzuki, and H. Kado, *A probabilistic solution to the MEG inverse problem via MCMC methods: The reversible jump and parallel tempering algorithms*. IEEE Transactions on Biomedical Engineering, 2001. **48**(5): p. 533-542.

Summary: We investigated the usefulness of probabilistic Markov chain Monte Carlo (MCMC) methods for solving the magnetoencephalography (MEG) inverse problem, by using an algorithm composed of the combination of two MCMC samplers: Reversible Jump (RJ) and Parallel Tempering (PT). The MEG inverse problem was formulated in a probabilistic Bayesian approach, and we describe how the RJ and PT algorithms are fitted to our application. This approach offers better resolution of the MEG inverse problem even when the number of source dipoles is unknown (RJ), and significant reduction of the probability of erroneous convergence to local modes (PT). First estimates of the accuracy and resolution of our composite algorithm are given from results of simulation studies obtained with an unknown number of sources, and with white and neuromagnetic noise. In contrast to other approaches, MCMC methods do not just give an estimation of a "single best" solution, but they provide confidence interval for the source localization, probability distribution for the number of fitted dipoles, and estimation of other almost equally likely solutions.

684. Berg, D., M.J. Herrmann, T.J. Müller, W.K. Strik, D. Aranda, T. Koenig, M. Naumann, and A.J. Fallgatter, *Cognitive response control in writer's cramp*. European Journal of Neurology, 2001. **8**(6): p. 587-594.

Summary: Disturbances of the motor and sensory system as well as an alteration of the preparation of movements have been reported to play a role in the pathogenesis of dystonias. However, it is unclear whether higher aspects of cortical - like cognitive - functions are also involved. Recently, the NoGo-anteriorization (NGA) elicited with a visual continuous performance test (CPT) during recording of a 21-channel electroencephalogram has been proposed as an electrophysiological standard-index for cognitive response control. The NGA consists of a more anterior location of the positive area of the brain electrical field associated with the inhibition (NoGo-condition) compared with that of the execution (Go-condition) of a prepared motor response in the CPT. This response control paradigm was applied in 16 patients with writer's cramp (WC) and 14 age matched healthy controls. Topographical analysis of the associated event-related potentials revealed a significant ($P<0.05$) NGA effect for both patients and controls. Moreover, patients with WC showed a significantly higher global field power value ($P<0.05$) in the Go-condition and a significantly higher difference-amplitude ($P<0.05$) in the NoGo-condition. A source location analysis with the low resolution electromagnetic tomography (LORETA) method demonstrated a hypoactivity for the Go-condition in the parietal cortex of the right hemisphere and a hyperactivity in the NoGo-condition in the left parietal cortex in patients with WC compared with healthy controls. These results indicate an altered response control in patients with WC in widespread cortical brain areas and therefore support the hypothesis that the pathogenesis of WC is not restricted to a pure sensory-motor dysfunction.

685. Baillet, S., J.J. Rira, G. Main, J.F. Magin, J. Aubert, and L. Ganero, *Evaluation of inverse methods and head models for EEG source localization using a human skull phantom*. Physics in Medicine and Biology, 2001. **46**(1): p. 77-96.

Summary: We used a real-skull phantom head to investigate the performances of representative methods for EEG source localization when considering various head models. We describe several experiments using a montage with current sources located at multiple positions and orientations inside a human skull filled with a conductive medium. The robustness of selected methods based on distributed source models is evaluated as various solutions to the forward problem (from the sphere to the finite element method) are considered. Experimental results indicate that inverse methods using appropriate cortex-based source models are almost always able to locate the active source with excellent precision, with little or no spurious activity in close or distant regions, even when two sources are simultaneously active. Superior regularization schemes for solving the inverse problem can dramatically help the estimation of sparse and focal active zones, despite significant approximation of the head geometry and the conductivity properties of the head tissues. Realistic head models are necessary, though, to fit the data with a reasonable level of residual variance.

686. Baillet, S., J.C. Mosher, and R.M. Leahy, *Electromagnetic brain mapping*. IEEE Signal Processing Magazine, 2001. **18**(6): p. 14-30.

Summary: An overview is given on the underlying models currently used in magnetoencephalography (MEG)/electroencephalography (EEG) source estimation, as well as the various signal processing steps required to compute these sources. Focus is on methods for computing the forward fields for known source distributions and parametric and imaging-based approaches to the inverse problem.

687. Anderer, P., G. Klösch, G. Gruber, E. Trenker, R.D. Pascual-Marqui, J. Zeitlhofer, M.J. Barbanoj, P. Rappelsberger, and B. Saletu, *Low-resolution brain electromagnetic tomography revealed simultaneously active frontal and parietal sleep spindle sources in the human cortex*. Neuroscience, 2001. **103**(3): p. 581-592.

Summary: Analyses of scalp-recorded sleep spindles have demonstrated topographically distinct slow and fast spindle waves. In the present paper, the electrical activity in the brain corresponding to different types of sleep spindles was estimated by means of low-resolution electromagnetic tomography. In its new implementation, this method is based on realistic head geometry and solution space is restricted to the cortical gray matter and hippocampus. In multichannel all-night electroencephalographic recordings, 10-20 artifact-free 1.25-s epochs with frontally, parietally and approximately equally distributed spindles were marked visually in 10 normal healthy subjects aged 20-35 years. As a control condition, artifact-free non-spindle epochs 1-3 s before or after the corresponding spindle episodes were marked. Low-resolution electromagnetic tomography demonstrated, independent of the scalp distribution, a distributed spindle source in the prefrontal cortex (Brodmann areas 9 and 10), oscillating with a frequency below 13 Hz, and in the precuneus (Brodmann area 7), oscillating with a frequency above 13 Hz. In extremely rare cases only the prefrontal or the parietal source was active. Brodmann areas 9 and 10 have principal connections to the dorsomedial thalamic nucleus; Brodmann area 7 is connected to the lateroposterior, laterodorsal and rostral intralaminar centrolateral thalamic nuclei. Thus, the localized cortical brain regions are directly connected with adjacent parts of the dorsal thalamus, where sleep spindles are generated. The results demonstrated simultaneously active cortical spindle sources which differed in frequency by approximately 2 Hz and were located in brain regions known to be critically involved in the processing of sensory input, which is in line with the assumed functional role of sleep spindles. © 2001 IBRO.

688. Zhukov, L., D. Weinsfein, and C. Johnson, *Independent component analysis for EEG source localization an algorithm that reduces the complexity of localizing multiple neural sources*. IEEE Engineering in Medicine and Biology Magazine, 2000. **19**(3): p. 87-96.

Summary:

689. Zappoli, R., A. Versari, F. Zappoli, R. Chiaramonti, G.D. Zappoli Thyrion, M. Grazia Arneodo, and V. Zerauschek, *The effects on auditory neurocognitive evoked responses and contingent negative variation activity of frontal cortex lesions or ablations in man: Three new case studies*. International Journal of Psychophysiology, 2000. **38**(2): p. 107-142.

Summary: Our previous research in patients with extensive surgical ablations of the prefrontal cortex contradict the hypothesis of some authors that the generators of several auditory event-related potentials (ERPs) (N100; P200; N200; P300; SW), recordable in humans with depth/scalp electrodes and MEG over the prefrontal dorsolateral cortical areas, are essentially located in medial prefrontal and anterior cingulate-limbic cortices. Using a standard CNV paradigm, 21 EEG electrodes and topographic mapping analysis, the post-warning (S1) auditory N100a b c, P200, P300 (binaural clicks) and CNV activity

were recorded in three additional patients after extensive dorsolateral and/or medial prefrontal cortex ablations, verified through CT/MRI examinations. No true post-S1/CNV components were recordable over the ablated frontal areas, only sporadic volume-conducted ERPs probably generated in the temporo-parietal lobes or posterior cingulate gyrus. For one of these patients, after excision of a vast right frontal epileptogenic cortical region (including extensive dorsolateral areas, but sparing the fronto-medial cortex and anterior/middle cingulate gyrus), no post-S1/CNV components were recordable over the ablated regions. These latest observations again indicate that independent neuronal generators of several post-S1 auditory and CNV components are located in the dorsolateral supramodal premotor/prefrontal cortical areas which are directly, ipsilaterally connected to the uni/multimodal temporo-parieto-occipital sensory and associative regions through the long, two-way, fairly superficial, superior arcuate-longitudinal and deeper superior and inferior occipito-frontal bundles. Clear and almost constant differences in the latency of some post-S1 N100 subcomponents (especially the time-lapses between onset and the highest amplitude of the N100 a and c) over various posterior, central and anterior cortical areas sequentially involved, roughly measured in 10 normal subjects along the scalp and with MRI cerebral imaging, may probably be accounted for by the transcortical homohemispheric conduction time, which varies in our scalp recordings from 1 cm/0.74-1.28 ms, mean ~1 cm/1.02 ms (~9.8 ms). (C) 2000 Elsevier Science B.V.

690. Worrell, G.A., T.D. Lagerlund, F.W. Sharbrough, B.H. Brinkmann, N.E. Busacker, K.M. Cicora, and T.J. O'Brien, *Localization of the epileptic focus by low-resolution electromagnetic tomography in patients with a lesion demonstrated by MRI*. Brain Topography, 2000. **12**(4): p. 273-282.

Summary: Patients with medically intractable partial epilepsy and well-defined symptomatic MRI lesions were studied using phase-encoded frequency spectral analysis (PEFSA) combined with low-resolution electromagnetic tomography (LORETA). Ten patients admitted to the epilepsy monitoring unit with MRI-identified lesions and intractable partial epilepsy were studied using 31-electrode scalp EEG. The scalp electrodes were located in three-dimensional space using a magnetic digitizer and coregistered with the patient's MRI. PEFSA was used to obtain a phase-encoded scalp map for the ictal frequencies. The ictal generators were obtained from the scalp map using LORETA. In addition, the generators of interictal epileptogenic spikes were identified using time-domain LORETA. The LORETA generators were rostral to the MRI lesion in 87% (7/8) of patients with temporal lobe lesions, but all were located in the mesial temporal lobe in concordance with the patients' MRI lesions. In patients with frontal lobe epilepsy, the ictal generators at the time that the spectral power was maximal localized to the MRI lesions. Eight of 10 patients had interictal spikes, of which 4 were bilateral independent temporal lobe spikes. Only generators of the interictal spikes that were ipsilateral to seizure onset correlated with the ictal generators. LORETA combined with PEFSA of the ictal discharge can localize ictal EEG discharges accurately and improve correlation with brain anatomy by allowing coregistration of the ictal generator with the MRI. Analysis of interictal spikes was less useful than analysis of the ictal discharge.

691. Winterer, G., M. Smolka, J. Samochowiec, C. Mulert, M. Ziller, R. Mahlberg, Y. Wuebben, J. Gallinat, H. Rommelspacher, W.M. Herrmann, and T. Sander, *Association analysis of GABA(A) β2 and γ2 gene polymorphisms with event-related prefrontal activity in man*. Human Genetics, 2000. **107**(5): p. 513-518.

Summary: Gamma-aminobutyric acid (GABA)(A)-receptors play a crucial role in the generation of electroencephalogram (EEG) oscillations and evoked potentials (ERPs). The present association study was designed to test whether EEG and ERPs are modulated by genetic variations of the human GABA(A) β2 (GABRB2) and γ2 (GABRG2) genes on chromosome 5q33. The genotypes of two nucleotide substitution polymorphisms of the GABRB2 and GABRG2 genes were assessed in 95 psychiatrically healthy subjects of German descent. Neurophysiological phenotyping was performed with four factorized EEG/ERP parameters: EEG activation, anterior and posterior EEG synchronization, and event-related activity (N100/P200-complex). No genotypic association was found for the GABRB2 nucleotide exchange polymorphism with any electrophysiological parameter. A significant association was found between the genotype of the intronic GABRG2 G→A nucleotide exchange and the event-related N100/P200 (ANOVA: F=3.81; df=2; P=0.026). A comparison of homozygous subjects carrying either the G/G or A/A genotype of the GABRG2 polymorphism consistently revealed an even stronger difference in the effect-size (ANOVA: F=11.13; df=1; P=0.002). Post hoc analysis of this association with current density analysis in three-dimensional neuroanatomic Talairach space-time showed a reduction in the event-related signal power after 120 ms in the right dorsolateral prefrontal cortex. Taking into account the risk of false-positive association findings attributable to multiple testing, our results encourage further replication studies to examine the phenotype-genotype relationship of GABRG2 gene variants and event-related prefrontal activity.

692. Weinstein, D., L. Zhukov, and C. Johnson, *Lead-field bases for electroencephalography source imaging*. Annals of Biomedical Engineering, 2000. **28**(9): p. 1059-1065.

Summary: Two methods are proposed for computing lead fields in finite element modeling of the head. The application of the lead field to source localization is demonstrated using simulated annealing.

693. Wang, Y. and U. Oertel, *Estimating scalp MEG from whole-head MEG measurements*. Brain Topography, 2000. **12**(3): p. 219-227.

Summary: Studies based on whole-head MEG recordings are providing more and more impressive results. In such recordings, the MEG sensors are several centimeters away from the scalp and the positions of the MEG sensors with respect to the head differ from subject to subject, and from session to session for the same subject. In this paper, a method is presented and tested to estimate the scalp MEG distributions from whole-head MEG measurements. The goal is to remove the discrepancy of MEG measurements caused by the various sensor positions with respect to the head, as well as to reduce the smearing effect caused by the distance of the MEG sensors from the scalp. The MEG measurement was first projected to a hypothetical dipole layer within the head volume conductor model using the inverse solution. The scalp MEG estimation was then obtained from the resultant dipole layer by the forward solution. The results from simulation studies, phantom experiments, and the auditory evoked field analysis demonstrated that, with reasonable signal to noise ratios, this method is a feasible way to achieve our goals.

694. Vuilleumier, P., F. Assal, O. Blanke, and P. Jallon, *Distinct behavioral and EEG topographic correlates of loss of consciousness in absences*. Epilepsia, 2000. **41**(6): p. 687-693.

Summary: Purpose: To describe the behavioral and EEG topographic correlates of absences with 3-Hz generalized spike-waves and partitioned impairment of consciousness. Methods: Two adult women had so-called 'phantom' absences, characterized by brief and mild impairments of consciousness that were previously inconspicuous to both patient and physician. Neuropsychological examination was performed under video-EEG monitoring during absence status. EEG topographic mapping of spike-wave discharges was obtained in the two cases. Results: Only mild attentional and executive disturbances were observed during absence status despite prolonged discharges. Spike-wave bursts were associated with selective impairment in the initiation of response and self-generated action, whereas short-term storage of external information during discharges was fully preserved. This is consistent with a predominant involvement of frontomesial cortex demonstrated by topographic mapping of spike-wave discharges in the two cases. By contrast, in two other patients with typical absences and a complete lack of retention for information given during the discharges, topographic mapping found a more lateral frontal involvement by spike-wave activity. Conclusions: Different types of absence seizures may impair distinct components of conscious behavior. A predominant involvement of frontomesial thalamocortical circuitry may underlie an 'inconspicuous' disorder of consciousness as seen in phantom absences with selective loss of initiation and goal-oriented behavior, whereas involvement of more lateral frontal areas in typical absences may additionally disrupt working memory processes.

695. Thut, G., C.A. Hauert, P. Viviani, S. Morand, L. Spinelli, O. Blanke, T. Landis, and C. Michel, *Internally driven vs. externally cued movement selection: a study on the timing of brain activity*. Cognitive Brain Research, 2000. **9**(3): p. 261-269.

Summary: Brain imaging studies in man and single cell recordings in monkey have suggested that medial supplementary motor areas (SMA) and lateral pre-motor areas (PMA) are functionally dissociated concerning their involvement in

internally driven and externally cued movements. This dichotomy, however, seems to be relative rather than absolute. Here, we searched for further evidence of relative differences and aimed to determine by what aspect of brain activity (duration, strength, or both) these might be accounted for. Event-related potentials (ERPs) were recorded while healthy, right-handed subjects selected one of three possible right hand digit movements based either on 'internal' choice or 'external' cues. The results obtained from ERP mapping suggest that movement selection evokes the same electrical brain activity patterns in terms of surface potential configurations in the same order and at the same strength independent of the selection mode. These identical configurations, however, differed in their duration. Combined with the results of a distributed source localization procedure, our data are suggestive of longer lasting activity in SMA during the 'internal' and longer lasting activity in PMA during the 'external' condition. Our results confirm previous findings in showing that SMA and PMA are distinctively involved in the two tasks and that this functional dichotomy is relative rather than absolute but indicate that such a dissociation can result from differences in duration rather than pure strength of activation. Copyright (C) 2000 Elsevier Science B.V.

696. Steger, J., K. Imhof, H.C. Steinhausen, and D. Brandeis, *Brain mapping of bilateral interactions in attention deficit hyperactivity disorder and control boys*. Clinical Neurophysiology, 2000. **111**(7): p. 1141-1156.

Summary: Objectives: Children with attention deficit hyperactivity disorder (ADHD) are thought to have deficits in attentional control, whereas the status of deficits at visual and pre-motor processing stages is unclear. Methods: The timing of such deficits was examined with event-related potential (ERP) microstates (stimulus- and response-related) and continuous force recordings in 15 ADHD and 16 control boys in a choice reaction time task. Unilateral and bilateral stimulus and response conditions were used to assess bilateral interactions at visual, central, and pre-motor stages. Results: ADHD boys showed poorer performance, particularly in the bilateral conditions. In the visual P1 microstates, they exhibited less suppression of visual evoked potential (VEP) amplitudes but similar speeding of VEP latencies in the bilateral compared to the summed unilateral condition. The central P3 and pre-/post-response microstates were attenuated and topographically altered in ADHD boys. The attenuation was most pronounced in the bilateral condition and was similar for stimulus- and response-related averages. The lateralized readiness potential was also reduced in ADHD boys; this was most pronounced for the left hand responses. Conclusions: Brain mapping during uni- and bilateral stimulus and response conditions thus indicates multilevel deficits in ADHD boys affecting visuo-attentional, central, and pre-motor processes. Copyright (C) 2000 Elsevier Science Ireland Ltd.

697. Spinelli, L., S.G. Andino, G. Lantz, M. Seeck, and C.M. Michel, *Electromagnetic inverse solutions in anatomically constrained spherical head models*. Brain Topography, 2000. **13**(2): p. 115-125.

Summary: Two classes of functional neuroimaging methods exist: hemodynamic techniques such as PET and fMRI, and electromagnetic techniques such as EEG/ERP and MEG. In order to fusion these images with anatomical information, co-registration with volumetric MRI is needed. While such co-registration techniques are well established for hemodynamic images, additional steps are needed for electromagnetic recordings, because the activity is only recorded on the scalp surface and inverse solutions based on specific head models have to be used to estimate the 3-dimensional current distribution. To date most of the experimental and clinical studies use multi-shell concentric sphere models of the head, solve the inverse problem on this simplistic model, and then co-register the solution with the MRI using homogeneous transform operations. Contrary to this standard method, we here propose to map the MRI to the spherical system by defining transformation operations that transform the MRI to a best-fitting sphere. Once done so, the solution points are defined in the cerebral tissue of this deformed MRI and the lead field for the distributed linear inverse solutions is calculated for this solution space. The method, that we call SMAC (Spherical Model with Anatomical Constrains) is tested with simulations, as well as with the following real data: 1) estimation of the sources of visual evoked potentials to unilateral stimulation from data averaged over subjects, and 2) localization of interictal discharges of two epileptic patients, one with a temporal, the other with an occipital focus, both confirmed by seizure freedom after resection of the epileptogenic region.

698. Schnitzler, A., J. Gross, and L. Timmermann, *Synchronised oscillations of the human sensorimotor cortex*. Acta Neurobiologiae Experimentalis, 2000. **60**(2): p. 271-287.

Summary: Oscillations are a prominent feature of macroscopic human sensorimotor cortical activity as recorded non-invasively with electroencephalography (EEG) and magnetoencephalography (MEG). The advent of whole-scalp MEG systems allowing rapid non-invasive recording from the entire cortex and accurate localisation of neural sources, and the development of refined signal analysis methods are important factors that led to an increasing interest in studies of sensorimotor oscillations during the last 10 years. Investigations on healthy subjects revealed frequency-specific localisation and modality- specific reactivity of 10 Hz and 20 Hz sensorimotor oscillations. Task-specific coherence between motor cortical and electromyographic oscillations, reflecting cortico-motoneuronal coupling, point towards a functional role of precentral oscillations in the cortical control of voluntary movements. Furthermore, abnormal cortico-motoneuronal coupling may underlie clinical symptoms of motor disorders, such as tremor. Thus, investigation of oscillatory sensorimotor activity proceeds from phenomenology to function and provides an interesting approach to address questions in human motor physiology and pathophysiology.

699. Pizzagalli, D., D. Lehmann, T. Koenig, M. Regard, and R.D. Pascual-Marqui, *Face-elicited ERPs and affective attitude: Brain electric microstate and tomography analyses*. Clinical Neurophysiology, 2000. **111**(3): p. 521-531.

Summary: Objectives: Although behavioral studies have demonstrated that normative affective traits modulate the processing of facial and emotionally charged stimuli, direct electrophysiological evidence for this modulation is still lacking. Methods: Event-related potential (ERP) data associated with personal, traitlike approach- or withdrawal-related attitude (assessed post- recording and 14 months later) were investigated in 18 subjects during task- free (i.e. unrequested, spontaneous) emotional evaluation of faces. Temporal and spatial aspects of 27 channel ERP were analyzed with microstate analysis and low resolution electromagnetic tomography (LORETA), a new method to compute 3 dimensional cortical current density implemented in the Talairach brain atlas. Results: Microstate analysis showed group differences 132-196 and 196-272 ms poststimulus, with right-shifted electric gravity centers for subjects with negative affective attitude. During these (over subjects reliably identifiable) personality-modulated, face-elicited microstates, LORETA revealed activation of bilateral occipito-temporal regions, reportedly associated with facial configuration extraction processes. Negative compared to positive affective attitude showed higher activity right temporal; positive compared to negative attitude showed higher activity left temporo- parieto-occipital. Conclusions: These temporal and spatial aspects suggest that the subject groups differed in brain activity at early, automatic, stimulus-related face processing steps when structural face encoding (configuration extraction) occurs. In sum, the brain functional microstates associated with affect-related personality features modulate brain mechanisms during face processing already at early information processing stages. (C) 2000 Elsevier Science Ireland Ltd.

700. Picton, T.W., S. Bentin, P. Berg, E. Donchin, S.A. Hillyard, R. Johnson Jr, G.A. Miller, W. Ritter, D.S. Ruchkin, M.D. Rugg, and M.J. Taylor, *Guidelines for using human event-related potentials to study cognition: Recording standards and publication criteria*. Psychophysiology, 2000. **37**(2): p. 127-152.

Summary: Event-related potentials (ERPs) recorded from the human scalp can provide important information about how the human brain normally processes information and about how this processing may go awry in neurological or psychiatric disorders. Scientists using or studying ERPs must strive to overcome the many technical problems that can occur in the recording and analysis of these potentials. The methods and the results of these ERP studies must be published in a way that allows other scientists to understand exactly what was done so that they can, if necessary, replicate the experiments. The data must then be analyzed and presented in a way that allows different studies to be compared readily. This paper presents guidelines for recording ERPs and criteria for publishing the results.

701. Phillips, C., M.D. Rugg, and K.J. Friston, *Direct extraction of realistic constraints from T1 structural MR image for electromagnetic source localisation*. NeuroImage, 2000. **11**(5 PART II).

Summary:

702. Nunez, P.L. and R.B. Silberstein, *On the relationship of synaptic activity to macroscopic measurements: Does co-registration of EEG with fMRI make sense?* Brain Topography, 2000. **13**(2): p. 79-96.

Summary: A two-scale theoretical description outlines relationships between brain current sources and the resulting extracranial electric field, recorded as EEG. Finding unknown sources of EEG, the so-called "inverse problem", is discussed in general terms, with emphasis on the fundamental non-uniqueness of inverse solutions. Hemodynamic signatures, measured with fMRI, are expressed as vowel integrals to facilitate comparisons with EEG. Two generally distinct cell groups (1 and 2), generating EEG and fMRI signals respectively, are embedded within the much broader class of synaptic action fields. Cell groups 1 and 2 may or may not overlap in specific experiments. Implications of this incomplete overlap for co-registration studies are considered. Each experimental measure of brain function is generally sensitive to a different kind of source activity and to different spatial and temporal scales. Failure to appreciate such distinctions can exacerbate conflicting views of brain function that emphasize either global integration or functional localization.

703. Nolte, G. and G. Curio, *Current multipole expansion to estimate lateral extent of neuronal activity: A theoretical analysis*. IEEE Transactions on Biomedical Engineering, 2000. **47**(10): p. 1347-1355.

Summary: High-resolution magnetoencephalography (MEG) allows for a detailed description of focal neuronal current sources going far beyond the dipole approximation which merely indicates the center and magnitude of neuronal activity. Higher order multipole coefficients can be related to other bulk properties, like spatial extent or curvature. The possibility and limitations of measuring spatial extent by interpreting reconstructed multipole coefficients was tested under realistic noise conditions and for model misspecifications; for this analysis the primary cortical response ('N20') to electric median nerve stimulation was modeled by a one dimensional source distribution. The forward calculation was done analytically up to octapolar order for a spherical volume conductor. The multipole expansion is shown to estimate the lateral source extent with negligible bias; this estimate is to first-order stable against additional source features, like gyral curvature or spatial extent in a second direction (gyral depth, neuronal length). For a dipole moment of 20 nAm a lateral extent of 2 cm can be detected for a realistic noise level with large but experimentally still reasonable effort. Approximating a realistic head model by a sphere results in errors larger than the extent to be estimated; accordingly, studies on human cortical evoked responses will require multipole fitting in realistic head models. High-resolution magnetoencephalography (MEG) allows for a detailed description of focal neuronal current sources going far beyond the dipole approximation which merely indicates the center and magnitude of neuronal activity. Higher order multipole coefficients can be related to other bulk properties, like spatial extent or curvature. The possibility and limitations of measuring spatial extent by interpreting reconstructed multipole coefficients was tested under realistic noise conditions and for model misspecifications; for this analysis the primary cortical response ('N20') to electric median nerve stimulation was modeled by a one dimensional source distribution. The forward calculation was done analytically up to octapolar order for a spherical volume conductor. The multipole expansion is shown to estimate the lateral source extent with negligible bias; this estimate is to first-order stable against additional source features, like gyral curvature or spatial extent in a second direction (gyral depth, neuronal length). For a dipole moment of 20 nAm a lateral extent of 2 cm can be detected for a realistic noise level with large but experimentally still reasonable effort. Approximating a realistic head model by a sphere results in errors larger than the extent to be estimated; accordingly, studies on human cortical evoked responses will require multipole fitting in realistic head models.

704. Khateb, A., C.M. Michel, A.J. Pegna, T. Landis, and J.M. Annoni, *New insights into the Stroop effect: A spatio-temporal analysis of electric brain activity*. NeuroReport, 2000. **11**(9): p. 1849-1855.

Summary: Recent clinical and imaging studies suggest the involvement of anterior brain regions in the Stroop effect without providing consensus on the hemisphere being involved. Here, we investigated the dynamics of brain activation during a modified Stroop task using behavioural, event-related potential map series and source localization analysis. Behavioural analysis showed an increased RT in the interference (IC) as compared to the neutral (NC) and congruence conditions (CC). Map series analysis in these conditions displayed a similar sequence of 10 stable segments. From these, only segment S6, occurring at ~300 ms and displaying a dominant right anterior activation, was of increased duration in IC. Furthermore, in IC only, RT was shown to correlate with S6 duration. These results are discussed in terms of increased duration of an attentional process needed to solve the conflict. (C) 2000 Lippincott Williams and Wilkins.

705. Khateb, A., C.M. Michel, A.J. Pegna, T. Landis, and J.M. Annoni, *New insights into the stroop effect: Spatio-temporal analysis of electric brain activity*. NeuroImage, 2000. **11**(5 PART II).

Summary:

706. Grave De Peralta Menendez, R. and S.L. Gonzalez Andino, *Discussing the capabilities of Laplacian Minimization*. Brain Topography, 2000. **13**(2): p. 97-104.

Summary: This paper discusses the properties and capabilities of linear inverse solutions to the neuroelectromagnetic inverse problem obtained under the assumption of smoothness (Laplacian Minimization). Simple simulated counter examples using smooth current distributions as well as single or multiple active dipoles are presented to refute some properties attributed to a particular implementation of the Laplacian Minimization coined LORETA. The problem of the selection of the test sources to be used in the evaluation is addressed and it is demonstrated that single dipoles are far from being the worst test case for a smooth solution as generally believed. The simulations confirm that the dipole localization error cannot constitute the tool to evaluate distributed inverse solutions designed to deal with multiple sources and that the necessary condition for the correct performance of an inverse is the adequate characterization of the source space, i.e., the characterization of the properties of the actual generators.

707. Gamma, A., E. Frei, D. Lehmann, R.D. Pascual-Marqui, D. Hell, and F.X. Vollenweider, *Mood state and brain electric activity in Esctasy users*. NeuroReport, 2000. **11**(1): p. 157-162.

Summary: Resting EEG during open and closed eyes and subsequent mood ratings were obtained from 15 Ecstasy users and 14 Ecstasy-naive controls. Absolute spectral power on the scalp, and the three-dimensional, intracerebral distribution of neuroelectric activity using low resolution brain electromagnetic tomography (LORETA) were computed. LORETA revealed global increases of theta, alpha1 and beta2/3 power during eyes open in Ecstasy users, and spectral analyses revealed a right-posterior increase of alpha2 power (confirmed by LORETA) and increased beta band activity during open eyes. Ecstasy users had higher levels of state depressiveness, emotional excitability and a trend-level increase in state anxiety. The observed differences may be related to regular exposure to Ecstasy or other illicit drugs, or may be pre-existing.

708. Fallgatter, A.J., S.S. Eisenack, B. Neuhauser, D. Aranda, P. Scheuerpflug, and M.J. Herrmann, *Stability of late event-related potentials: Topographical descriptors of motor control compared with the P300 amplitude*. Brain Topography, 2000. **12**(4): p. 255-261.

Summary: The P300-amplitude evoked with an acoustic oddball-paradigm is considered the most stable late event-related potential (ERP). This amplitude-index has become a standard parameter in electrophysiology. Recently, a robust ERP-parameter (NoGo-anteriorization, NGA) has been introduced, which reflects spatial brain electrical changes in relation to execution and inhibition of a motor response elicited with a Continuous Performance Test (CPT). The current study refers to the stability of this new topographical ERP-parameter compared to the stability of the classical P300-amplitude. For that purpose, 12 healthy subjects were investigated with both paradigms during recording of a 21-channel EEG. Analysis of the resulting ERPs revealed a very high stability for both, topographical and amplitude index: In every single subject, the brain electrical fields were characterized by a more anterior location in the NoGo- compared to

the Go-condition (= NGA) and by higher amplitudes after target compared to distractor condition. T-tests, analyses of the effect size and of the power revealed equivalent differences between the two contrasting conditions for the topographical compared to the amplitude index. These results indicate that the stability of the topographical ERP-parameters elicited with the CPT is sufficient for an electrophysiological standard-index. The possibility to elicit a robust and specific spatial brain activation with the CPT is an ideal completion to the classical P300 amplitude effect and, therefore, hopefully will be a useful expansion of the standard paradigms in electrophysiological laboratories.

709. Dierks, T., V. Jelic, R.D. Pascual-Marqui, L.O. Wahlund, P. Julin, D.E.J. Linden, K. Maurer, B. Winblad, and A. Nordberg, *Spatial pattern of cerebral glucose metabolism (PET) correlates with localization of intracerebral EEG-generators in Alzheimer's disease*. Clinical Neurophysiology, 2000. **111**(10): p. 1817-1824.

Summary: Background: Since the measurement of human cerebral glucose metabolism (GluM) by positron emission tomography (PET) and that of human cerebral electrical activity by EEG reflect synaptic activity, both methods should be related in their cerebral spatial distribution. Healthy subjects do indeed demonstrate similar metabolic and neuroelectric spatial patterns. Objective: The aim of the study was to show that this similarity of GluM and EEG spatial patterns holds true in a population with a high variability of glucose metabolism. Methods: We investigated healthy control subjects and patients with varying degrees of cognitive dysfunction and varying GluM patterns by applying [18F]FDG PET and EEG. Results: We demonstrated that the localization of intracerebral generators of EEG correlates with spatial indices of GluM. Conclusion: These results indicates that EEG provides similar spatial information about brain function as GluM-PET. Since EEG is a non-invasive technique, which is more widely available and can be repeated more often than PET, this may have important implications both for neuropsychiatric research and for clinical diagnosis. However, further studies are required to determine whether equivalent EEG dipole generators can yield a diagnostic specificity and sensitivity similar to that of GluM-PET. (C) 2000 Elsevier Science Ireland Ltd.

710. Anderer, P., B. Saletu, and R.D. Pascual-Marqui, *Effect of the 5-HT(1A) partial agonist buspirone on regional brain electrical activity in man: A functional neuroimaging study using low-resolution electromagnetic tomography (LORETA)*. Psychiatry Research - Neuroimaging, 2000. **100**(2): p. 81-96.

Summary: In a double-blind, placebo-controlled study, the effects of 20 mg buspirone - a 5-HT(1A) partial agonist - on regional electrical generators within the human brain were investigated utilizing three-dimensional EEG tomography. Nineteen-channel vigilance-controlled EEG recordings were carried out in 20 healthy subjects before and 1, 2, 4, 6 and 8 h after drug intake. Low-resolution electromagnetic tomography (LORETA; Key Institute for Brain-Mind Research, software: http://www.keyinst.unizh.ch) was computed from spectrally analyzed EEG data, and differences between drug- and placebo-induced changes were displayed as statistical parametric maps. Data were registered to the Talairach-Tournoux human brain atlas available as a digitized MRI (McConnell Brain Imaging Centre: http://www.bic.mni.mcgill.ca). At the pharmacodynamic peak (1st hour), buspirone increased theta and decreased fast alpha and beta sources. Areas of theta increase were mainly the left temporo-occipito-parietal and left prefrontal cortices, which is consistent with PET studies on buspirone-induced decreases in regional cerebral blood flow and fenfluramine-induced serotonin activation demonstrated by changes in regional cerebral glucose metabolism. In later hours (8th hour) with lower buspirone plasma levels, delta, theta, slow alpha and fast beta decreased, predominantly in the prefrontal and anterior limbic lobe. Whereas the results of the 1st hour speak for a slight CNS sedation (more in the sense of relaxation), those obtained in the 8th hour indicate activation. Thus, LORETA may provide useful and direct information on drug-induced changes in central nervous system function in man. Copyright (C) 2000 Elsevier Science Ireland Ltd.

711. Aine, C., M. Huang, J. Stephen, and R. Christner, *Multistart algorithms for MEG empirical data analysis reliably characterize locations and time courses of multiple sources*. NeuroImage, 2000. **12**(2): p. 159-172.

Summary: We applied our newly developed Multistart algorithm (M. Huang et al., 1998, Electroencephalogr. Clin. Neurophysiol. 108, 32-44) to high signal-to-noise ratio (SNR) somatosensory responses and low SNR visual data to demonstrate the reliability of this analysis tool for determining source locations and time courses of empirical multisource neuromagnetic data. This algorithm performs a downhill simplex search hundreds to thousands of times with multiple, randomly selected initial starting parameters from within the head volume, in order to avoid problems of local minima. Two subjects participated in two studies: (1) somatosensory (left and right median nerves were stimulated using a square wave pulse of 0.2 ms duration) and (2) visual (small black and white bull's-eye patterns were presented to central and peripheral locations in four quadrants of the visual field). One subject participated in both of the studies mentioned above and in a third study (i.e., simultaneous somatosensory/visual stimulation). The best-fitting solutions were tightly clustered in high SNR somatosensory data and all dominant regions of activity could be identified in some instances by using a single model order (e.g., six dipoles) applied to a single interval of time (e.g., 15-250 ms) that captured the entire somatosensory response. In low SNR visual data, solutions were obtained from several different model orders and time intervals in order to capture the dominant activity across the entire visual response (e.g., 60-300 ms). Our results demonstrate that Multistart MEG analysis procedures can localize multiple regions of activity and characterize their time courses in a reliable fashion. Sources for visual data were determined by comparing results across several different models, each of which was based on hundreds to thousands of different fits to the data.

712. Winterer, G., W.M. Herrmann, and R. Coppola, *Electrophysiology in Neuropsychiatrie Research: A Network Perspective*. CNS Spectrums, 1999. **4**(8): p. 17-29.

Summary: A growing number of anatomic and physiologic studies have shown that parallel sensory and motor information processing occurs in multiple cortical areas. These findings challenge the traditional model of brain processing, which states that the brain is a collection of physically discrete processing modules that pass information to each other by neuronal impulses in a stepwise manner. New concepts based on neural network modeh suggest that the brain is a dynamically shifting collection of interpenetrating, distributed, and transient neural networks. Neither of these models is necessarily mutually exclusive, but each gives different perspectives on the brain that might be complementary. Each model has its own research methodology, with functional magnetic resonance imaging supporting notions of modular processing, and electrophysiology (eg, electroencephalography) emphasizing the network model. These two technologies might be combined fruitfully in the near future to provide us with a better understanding of the brain. However, this common enterprise can succeed only when the inherent limitations and advantages of both models and technologies are known. After a general introduction about electrophysiology as a research tool and its relation to the network model, several practical examples are given on the generation ofpathophysiologic models and disease classification, intermediate phenotyping for genetic investigations, and pharmacodynamic modeling. Finally, r proposals are made about how to integrate electrophysiology and neuroimaging methods.

713. Wang, J., Y. Jin, F. Xiao, S. Fan, and L. Chen, *Attention-sensitive visual event-related potentials elicited by kinetic forms*. Clinical Neurophysiology, 1999. **110**(2): p. 329-341.

Summary: Previous event-related potential (ERP) studies have shown that selectively attending to a relevant stimulus feature was associated with selection negativity (SN) components. The present study aimed at investigating the ERP indices of attentional selection based on forms defined by motion (kinetic forms). ERPs were recorded from subjects who attended selectively to sequentially presented kinetic forms of bars in one visual field and detected occasional tilted bar targets. Two kinds of kinetic forms were used as the visual stimuli in separate experiments. The main findings were that spatial attention enhanced the amplitude of early ERP Components PI and N1 as well as the late component N2. Topographic maps of voltage and low resolution electromagnetic tomography (LORETA) of the dN2 wave (difference waveform between N2 under attended condition and N2 under unattended condition) suggested an origin in the right occipitotemporal cortex. According to its timing and morphology, the dN2 wave was considered to be an endogenous ERP (like the SN) and was interpreted as reflecting attentional facilitation of the processing of forms defined by motion primarily involving the right occipitotemporal areas.

714. Uutela, K., M. Hämäläinen, and E. Somersalo, *Visualization of magnetoencephalographic data using minimum current estimates*. NeuroImage, 1999. **10**(2): p. 173-180.

Summary: The locations of active brain areas can be estimated from the magnetic field the neural current sources produce. In this work we study a visualization method of magnetoencephalographic data that is based on minimum l1-norm estimates. The method can represent several local or distributed sources and does not need explicit a priori information. We evaluated the performance of the method using simulation studies. In a situation resembling typical magnetoencephalographic measurement, the mean estimated source strength exceeded baseline level up to 2 cm from the simulated point-like source. The method can also visualize several sources, activated simultaneously or in a sequence, which we demonstrated by analyzing magnetic responses associated with sensory stimulation and a picture naming task.

715. Thut, G., C.A. Hauert, S. Morand, M. Seeck, T. Landis, and C. Michel, *Evidence for interhemispheric motor-level transfer in a simple reaction time task: An EEG study*. Experimental Brain Research, 1999. **128**(1-2): p. 256-261.

Summary: Simple visuomanual reaction time tasks require interhemispheric communication when stimuli are presented in the hemifield opposite the responding hand. Although confirmed in many studies, it is still a matter of debate when, at what functional level and at what site this interhemispheric transfer takes place. To address these questions, we recorded event-related potentials (ERPs) in 12 healthy subjects performing such a task and analyzed the data using techniques based on topographic ERP map characteristics. A method which has proved useful for associating ERP map configurations of different time periods with functional states of the brain was supplemented by a source localization procedure. The results suggest that transfer occurs late in time, on a functional motor level and at frontal sites, at least for left-to-right interhemispheric direction of transfer.

716. Thatcher, R.W., C. Biver, M. Juan Gomez, and A.M. Salazar, *3-Dimensional vector analysis of MRI relaxometry and current source localization (LORETA) of EEG in traumatic brain injury*. NeuroImage, 1999. **9**(6 PART II).

Summary:

717. Schmidt, D.M., J.S. George, and C.C. Wood, *Bayesian inference applied to the electromagnetic inverse problem*. Human Brain Mapping, 1999. **7**(3): p. 195-212.

Summary: We present a new approach to the electromagnetic inverse problem that explicitly addresses the ambiguity associated with its ill-posed character. Rather than calculating a single 'best' solution according to some criterion, our approach produces a large number of likely solutions that both fit the data and

any prior information that is used. Whereas the range of the different likely results is representative of the ambiguity in the inverse problem even with prior information present, features that are common across a large number of the different solutions can be identified and are associated with a high degree of probability. This approach is implemented and quantified within the formalism of Bayesian inference, which combines prior information with that of measurement in a common framework using a single measure. To demonstrate this approach, a general neural activation model is constructed that includes a variable number of extended regions of activation and can incorporate a great deal of prior information on neural current such as information on location, orientation, strength, and spatial smoothness. Taken together, this activation model and the Bayesian inferential approach yield estimates of the probability distributions for the number, location, and extent of active regions. Both simulated MEG data and data from a visual evoked response experiment are used to demonstrate the capabilities of this approach.

718. Saletu, B. and P. Anderer, *EEG in psychiatry.* EEG in der psychiatrie, 1999. **13**(4): p. 161-177.

Summary: Since the development of the EEG by Hans Berger in 1929 there has been increasing evidence that mental disorders are caused by aberrant electrophysiological brain function. Findings were initially based on visual, later on computer-assisted quantitative analyses. This article gives an overview of sources and registration techniques of normal and abnormal brain waves and provides an insight into quantitative EEG analysis and EEG mapping. It includes a description of EEG findings in the most important mental disorders such as schizophrenia with predominantly negative and positive symptomatology, major depression, generalized anxiety disorder, agoraphobia, obsessive compulsive disorder, multiinfarct dementia, dementia of the Alzheimer type and alcohol dependence. Moreover, EEG changes after the major representative drugs of the main psychopharmacological classes such as neuroleptics, antidepressants, anxiolytic sedatives, psychostimulants and nootropics are described. It is interesting that the EEG changes in mental disorders are opposite to those induced by the psychotropic drugs indicated for the treatment of the former. By means of pharmaco EEG one may determine if, how, when and at which dosage a drug acts on the target organ - the human brain. Based on multiple-channel recordings of the EEG and of event-related potentials with subsequent neuroimaging in 2 dimensions (mapping) and 3 dimensions (EEG-CT: LORETA = low resolution electromagnetic tomography) it seems possible to show differences in brain function between an individual patient and normal controls (e.g. Z-values = number of standard deviations from the norm), which is the basis for neurophysiological classification of psychiatric disorders and thus makes it possible to choose the optimum drug treatment. Thus, the EEG may represent a valuable objective and quantitative instrument in the diagnosis and treatment of mental disorders.

719. Picton, T., C. Alain, D.L. Woods, M.S. John, M. Scherg, P. Valdes-Sosa, J. Bosch-Bayard, and N.J. Trujillo, *Intracerebral sources of human auditory-evoked potentials*. Audiology and Neuro-Otology, 1999. **4**(2): p. 64-79.

Summary: Evoked potentials to brief 1000-Hz tones presented to either the left or the right ear were recorded from 30 electrodes arrayed over the head. These recordings were submitted to two different forms of source analysis: brain electric source analysis (BESA) and variable-resolution electromagnetic tomography (VARETA). Both analyses showed that the dominant intracerebral sources for the late auditory-evoked potentials (50-300 ms) were in the supratemporal plane and lateral temporal lobe contralateral to the ear of stimulation. The analyses also suggested the possibility of additional sources in the frontal lobes.

720. Phillips, C., M.D. Rugg, and K.J. Friston, *A priori informed spatio-temporal basis functions in minimum norm solutions*. NeuroImage, 1999. **9**(6 PART II).

Summary:

721. Pascual-Marqui, R.D. and E. Matsinos, *Functional mapping with electric brain wave imaging*. NeuroImage, 1999. **9**(6 PART II).

Summary:

722. Pascual-Marqui, R.D., D. Lehmann, T. Koenig, K. Kochi, M.C.G. Merlo, D. Hell, and M. Koukkou, *Low resolution brain electromagnetic tomography (LORETA) functional imaging in acute, neuroleptic-naive, first-episode, productive schizophrenia*. Psychiatry Research - Neuroimaging, 1999. **90**(3): p. 169-179.

Summary: Functional imaging of brain electrical activity was performed in nine acute, neuroleptic-naive, first-episode, productive patients with schizophrenia and 36 control subjects. Low-resolution electromagnetic tomography (LORETA, three-dimensional images of cortical current density) was computed from 19-channel of electroencephalographic (EEG) activity obtained under resting conditions, separately for the different EEG frequencies. Three patterns of activity were evident in the patients: (1) an anterior, near-bilateral excess of delta frequency activity; (2) an anterior-inferior deficit of theta frequency activity coupled with an anterior-inferior left-sided deficit of alpha-1 and alpha-2 frequency activity; and (3) a posterior-superior right-sided excess of beta-1, beta-2 and beta-3 frequency activity. Patients showed deviations from normal brain activity as evidenced by LORETA along an anterior-left-to-posterior-right spatial axis. The high temporal resolution of EEG makes it possible to specify the deviations not only as excess or deficit, but also as inhibitory, normal and excitatory. The patients showed a dis-coordinated brain functional state consisting of inhibited prefrontal/frontal areas and simultaneously overexcited right parietal areas, while left anterior, left temporal and left central areas lacked normal routine activity. Since all information processing is brain-state dependent, this dis-coordinated state must result in inadequate treatment of (externally or internally generated) information. Copyright (C) 1999 Elsevier Science Ireland Ltd.

723. Ossenblok, P., M. Fuchs, D.N. Velis, E. Veltman, J.P. Pijn, and F.H. Lopes Da Silva, *Source analysis of lesional frontal-lobe epilepsy: Spatio-temporal and cortical current-density approaches for locating the origin of interictal discharges*. IEEE Engineering in Medicine and Biology Magazine, 1999. **18**(3): p. 67-77.

Summary: A study was carried out to address the question of whether the functional localization of dynamic sources of interictal activity in patients with well-defined frontal lesions would yield clear evidence regarding both the topology of the primary sources in relation to the epileptogenic lesion and the pattern of spread of the epileptiform activity throughout the brain. High-resolution EEG recordings combined with MRI, as well as advanced source-reconstruction algorithms were used. For this study, data was obtained only from one patient. Extensive analysis of the data enabled to assess the power of different algorithms in determining the functional localization of dynamic sources of interictal activity.

724. Mosher, J.C., S. Baillet, and R.M. Leahy, *EEG source localization and imaging using multiple signal classification approaches*. Journal of Clinical Neurophysiology, 1999. **16**(3): p. 225-238.

Summary: Equivalent current dipoles are a powerful tool for modeling focal sources. The dipole is often sufficient to adequately represent sources of measured scalp potentials, even when the area of activation exceeds 1 cm2 of cortex. Traditional least-squares fitting techniques involve minimization of an error function with respect to the location and orientation of the dipoles. The existence of multiple local minima in this error function can result in gross errors in the computed source locations. The problem is further compounded by the requirement that the model order, i.e. the number of dipoles, be determined before error minimization can be performed. An incorrect model order can produce additional errors in the estimated source parameters. Both of these problems can be avoided using alternative search strategies based on the MUSIC (multiple signal classification) algorithm. Here the authors review the MUSIC approach and demonstrate its application to the localization of multiple current dipoles from EEG data. The authors also show that the number of detectable sources can be determined in a recursive manner from the data. Also, in contrast to least-squares, the method can find dipolar sources in the presence of additional non-dipolar sources. Finally, extensions of the MUSIC approach to allow the modeling of distributed sources are discussed.

725. Morand, S.M., G. Thut, S.L.G. Andino, and C.M. Michel, *Spatio-temporal analysis of colour and motion in humans visual cortical areas*. NeuroImage, 1999. **9**(6 PART II).

Summary:

726. Michel, C.M., M. Seeck, and T. Landis, *Spatiotemporal dynamics of human cognition*. News in Physiological Sciences, 1999. **14**(5): p. 206-214.

Summary: It is still largely unknown how the complex cortical neural network of the human brain can process information so rapidly. Multichannel evoked potential recordings with millisecond time resolution and spatiotemporal analysis methods now allow us to address this question and to unravel the temporal dynamics of the large-scale neurocognitive networks.

727. Michel, C.M., R.G. De Peralta, G. Lantz, S.G. Andino, L. Spinelli, O. Blanke, T. Landis, and M. Seeck, *Spatiotemporal EEG analysis and distributed source estimation in presurgical epilepsy evaluation*. Journal of Clinical Neurophysiology, 1999. **16**(3): p. 239-266.

Summary: In the attempts to localize electric sources in the brain on the basis of multichannel EEG and/or MEG measurements, distributed source estimation procedures have become of increasing interest. Several commercial software packages offer such localization programs and results using these methods are seen more and more frequently in the literature. It is crucial that the users understand the similarities and differences of these methods and that they become aware of the advantages and limitations that are inherent to each approach. This review provides this information from a theoretical as well as from a practical point of view. The theoretical part gives the algorithmic basis of the electromagnetic inverse problem and shows how the different a priori assumptions are formally integrated in these equations. The authors restrict this formalism to the linear inverse solutions i.e., those solutions in which the inversion procedure can be represented as a matrix applied to the data. It will be shown that their properties can be best characterized by their resolution kernels and that methods with optimal resolution matrices can be designed. The authors also discuss the important problem of regularization strategies that are used to minimize the influence of noise. Finally, a new kind of inverse solution, termed ELECTRA (for ELECTRical Analysis), is presented that is based on constraining the source model on the basis of the currents that can actually be measured by the scalp recorded EEG. The practical part of the review illustrates the localization procedures with different clinical data sets. Three aspects become important when working with real data: 1)Clinical data is usually far from ideal (limited number of electrodes, noise, etc.). The behavior of inverse procedures in such unfortunate situations has to be evaluated. 2) The selection of the time points or time periods of interest is crucial, especially in the analysis of spontaneous EEG. 3) Additional information coming from other modalities is usually available and can be incorporated. The authors are illustrating these important points in the case of interictal and ictal epileptiform activity. Spike averaging, frequency domain source localization, and temporal segmentation based on electric field topographies will be discussed. Finally, the technique of EEG-triggered functional magnetic resonance imaging (fMRI) will be illustrated, where EEG is recorded in the magnet and is used to synchronize fMRI acquisition with interictal events. The analysis of both functional data, i.e. the EEG in terms of three-dimensional source localization and the EEG-triggered fMRI, combines the advantages of the two techniques: the temporal resolution of the EEG and the spatial resolution of the fMRI.

728. Knösche, T.R., B. Maeß, and A.D. Friederici, *Processing of syntactic information monitored by brain surface current density mapping based on MEG*. Brain Topography, 1999. **12**(2): p. 75-87.

Summary: The cortical network subserving language processing is likely to exhibit a high spatial and temporal complexity. Studies using brain imaging methods, like fMRI or PET, succeeded in identifying a number of brain structures that seem to contribute to the processing of syntactic structures, while their dynamic interaction remains unclear due to the low temporal resolution of the methods. On the other hand, ERP studies have revealed a great deal of the temporal dimension of language processing without being able to provide more than very coarse information on the localisation of the underlying generators. MEG has a temporal resolution similar to EEG combined with a better spatial resolution. In this paper, Brain Surface Current Density (BSCD) mapping in a standard brain model was used to identify statistically significant differences between the activity of certain brain regions due to syntactically correct and incorrect auditory language input. The results show that the activity in the first 600 ms after violation onset is mainly concentrated in the temporal cortex and the adjacent frontal and parietal areas of both hemispheres. The statistical analysis reveals significantly different activity mainly in both frontal and temporal cortices. For longer latencies above 250 ms, the differential activity is more prominent in the right hemisphere. These findings confirm other recent results that suggest right hemisphere involvement in auditory language processing. One interpretation might be that right hemisphere regions play an important role in repair and re-analysis processes in order to free the specialised left hemisphere language areas for processing further input.

729. Kincses, W.E., C. Braun, S. Kaiser, and T. Elbert, *Modeling extended sources of event-related potentials using anatomical and physiological constraints*. Human Brain Mapping, 1999. **8**(4): p. 182-193.

Summary: For the study of functional organization and reorganization of the human cortex by means of electromagnetic source imaging, a measure of the location and spatial extent of neural sources is of interest. This study evaluates the cortical patch method (CPM), an iterative procedure introduced by Lutkenhoner et al. [1995] that models EEG/MEG activity by means of extended cortical patches. Anatomical information is used to constrain estimates of location and extent of neural sources that generate the measured evoked potential. Whereas minimum norm approaches use mathematical constraints to solve the ambiguity of the inverse problem, the CPM introduces constraints based on anatomical and physiological knowledge about neural mass activity. In order to test the proposed method, the simulated activity in an artificial sulcus was subjected to the CPM. The results show that even activity on opposing walls of a sulcus can be well reconstructed. The simulations demonstrate the usefulness and limits of the CPM in estimating the spatial extent of neural sources in the cerebral cortex. As an example, an application of the method on experimental somatosensory evoked potentials is presented in the Appendix.

730. Khateb, A., C. Michel, T. Landis, and J.M. Annoni, *Processing of semantic category in the left and right visual field: Analysis of electric brain activity during a judgement task*. NeuroImage, 1999. **9**(6 PART II).

Summary:

731. Khateb, A., J.M. Annoni, T. Landis, A.J. Pegna, M.C. Custodi, E. Fonteneau, S.M. Morand, and C.M. Michel, *Spatio-temporal analysis of electric brain activity during semantic and phonological word processing*. International Journal of Psychophysiology, 1999. **32**(3): p. 215-231.

Summary: There is an ongoing debate in cognitive neuroscience about the time course and the functional independence of the different processes involved in encoding written language material. New data indicate very fast and highly parallel language analysis networks in the brain. Here we demonstrate a methodological approach to study the temporal dynamics of this network by searching for time periods where different task demands emphasize different aspects of the network. Multi-channel event related potentials (ERPs) were recorded during a semantic and a phonological reading task from 14 healthy subjects. Signals were analyzed exclusively on the basis of the spatial configuration of the electric potential distributions (ERP maps), since differences in these spatial patterns directly reflect changes in the configuration of the active sources in the brain. This analysis did not reveal any differences of the evoked brain electric fields between the two tasks up to 280 ms post-stimulus. The ERP maps then differed for a brief period between 280 and 380 ms, before they were similar again. The analysis of the maps using a global linear localization procedure revealed a network of areas, active in both tasks, that mainly involved the left postero-temporal and left antero-temporal regions. The left posterior activation was found already around 100 ms post-stimulus, indicating that language-specific functions appear early in time. We therefore conclude that phonological and semantic processing are essentially performed in both tasks and that only late decision-related processes influence the relative strength of activity of the different modules in the complex language network.

732. Hughes, J.R. and E.R. John, *Conventional and quantitative electroencephalography in psychiatry*. Journal of Neuropsychiatry and Clinical Neurosciences, 1999. **11**(2): p. 190-208.

Summary: Electrical activity of each brain region is homeostatically regulated, resulting in predictable frequency composition of the background EEG. Replicated normative databases have established that the EEG power spectrum is independent of ethnic backgrounds. Artifact-free EEG evaluated relative to such norms displays few deviant values in healthy, normally functioning individuals. In subjects with psychiatric disorders, high proportions of abnormal findings have been reported with good concordance and high specificity and sensitivity across numerous studies, distinctive within a wide variety of disorders and often contributing to differential diagnosis and selection of treatment. New three-dimensional QEEG imaging methods offer an economical alternative to other functional brain imaging modalities.

733. He, B., *Brain electric source imaging: Scalp Laplacian mapping and cortical imaging*. Critical Reviews in Biomedical Engineering, 1999. **27**(3-5): p. 149-188.

Summary: This article reviews recent progress in high-resolution EEG methodologies, in particular two widely studied approaches: scalp Laplacian mapping and cortical imaging. The common theoretical background behind these two high-resolution EEG approaches is discussed. The state of the art of the two methodologies are reviewed with examples illustrating their applications in imaging brain electrical activity. The emphasis is placed on the treatment of the mathematical and engineering methods of high-resolution EEG techniques, and reviews of our recent research in both scalp Laplacian mapping and cortical potential imaging. This article reviews recent progress in high-resolution EEG methodologies, in particular two widely studied approaches: scalp Laplacian mapping and cortical imaging. The common theoretical background behind these two high-resolution EEG approaches is discussed. The state of the art of the two methodologies are reviewed with examples illustrating their applications in imaging brain electrical activity. The emphasis is placed on the treatment of the mathematical and engineering methods of high-resolution EEG techniques, and reviews of our recent research in both scalp Laplacian mapping and cortical potential imaging.

734. Han, S., S. Fan, L. Chen, and Y. Zhuo, *Modulation of brain activities by hierarchical processing: A high-density ERP study*. Brain Topography, 1999. **11**(3): p. 171-183.

Summary: The present study investigated how attention to global or local levels of hierarchical patterns modulates brain activities by recording high-density event-related brain potentials (ERPs) evoked by hierarchical stimuli. 120-channel recordings of ERPs were obtained from subjects while they detected targets at global or local levels of hierarchical stimuli displayed in the left or the right visual field. We found that attention to local stimulus features enhanced posterior P1 and N2 components, with the N2 enhancement showing a left hemisphere predominance regardless of stimulus positions. Difference was also seen in the distribution of the frontal P2. Reaction times were slowed when global and local levels of stimuli were incompatible, and an interference effect was observed on anterior N2 amplitudes and latencies. Three-dimensional current distributions showed common sources over the posterior cortex between 80-230 ms and a contralateral frontal source between 300-400 ms for global and local conditions. However, an additional ipsilateral frontal focus between 230-350 ms was found specially for local processing. The results corroborate the findings of previous ERP studies, and suggest that the frontal lobe is particularly important for the selective processing of local parts of a global structure.

735. Greenblatt, R., *Bayesian priors for M/EEG distributed source estimation*. NeuroImage, 1999. **9**(6 PART II).

Summary:

736. Fuchs, M., M. Wagner, T. Köhler, and H.A. Wischmann, *Linear and nonlinear current density reconstructions*. Journal of Clinical Neurophysiology, 1999. **16**(3): p. 267-295.

Summary: Minimum norm algorithms for EEG source reconstruction are studied in view of their spatial resolution, regularization, and lead-field normalization properties, and their computational efforts. Two classes of minimum norm solutions are examined: linear least squares methods and nonlinear L1-norm approaches. Two special cases of linear algorithms, the well known Minimum Norm Least Squares and an implementation with Laplacian smoothness constraints, are compared to two nonlinear algorithms comprising sparse and standard L1-norm methods. In a signal-to-noise-ratio framework, two of the methods allow automatic determination of the optimum regularization parameter. Compensation methods for the different depth dependencies of all approaches by lead-field normalization are discussed. Simulations with tangentially and radially oriented test dipoles at two different noise levels are performed to reveal and compare the properties of all approaches. Finally, cortically constrained versions of the algorithms are applied to two epileptic spike data sets and compared to results of single equivalent dipole fits and spatiotemporal source models.

737. Fernández-Bouzas, A., T. Harmony, J. Bosch, E. Aubert, T. Fernández, P. Valdés, J. Silva, E. Marosi, M. Martínez-López, and G. Casián, *Sources of abnormal EEG activity in the presence of brain lesions*. Clinical EEG Electroencephalography, 1999. **30**(2): p. 46-52.

Summary: In routine clinical EEG, a common origin is assumed for delta and theta rhythms produced by brain lesions. In previous papers, we have provided some experimental support, based on High Resolution qEEG and dipole fitting in the frequency domain, for the hypothesis that delta and theta spectral power have independent origins related to lesion and edema respectively. This paper describes the results obtained with Frequency Domain VARETA (FD-VARETA) in a group of 13 patients with cortical space-occupying lesions, in order to: 1) Test the accuracy of FD-VARETA for the localization of brain lesions, and 2) To provide further support for the independent origin of delta and theta components. FD VARETA is a distributed inverse solution, constrained by the Montreal Neurological institute probabilistic atlas that estimates the spectra of EEG sources. In all patients, logarithmic transformed source spectra were compared with age-matched normative values, defining the Z source spectrum. Maximum Z values were found in 10 patients within the delta band (1.56 to 3.12 Hz); the spatial extent of these sources in the atlas corresponded with the location of the tumors in the C T. In 2 patients with small metastases and large volumes of edema and in a patient showing only edema, maximum Z values were found between 4.29 and 5.12 Hz. The spatial extent of the sources at these frequencies was within the volume of the edema in the CT. These results provided strong support to the hypothesis that both delta and theta abnormal EEG activities are the counterparts of two different pathophysiological processes.

738. Fallgatter, A.J. and W.K. Strik, *The NoGo-anteriorization as a neurophysiological standard-index for cognitive response control.* International Journal of Psychophysiology, 1999. **32**(3): p. 233-238.

Summary: Event related potentials (ERPs) during the Go- and the NoGo-condition of the Continuous Performance Test (CPT) were applied to investigate the neurophysiological basis of cognitive response control. These conditions of the test represent the execution and the inhibition of an anticipated motor response. In a previous study, the comprehensive spatial analysis of the ERPs allowed to define a parameter which robustly reflected the anteriorization of the positive P300 field area during the NoGo- compared to the Go-condition (NoGo-anteriorisation, NGA). The result was found consistently in all investigated subjects. The present study replicated the finding in 27 healthy subjects without any exception. Moreover, the latencies were longer and the amplitudes showed a trend to be higher in the NoGo- compared to the Go-ERP. This is interpreted as a sign of higher processing demands in the NoGo-condition. In conclusion, the ability of the NGA to express reliably the differences of brain activity leading to execution or suppression of a prepared motor response qualifies this parameter as a topographical standard-index for cognitive response control.

739. Fallgatter, A.J., T.J. Mueller, and W.K. Strik, *Age-related changes in the brain electrical correlates of response control.* Clinical Neurophysiology, 1999. **110**(5): p. 833-838.

Summary: Objectives: Previously, a quantification method was validated which, on a single case basis, allows one to assess the NoGo-anteriorisation (NGA) of the positive area of long latency event-related potential (ERP) fields elicited by a cued continuous performance test (CPT). The NGA was shown to be associated with

right frontal activity. The present study was conducted to investigate the influence of age and gender on this topographical index of cognitive response control. Methods: Thirty-seven healthy controls were investigated with 21-channel recordings during the execution of a cued CPT, and ERPs of the Go and NoGo condition were obtained. The location of the positive area centroids in a P300 range and the NGA were calculated and related to age and gender by means of correlation analysis and t tests. Results: The centroid locations of the brain electrical activity during the NoGo- and the Go-condition of the CPT, were both located in more anterior brain regions with increasing age ($P < 0.01$ and $P < 0.1$, respectively); the NGA, however, was not correlated with the subject's age. Latencies and amplitudes of the Go- and NoGo-centroids were not correlated with age. No gender differences were found. Conclusions: The study showed that age is a source of variance for the positive area centroid locations in this Go-NoGo paradigm. The NGA, on the other hand, was robust to age and gender effects. The result is interpreted as a sign of an increasing contribution of frontal brain areas to cognitive response control during lifespan. The finding is consistent with the age-related topographical changes described in acoustic oddball-paradigms and, therefore, appears to be a general topographical ERP effect.

740. Fallgatter, A.J., S. Jatzke, A.J. Bartsch, B. Hamelbeck, and K.P. Lesch, *Serotonin transporter promoter polymorphism influences topography of inhibitory motor control.* International Journal of Neuropsychopharmacology, 1999. **2**(2): p. 115-120.

Summary: The prefrontal cortex participates in motor control and is modulated by serotonergic activity. The serotonin transporter (5-HTT) is a major regulator of serotonergic neurotransmission and may thus influence motor control. The short allele(s) of the 5-HTT linked polymorphic region (5-HTTLPR) is associated with less 5-HTT expression and function than the long variant (I). The neurophysiological parameters termed 'Go- and NoGo-centroid location' represent characteristic brain electrical substrates of the execution and inhibition of motor response elicited by the Continuous Performance Test (CPT). In the present study, the impact of the 5-HTTLPR genotype on the centroid locations was investigated in 23 healthy subjects. The NoGo-centroid, but not the Go-centroid, was located significantly more anteriorly in the short allele group (mean electrode location in s/s and s/l, 2.86 ± 0.37) compared to the group with two long alleles (l/l 3.34 ± 0.49; $t = 2.66$, $p < 0.05$). Age, gender, and test performance did not differ between groups. The results indicate that 5-HTTLPR genotype dependent 5-HTT function is associated with the neurophysiologically assessed topography of inhibitory motor control and provides further evidence for a genetic influence on central serotonergic and motor function.

741. Beisteiner, R., M. Erdler, D. Mayer, A. Gartus, V. Edward, T. Kaindl, S. Golaszewski, G. Lindinger, and L. Deecke, *A marker for differentiation of capabilities for processing of musical harmonies as detected by*

magnetoencephalography in musicians. Neuroscience Letters, 1999. **277**(1): p. 37-40.

Summary: This investigation was designed to study the characteristics of a marker for harmonic processing and to test whether it could be used for differentiating harmonic processing capabilities. The first three chords of an ordinary musical cadenca were presented to the left ear to establish a harmonic context followed by a harmonic or non-harmonic target tone. Cadencas were presented rapidly and randomly in different keys to render the task difficult. Results showed a specific P3m (magnetic P300) effect to the non-harmonic targets which was only visible in subjects with low target recognition errors. Low resolution electro-magnetic tomography current density maps showed P3m sources in the right temporoparietal, left temporoparietal and frontocentral brain areas with right temporoparietal sources being strongest and most reliable. The results offer new possibilities to selectively study harmonic variables in music processing. Copyright (C) 1999 Elsevier Science Ireland Ltd.

742. Alper, K.R., *The EEG and cocaine sensitization: A hypothesis*. Journal of Neuropsychiatry and Clinical Neurosciences, 1999. **11**(2): p. 209-221.

Summary: The author presents the hypothesis that reduced delta EEG power observed in cocaine withdrawal is related to changes in dopamine (DA) transmission related to cocaine sensitization. Evidence for this hypothesis includes the topographic anatomical correspondence between the putative site of delta generation and the cortical terminal field of the mesotelencephalic DA system, as well as the laminar distribution and ultrastructural features of DA terminals in frontal cortex that appear to be adapted to the modulation of the delta rhythm, a global forebrain EEG mode. The effect of DA on membrane conductances of individual pyramidal neurons also suggests that DA exerts a significant influence on delta power by modulating the transition between global and local EEG modes. Access to a neural correlate of sensitization via non-invasive EEG methodology could be useful in investigating the relationship of stimulant sensitization to the clinical syndrome of cocaine dependence.

743. Wieser, H.G., *What are cognitive evoked potentials?* Schweizer Archiv fur Neurologie und Psychiatrie, 1998. **149**(6): p. 268-272.

Summary:

744. Wang, J., Y. Jin, F. Xiao, and L. Chen, *Attention-sensitive ERPs elicited by kinetic forms*. NeuroImage, 1998. **7**(4 PART II).

Summary:

745. Waberski, T.D., H. Buchner, K. Lehnertz, A. Hufnagel, M. Fuchs, R. Beckmann, and A. Rienäcker, *Properties of advanced headmodelling and source*

reconstruction for the localization of epileptiform activity. Brain Topography, 1998. **10**(4): p. 283-290.

Summary: During the last decade multiple work has been done to determine the sources of epileptiform activity by means of dipole source localization based on recordings of the magnetoencephalogram (MEG) or the electroencephalogram (EEG). The actual available advanced volume conductor models and the multiple source reconstruction by regularization may give new impulse to EEG based source analyses in epilepsy patients. This study demonstrates the principal properties of these techniques. We applied two different EEG source reconstruction techniques within different volume conductor models to localize induced spike activity in a selected patient suffering from medically intractable temporal lobe epilepsy: 1) single moving dipole solution in a 3-shell spherical model versus individual head models (boundary-element-model, BEM, and finite-element-model, FEM); 2) a regularization technique for current density reconstructions using both BEM and FEM. When compared to findings of invasive recordings no adequate source locations were derived from the moving dipole solution in both the 3-shell head model and BEM. In contrast, a high congruence of source reconstruction and invasive determination of the focus was obtained using the regularization techniques in both BEM and FEM, indicating the high spatial accuracy of this technique in individual head models.

746. Vitacco, D., D. Brandeis, R. Pascual-Marqui, F. Girard, C. Spelgatti, and E. Martin, *Correspondence of fMRI & ERP activity maps in a language task*. NeuroImage, 1998. **7**(4 PART II).

Summary:

747. Van Leeuwen, T.H., H.C. Steinhausen, C.C.E. Overtoom, R.D. Pascual-Marqui, B. Van'T Klooster, A. Rothenberger, J.A. Sergeant, and D. Brandeis, *The continuous performance test revisited with neuroelectric mapping: Impaired orienting in children with attention deficits*. Behavioural Brain Research, 1998. **94**(1): p. 97-110.

Summary: A total of 11 children with attention deficit disorder (ADD) and nine control children performed a continuous performance test (CPT) of the A-X type with concurrent neuroelectric brain mapping to assess preparatory processing, purportedly mediated by the frontal lobes. This cued CPT task proved to be a highly specific task. The groups could be clearly differentiated both at the behavioral and electrophysiological level. ADD children detected fewer signals and made more false alarms. There were no major group differences in topographical distribution of the event-related potential microstates, but ADD children displayed reduced global field power (GFP) in an early CNV/P3 microstate to cues. This indicated that impaired orienting to cues, rather than impaired executive target processing, determines the initial processing stages in ADD. In comparison with data from the same task run in Utrecht, the same orienting deficit in clinically diagnosed ADHD children was demonstrated. Low resolution electromagnetic tomography (LORETA) estimated posterior sources underlying these orienting processes and the orienting deficit. This argued against frontal lobe involvement at this stage and suggested involvement of a posterior attention system.

748. Valdés, P., T. Picton, N. Trujillo, J. Bosch, E. Aubert, J. Riera, R. Biscay, F. Carbonell, E. Barroso, A. Fernández, and A. Evans, *Constraining EEG-MEG source imaging with statistical neuroanatomy*. NeuroImage, 1998. **7**(4 PART II).

Summary:

749. Trujillo, N.J., P.A. Valdes, and J. Bosch, *Fast transform methods for regularized EEG/MEG inverse solutions*. NeuroImage, 1998. **7**(4 PART II).

Summary:

750. Thut, G., C.A. Hauert, S. Morand, T. Landis, and C. Michel, *Mapping the temporal dynamics of preparatory motor processes*. NeuroImage, 1998. **7**(4 PART II).

Summary:

751. Strik, W.K., A.J. Fallgatter, D. Brandeis, and R.D. Pascual-Marqui, *Three-dimensional tomography of event-related potentials during response inhibition: Evidence for phasic frontal lobe activation*. Electroencephalography and Clinical Neurophysiology - Evoked Potentials, 1998. **108**(4): p. 406-413.

Summary: Objectives: Spatial analysis of the evoked brain electrical fields during a cued continuous performance test (CPT) revealed an extremely robust anteriorization of the positivity of a P300 microstate in the NoGo compared to the Go condition (NoGo-anteriorization in a previous study). To allow a neuroanatomical interpretation the NoGo-anteriorization was investigated with a new three-dimensional source tomography method (LORETA) was applied. Methods: The CPT contains subsets of stimuli requiring the execution (Go) or the inhibition (NoGo) of a cued motor response which can be considered as mutual control conditions for the event-related potential (ERP) study of inhibitory brain functions 21-channel ERPs were obtained from 10 healthy subjects during a cued CPT, and analyzed with LORETA. Results: Topographic analyses revealed significantly different scalp distributions between the Go and the NoGo conditions in both P100 and P300 microstates, indicating that already at an early stage different neural assemblies are activated. LORETA disclosed a significant hyperactivity located in the right frontal lobe during the NoGo condition in the P300 microstate. Conclusions: The results indicate that right frontal sources are responsible for the NoGo- anteriorization of the scalp P300 which is consistent with animal and human lesion studies of inhibitory brain functions. Furthermore, it demonstrates that frontal activation is confined to a brief microstate and time-locked to phasic inhibitory motor control. This adds important functional and chronometric specificity to findings of frontal activation obtained with PET and Near-Infrared-Spectroscopy studies during the cued CPT, and suggests that these metabolic results are not due to general task demands.

752. Seri, S., A. Cerquiglini, F. Pisani, C.M. Michel, R.D. Pascual Marqui, and P. Curatolo, *Frontal lobe epilepsy associated with tuberons sclerosis: Electroencephalographic-magnetic resonance image fusioning*. Journal of Child Neurology, 1998. **13**(1): p. 33-38.

Summary: We studied the topographic relationships between cortical and subcortical lesions shown on magnetic resonance images (MRI) and sources of epileptiform activity in a series of nine children with intractable epilepsy and tuberous sclerosis complex. Although video-electroencephalographic (EEG) monitoring was suggestive of the frontal seizure onset, interictal EEG was, in seven of nine cases, in the form of apparently bisychronous discharges. In all cases, the use of a short time lag estimation procedure based on a nonlinear procedure correlation functin between surface recorded EEG signal allowed the detection of a lateralized onset of EEG paroxysmal activity. Furthermore, a computerized method based on a source localization EEG-MRI image fusioning procedure, has revealed a topographic concordance between well-defined frontal cortical lesions shown on MRI and site of onset of paroxysmal discharges. Lennox-like EEG patterns frequently reported in children with tuberous sclerosis complex could be the result of the tendency of frontal tubers to induce secondary bilateral synchrony, with implications in the medical and eventually surgical management of the often drug-resistant associated seizures.

753. Seri, S., A. Cerquiglini, and F. Pisani, *Spike-induced interference in auditory sensory processing in Landau- Kleffner syndrome*. Electroencephalography and Clinical Neurophysiology - Evoked Potentials, 1998. **108**(5): p. 506-510.

Summary: Objectives: Landau-Kleffner Syndrome (LKS) is an epileptic syndrome characterised by a deficit in language comprehension and production, paroxysmal epileptiform activity in the posterior temporal leads, and by the inconsistent presence of epileptic fits. Its interest lies in the fact that it stands as a model for the study of interference of epileptiform activity on cognitive function, although the pathophysiology of the decline in language skills that follows its onset has not yet been clarified. Methods: We have recorded spike-triggered auditory evoked responses in a group of 6 children with LKS, to investigate whether the occurrence of individual EEG paroxysms is able per se to induce a decline in the response of the auditory cortex. Results: Results have indicated that left hemisphere spikes are associated with a greater reduction in amplitude and an increase in latency of the N1, than spikes occurring in the right hemisphere. No stable change in the evoked response has been detected outside of the EEG paroxysm. Conclusions: We postulate EEG interictal activity is able to induce impairment in processing auditory information and that this may play a role in the pathogenesis of language deficit in LKS.

754. Seeck, M., F. Lazeyras, C.M. Michel, O. Blanke, C.A. Gericke, J. Ives, J. Delavelle, X. Golay, C.A. Haenggeli, N. De Tribolet, and T. Landis, *Non-invasive epileptic focus localization using EEG-triggered functional MRI and electromagnetic tomography*. Electroencephalography and Clinical Neurophysiology, 1998. **106**(6): p. 508-512.

Summary: We present a new approach for non-invasive localization of focal epileptogenic discharges in patients considered for surgical treatment. EEG-triggered functional MR imaging (fMRI) and 3D EEG source localization were combined to map the primary electrical source with high spatial resolution. The method is illustrated by the case of a patient with medically intractable frontal lobe epilepsy. EEG obtained in the MRI system allowed triggering of the fMRI acquisition by the patient's habitual epileptogenic discharges. fMRI revealed multiple areas of signal enhancement. Three-dimensional EEG source localization identified the same active areas and provided evidence of onset in the left frontal lobe. Subsequent electrocorticography from subdural electrodes confirmed spike and seizure onset over this region. This approach, i.e. the combination of EEG-triggered fMRI and 3D EEG source analysis, represents a promising additional tool for presurgical epilepsy evaluation allowing precise non-invasive identification of the epileptic foci.

755. Riera, J.J., M.E. Fuentes, P.A. Valdés, and Y. Ohárriz, *EEG-distributed inverse solutions for a spherical head model*. Inverse Problems, 1998. **14**(4): p. 1009-1019.

Summary: The theoretical study of the minimum norm solution to the MEG inverse problem has been carried out in previous papers for the particular case of spherical symmetry. However, a similar study for the EEG is remarkably more difficult due to the very complicated nature of the expression relating the voltage differences on the scalp to the primary current density (PCD) even for this simple symmetry. This paper introduces the use of the electric lead field (ELF) on the dyadic formalism in the spherical coordinate system to overcome such a drawback using an expansion of the ELF in terms of longitudinal and orthogonal vector fields. This approach allows us to represent EEG Fourier coefficients on a 2-sphere in terms of a current multipole expansion. The choice of a suitable basis for the Hubert space of the PCDs on the brain region allows the current multipole moments to be related by spatial transfer functions to the PCD spectral coefficients. Properties of the most used distributed inverse solutions are explored on the basis of these results. Also, a part of the ELF null space is completely characterized and those spherical components of the PCD which are possible silent candidates are discussed.

756. Prichep, L.S., E.R. John, E.R. Valdes, and F. Di Michele, *QEEG-LORETA statistical images of cognitive deterioration in the elderly*. NeuroImage, 1998. **7**(4 PART II).

Summary:

757. Pascual-Marqui, R.D., M. Koukkou, K. Kochi, and D. Lehmann, *Low resolution brain electromagnetic tomography (LORETA) cross-registered to the standard talairach brain atlas*. NeuroImage, 1998. **7**(4 PART II).

Summary:

758. Müller, M.M., T.W. Picton, P. Valdes-Sosa, J. Riera, W.A. Teder-Sälejärvi, and S.A. Hillyard, *Effects of spatial selective attention on the steady-state visual evoked potential in the 20-28 Hz range*. Cognitive Brain Research, 1998. **6**(4): p. 249-261.

Summary: Steady-state visual evoked potentials (SSVEPs) were recorded from the scalp of subjects who attended to a flickering LED display in one visual field while ignoring a similar display (flickering at a different frequency) in the opposite visual field. The flicker frequencies were 20.8 Hz in the left-field display and 27.8 Hz in the right-field display. The SSVEP to the flicker in either field was enhanced in amplitude when attention was directed to its location. The scalp distribution of this SSVEP enhancement was narrowly focused over the posterior scalp contralateral to the visual field of stimulation. A source analysis using Variable Resolution Electromagnetic Tomography (VARETA) indicated that the source current densities for the SSVEP attention effect had a focal origin in the contralateral parieto-occipital cortex.

759. Moulden, D.J.A., T.W. Picton, N. Meiran, D.T. Stuss, J.J. Riera, and P. Valdes-Sosa, *W-19. Event-related potentials when switching attention between task-sets*. Brain and Cognition, 1998. **37**(1): p. 186-190.

Summary: Cues designating one of two possible tasks preceded a target requiring a discriminative button-press response. The two tasks occurred randomly so that on each trial the subject either repeated the task from the previous trial or switched to the other task. Bi-occipital (N200), parietal (P390) and fronto-central (N430) event related potentials (ERPs) to the cue stimulus were larger for switch than repeat tasks. These results suggest that both posterior and frontal cortices participate in switching. The N200, P390, and N430 may reflect perceptual (stimulus), conceptual, and response-set shifting, respectively.

760. Mas, F., L.S. Prichep, E.R. John, F. DiMichele, and P. Valdes, *QEEG-LORETA statistical images of obsessive compulsive disorder heterogeneity*. NeuroImage, 1998. **7**(4 PART II).

Summary:

761. Marin, G., C. Guerin, S. Baillet, L. Garnero, and G. Meunier, *Influence of skull anisotropy for the forward and inverse problem in EEG: Simulation studies using FEM on realistic head models*. Human Brain Mapping, 1998. **6**(4): p. 250-269.

Summary: For the sake of realism in the description of conduction from primary neural currents to scalp potentials, we investigated the influence of skull anisotropy on the forward and inverse problems in brain functional imaging with EEG. At present, all methods available for cortical imaging assume a spherical geometry, or when using realistic head shapes do not consider the anisotropy of head tissues. However, to our knowledge, no study relates the implication of this simplifying hypothesis on the spatial resolution of EEG for source imaging. In this paper, a method using finite elements in a realistic head geometry is implemented and validated. The influence of erroneous conductivity values for the head tissues is presented, and results show that the conductivities of the brain and the skull in the radial orientation are the most critical ones. In the inverse problem, this influence has been evaluated with simulations using a distributed source model with a comparison of two regularization techniques, with the isotropic model working on data sets produced by a nonisotropic model. Regularization with minimum norm priors produces source images with spurious activity, meaning that the errors in the head model totally annihilate any localization ability. But nonlinear regularization allows the accurate recovery of simultaneous spots of activity, while the restoration of very close active regions is profoundly disabled by errors in the head model. We conclude that for robust cortical source imaging with EEG, a realistic head model taking anisotropy of tissues into account should be used.

762. Liu, A.K., J.W. Belliveau, and A.M. Dale, *Spatiotemporal imaging of human brain activity using functional MRI constrained magnetoencephalography data: Monte Carlo simulations*. Proceedings of the National Academy of Sciences of the United States of America, 1998. **95**(15): p. 8945-8950.

Summary: The goal of our research is to develop an experimental and analytical framework for spatiotemporal imaging of human brain function. Preliminary studies suggest that noninvasive spatiotemporal maps of cerebral activity can be produced by combining the high spatial resolution (millimeters) of functional MRI (fMRI) with the high temporal resolution (milliseconds) of electroencephalography (EEG) and magnetoencephalography (MEG). Although MEG and EEG are sensitive to millisecond changes in mental activity, the ability to resolve source localization and timing is limited by the ill-posed 'inverse' problem. We conducted Monte Carlo simulations to evaluate the use of MRI constraints in a linear estimation inverse procedure, where fMRI weighting, cortical location and orientation, and sensor noise statistics were realistically incorporated. An error metric was computed to quantify the effects of fMRI invisible ('missing') sources, 'extra' fMRI sources, and cortical orientation errors. Our simulation results demonstrate that prior anatomical and functional information from MRI can be used to regularize the EEG/MEG inverse problem, giving an improved solution with high spatial and temporal resolution. An fMRI weighting of approximately 90% was determined to provide the best compromise between separation of activity from correctly localized sources and minimization of error caused by missing sources. The accuracy of the estimate was relatively independent of the number and extent of the sources, allowing for incorporation of physiologically realistic multiple distributed sources. This linear estimation method provides an operator-independent approach for combining information from fMRI, MEG, and EEG and represents a significant advance over traditional dipole modeling.

763. Koles, Z.J., *Trends in EEG source localization*. Electroencephalography and Clinical Neurophysiology, 1998. **106**(2): p. 127-137.

Summary: The concepts underlying the quantitative localization of the sources of the EEG inside the brain are reviewed along with the current and emerging approaches to the problem. The concepts mentioned include monopolar and dipolar source models and head models ranging from the spherical to the more realistic based on boundary and finite elements. The forward and inverse problems in electroencephalography are discussed, including the non-uniqueness of the inverse problem. The approaches to the solution of the inverse problem described include single and multiple time-slice localization, equivalent dipole localization and the weighted minimum norm. The multiple time-slice localization approach is highlighted as probably the best available at this time and is discussed in terms of the spatiotemporal model of the EEG. The effect of noise corruption, artifacts and the number of recording electrodes on the accuracy of source localization is also mentioned. It is suggested that the main appeal of the minimum norm is that it does not assume a model for the sources and provides an estimate of the current density everywhere in the three dimensional volume of the head.

764. Kaplan, A.Y., *Nonstationary EEG: Methodological and experimental analysis*. Uspekhi Fiziologicheskikh Nauk, 1998. **29**(3): p. 50-55.

Summary: Theoretical, methodological and methodical aspects on nonstationary EEGs, that is, EEGs whose patterns undergo changes with time are reviewed. The piecewise description of the EEG is confirmed on the base of the own data and results of another investigators. It is analysed the basic approach to statistical evaluation of nonstationary EEGs in the terms of quasi-stationary segments. The special attention is devoted tho the data of segmental organization of the bioelectrical field of the cortex. Taking into consideration new experimental data concerning the time consistence of the segmental descriptions of regional EEGs it is suggested conception of "operational synchrony" as a form of discretial cooperation of cortex process. The theoretical explanations of the phenomenology for pies-wise functioning of neuron nets are discussed.

765. Johannes, S., M.E. Jöbges, R. Dengler, and T.F. Münte, *Cortical auditory disorders: A case of non-verbal disturbances assessed with event-related brain potentials*. Behavioural Neurology, 1998. **11**(1): p. 55-73.

Summary: In the auditory modality, there has been a considerable debate about some aspects of cortical disorders, especially about auditory forms of agnosia. Agnosia refers to an impaired comprehension of sensory information in the absence of deficits in primary sensory processes. In the non-verbal domain, sound agnosia and amusia have been reported but are frequently accompanied by language deficits whereas pure deficits are rare. Absolute pitch and musicians' musical abilities have been associated with left hemispheric functions. We report the case of a right handed sound engineer with the absolute pitch who developed sound agnosia and amusia in the absence of verbal deficits after a right perisylvian stroke. His disabilities were assessed with the Seashore Test of Musical Functions, the tests of Wertheim and Botez and by event-related potentials (ERP) recorded in a modified 'oddball paradigm'. Auditory ERP revealed a dissociation between the amplitudes of the P3a and P3b subcomponents with the P3b being reduced in amplitude while the P3a was undisturbed. This is interpreted as reflecting disturbances in target detection processes as indexed by the P3b. The findings that contradict some aspects of current knowledge about left/right hemispheric specialization in musical processing are discussed and related to the literature concerning cortical auditory disorders.

766. Garnero, L., S. Baillet, and B. Renault, *Magnétoencéphalographie / électroencéphalographie et imagerie cérébrale fonctionnelle*. Annales de l'Institut Pasteur/Actualites, 1998. **9**(3): p. 215-226.

Summary:

767. Chabot, R.J., F. Di Michele, E.R. John, and P. Valdes-Sosa, *QEEG profiles and LORETA imaging in attention deficit disorder*. NeuroImage, 1998. **7**(4 PART II).

Summary:

768. Brandeis, D., T.H. Van Leeuwen, K. Rubia, D. Vitacco, J. Steger, R.D. Pascual-Marqui, and H.C. Steinhausen, *Neuroelectric mapping reveals precursor of stop failures in children with attention deficits*. Behavioural Brain Research, 1998. **94**(1): p. 111-125.

Summary: Children with attention deficit disorders (ADD) may have specific problems with response inhibition in the STOP task. This task requires that subjects stop responses to a primary task if a second signal follows. However, it is unclear whether these problems reflect an impairment of the stopping process per se, whether they are related to reduced frontal lobe activation and whether they are confined to severe and pervasive forms of ADD. In 11 ADD and nine control children, 32 channel event-related EEG potentials (ERPs) were recorded in a STOP and a delayed GO task. Mapping revealed that both tasks evoked a similar sequence of neuroelectric microstates, i.e. of time segments with stable map topography. Adaptive segmentation identified the transition between these microstates. Reliable group differences were found in several microstates and in both tasks despite matched performance. In the GO task, ADD children had topographically altered P2/N2 microstates and attenuated P300-type microstates. In the STOP task, a topographically altered N1 microstate which coincided with the onset of the stop signal preceded the stop failures of ADD children. The timing of this microstate is too early to reflect deficits in actual stop signal processing and instead suggests altered initial orienting of attention to the primary signal in ADD children. Imaging with low resolution tomography (LORETA) during this microstate to stop failures indicated mainly posterior activation for both groups and increased rather than reduced frontal activation in ADD children. For a later microstate (P550), LORETA indicated strong frontal activation after successful stopping, but no group differences. The results suggest that information processing of ADD children deviates during activation of posterior mechanisms which may be related to the orienting of attention and which precedes and partly determines inhibitory control problems in ADD.

769. Brandeis, D. and D. Lehmann, *Functional brain mapping with cognitive evoked potentials*. Schweizer Archiv fur Neurologie und Psychiatrie, 1998. **149**(6): p. 273-279.

Summary: Mapping of cognitive evoked scalp potentials (EPs) offers excellent temporal and cognitive resolution. Its spatial resolution distinguishes even subtle differences in afferent and cognitive processes and is commonly underestimated. The noninvasive method reveals a temporally ordered sequence of transient, covert, functional microstates of the brain. Tomographic and gradient-based source localization can translate this spatial into neuroanatomical resolution which depends on the three-dimensional configuration of the active sources. Such functional brain map ping with EPs has the potential to integrate current structural (neurological) and dynamic (information processing) models of brain function and dysfunction. We review contributions to a neurophysiological understanding of language, attention, inhibition, and of psychiatric disorders such as schizophrenia and ADHD (attention deficit/hyperactivity disorders).

770. Bidaut, L., J.G. Villemure, N. De Tribolet, and F. Terrier, *Integration of neurosurgery with complete multisensor assessment of brain (dys-)function*. NeuroImage, 1998. **7**(4 PART II).

Summary:

771. Anderer, P., R.D. Pascual-Marqui, H.V. Semlitsch, and B. Saletu, *Differential effects of normal aging on sources of standard N1, target N1 and target P300 auditory event-related brain potentials revealed by low resolution electromagnetic tomography (LORETA)*. Electroencephalography and Clinical Neurophysiology, 1998. **108**(2): p. 160-174.

Summary: The P300 event-related potential (ERP) is considered to be closely related to cognitive processes. In normal aging, P300 scalp latencies increase, parietal P300 scalp amplitudes decrease and the scalp potential field shifts to a relatively more frontal distribution. Based on ERPs recorded in 172 normal healthy subjects aged between 20 and 88 years in an auditory oddball paradigm,

the effects of age on the electrical activity in the brain corresponding to Nl and P300 components were estimated by means of low resolution electromagnetic tomography (LORETA). This distributed approach directly computes a unique 3-dimensional electrical source distribution by assuming that neighbouring neurons are simultaneously and synchronously active. Nl LORETA generators, located predominantly in both auditory cortices and also symmetrically in prefrontal areas, increased with advancing age for standards but remained stable for targets. P300 LORETA generators, located symmetrically in the prefrontal cortex, in the parieto-occipital junction and in the inferior parietal cortex (supramarginal gyrus) and medially in the superior parietal cortex, were differentially affected by age. While age did not affect parieto-occipital sources, superior parietal and right prefrontal sources decreased pronouncedly. Thus, in normal aging, P300 current density decreased in regions were a fronto-parietal network for sustained attention was localized. © 1998 Elsevier Science Ireland Ltd.

772. Zeitlhofer, J., G. Gruber, P. Anderer, S. Asenbaum, P. Schimicek, and B. Saletu, *Topographic distribution of sleep spindles in young healthy subjects*. Journal of Sleep Research, 1997. **6**(3): p. 149-155.

Summary: The application of an automatic sleep spindle detection procedure allowed the documentation of the topographic distribution of spindle characteristics, such as number, amplitude, frequency and duration, as a function of sleep depth and of recording time. Multichannel all-night EEG recordings were performed in 10 normal healthy subjects aged 20-35 years. Although the interindividual variability in the number of sleep spindles was very high (2.7 ± 2.1 spindles per minute stage 2 sleep), all but two subjects showed maximal spindle activity in centro-parietal midline leads. Moreover, this topography was seen in all sleep stages and changed only slightly - to a more central distribution - towards the end of the night. On the other hand, slow (11.5-14 Hz) and fast (14-16 Hz) spindles showed a completely different topography, with slow spindles distributed anteriorly and fast spindles centro-parietally. The number of sleep spindles per min was significant depending on sleep stages, with the expected highest occurrence in stage 2, and on recording time, with a decrease in spindle density from the beginning towards the end of the night. However, spindle amplitude, frequency and individual duration was not influenced by sleep depth or time of the night.

773. Werth, E., P. Achermann, D.J. Dijk, and A.A. Borbély, *Spindle frequency activity in the sleep EEG: Individual differences and topographic distribution*. Electroencephalography and Clinical Neurophysiology, 1997. **103**(5): p. 535-542.

Summary: The brain topography of EEG power spectra in the frequency range of sleep spindles was investigated in 34 sleep recordings from 20 healthy young men. Referential (F3-A2, C3-A2, P3-A2 and O1-A2) and bipolar derivations (F3-C3, C3-P3 and P3-O1) along the anteroposterior axis were used. Sleep spindles gave rise to a distinct peak in the EEG power spectrum. The distribution of the peak frequencies pooled over subjects and derivations showed a bimodal pattern with modes at 11.5 and 13.0 Hz, and a trough at 12.25 Hz. The large intersubject variation in peak frequency (range: 1.25 Hz) contrasted with the small intra-subject variation between derivations, non-REM sleep episodes and different nights. In some individuals and/or some derivations, only a single spindle peak was present. The topographic distributions from referential and bipolar recordings showed differences. The power showed a declining trend over consecutive non-REM sleep episodes in the low range of spindle frequency activity and a rising trend in the high range. The functional and topographic heterogeneity of sleep spindles in conjunction with the intra-subject stability of their frequency are important characteristics for the analysis of sleep regulation on the basis of the EEG.

774. Werth, E., P. Achermann, and A.A. Borbély, *Fronto-occipital EEG power gradients in human sleep*. Journal of Sleep Research, 1997. **6**(2): p. 102-112.

Summary: The brain topography of power spectra along the antero-posterior (A-P) axis was studied in the all-night human sleep EEG. Spectra (0.25-25.0 Hz) were computed for an anterior (A; F3-C3), a middle (M; C3-P3) and a posterior (P; P3-01) bipolar derivation, and the spectral gradients between two adjacent derivations were expressed by power ratios (A/M and M/P). At NREM-REM sleep transitions a power shift from A to M was present over almost the entire frequency range, while the direction of shifts between M and P differed between frequency bands. Within NREM sleep, frequency specific power gradients were present: In the low delta band power in both A (0.25 Hz bin) and P (0.25-1.0 Hz bins) was higher than in M. In the 4-9 Hz range the relation was A>M>P, and in the 15-25 Hz range power was largest in M. Power in the spindle frequency range was highest at 11.75 Hz in M, and at 13.5-13.75 Hz in A. Topographical differences were seen also in the temporal changes of power across and within NREM sleep episodes. Whereas NREM sleep power in the 2-Hz bin was higher in A than in M in the first episode, this difference vanished in the course of the night. This result points to a specific involvement of frontal parts of the cortex in sleep homeostasis. The regional differences in sleep EEG spectra indicate that sleep is not only a global phenomenon but also a local brain process with a different regional involvement of neuronal populations.

775. Wagner, H., M. Eiselt, and U. Zwiener, *Exactness of source analysis of biomagnetic signals of epileptiform spikes by the method of spatial filtering: A computer simulation*. Medical and Biological Engineering and Computing, 1997. **35**(6): p. 708-714.

Summary: On the basis of spatial covariance, it is found that, by spatial filtering the localisation of a single dipole source, both parallel and perpendicular to the measurement plane (assuming a signal-noise ratio of 5:1), can be performed with an accuracy of < 0.5 mm. When the signal-noise ratio is increased to 30:1, the resolution of temporally independent current sources separated by 2 mm becomes practicable. This resolution study is carried out by means of a pair of

unity current dipoles with the dipole distance as a varying source model parameter. The conclusions, drawn from the results of computer simulation and supported by statistical calculations, refer to the spherical model of the volume conductor of the brain. On the basis of spatial covariance, it is found that, by spatial filtering the localization of a single dipole source, both parallel and perpendicular to the measurement plane (assuming a signal-noise ratio of 5:1), can be performed with an accuracy of <0.5 mm. When the signal-noise ratio is increased to 30:1, the resolution of temporally independent current sources separated by 2 mm becomes practicable. This resolution study is carried out by means of a pair of unity current dipoles with the dipole distance as a varying source model parameter. The conclusions, drawn from the results of computer simulation and supported by statistical calculations, refer to the spherical model of the volume conductor of the brain.

776. Uusitalo, M.A. and R.J. Ilmoniemi, *Signal-space projection method for separating MEG or EEG into components*. Medical and Biological Engineering and Computing, 1997. **35**(2): p. 135-140.

Summary: The mathematical basis of signal-space projection (SSP) method was related to other comparable methods and the accuracy of the method was analyzed. Projection operators were constructed to divide the electroencephalography (EEG) and magnetoencephalography (MEG) signals into two parts. Errors were inversely proportional to the signal-to-noise ratio and sin Θ. The directions of the signals, the locations and orientations of the dipoles included in the projection operator were assumed to be known. The error ΔΓ in knowing the exact directions in the signal space caused additional noise in the analysis. The angle Θ between component vectors determined the separability of the two sources.

777. Seri, S. and A. Cerquiglini, *Effect of interictal discharges on sources of auditory evoked responses in Landau-Kleffner syndrome. EPs-MRI fusioning*. NeuroImage, 1997. **5**(4 PART II).

Summary:

778. Phillips, J.W., R.M. Leahy, and J.C. Mosher, *MEG-Based imaging of focal neuronal current sources*. IEEE Transactions on Medical Imaging, 1997. **16**(3): p. 338-348.

Summary: We describe a new approach to imaging neural current sources from measurements of the magnetoencephalogram (MEG) associated with sensory, motor, or cognitive brain activation. Many previous approaches to this problem have concentrated on the use of weighted minimum norm (WMN) inverse methods. While these methods ensure a unique solution, they do not introduce information specific to the MEG inverse problem, often producing overly smoothed solutions and exhibiting severe sensitivity to noise. We describe a Bayesian formulation of the inverse problem in which a Gibbs prior is constructed to reflect the sparse focal nature of neural current sources associated with evoked response data. We demonstrate the method with simulated and experimental phantom data, comparing its performance with several WMN methods. © 1997 IEEE.

779. Penke, M., H. Weyerts, M. Gross, E. Zander, T.F. Münte, and H. Clahsen, *How the brain processes complex words: An event-related potential study of German verb inflections*. Cognitive Brain Research, 1997. **6**(1): p. 37-52.

Summary: Event-related brain potentials (ERPs) were recorded as German-speaking subjects read verbs in correct and incorrect participle forms. The critical words were presented in three different versions to three different groups of subjects, as part of a simple sentence, in a word list, and embedded in a story; for each version separate ERPs were recorded. Three types of verbs were investigated, regulars, irregulars and nonce verbs. We compared correct regular and irregular participles with incorrect ones; the latter had -(e)n on verbs that actually take -t participles (*getanz-en), or -(e)t on verbs that require -(e)n (*gelad-et). For the nonce verbs, we compared participles with the unexpected -(e)n ending with the expected -t participle forms. The ERP responses were very consistent across the three versions of the experiment: (i) incorrect irregular participles (* gelad-et) elicited a left frontotemporal negativity; (ii) incorrect regulars (* getanz-en) produced no differences to the correct ones; (iii) nonce verbs were associated with an N400 component but did not show a difference between expected and unexpected endings. We will interpret these findings with respect to psycholinguistic models of morphological processing and argue that the brain processes regularly inflected words differently from irregularly inflected ones, the latter by accessing full-form entries stored in memory and the former by a computational process that decomposes complex words into stems and affixes.

780. Pegna, A.J., A. Khateb, L. Spinelli, M. Seeck, T. Landis, and C.M. Michel, *Unraveling the cerebral dynamics of mental imagery*. Human Brain Mapping, 1997. **5**(6): p. 410-421.

Summary: Evidence from functional brain imaging studies suggests that mental imagery processes, like other higher cognitive functions, simultaneously activate different neuronal networks involving multiple cortical areas. The question of whether these different areas are truly simultaneously active or whether they are temporally distinct and might reflect different steps of information processing cannot be answered by these imaging methods. We applied spatiotemporal analysis techniques to multichannel event-related potential (ERP) recordings in order to elucidate the topography and chronology of brain processes involved in mental rotation. We measured 41- electrode ERPs in 12 healthy subjects who had to evaluate whether rotated letters were in a normal or mirror-reflected position. These figures were presented in the left, right, or central visual fields and were randomly rotated by 0°, 50°, 100°, or 150°. Behaviorally, we replicated the observation that reaction time increases with greater angles of rotation.

Electrophysiologically, we identified a set of dominant electric potential distributions, each of them stable for a certain time period. Only one of these time segments (appearing between 400-600 msec) increased significantly in duration with greater angles of rotation mirroring reaction time. We suggest that the rotation of mental images is carried out during this time segment. A general linear inverse solution applied to this segment showed occipito-parietal cerebral activity that was lateralized to the right hemisphere.

781. Pegna, A.J., A. Khateb, S.M. Morand, M. Seeck, T. Landis, and C.M. Michel, *Spatio-temporal analysis of electric brain activity during mental rotation: An event-related potentials study*. NeuroImage, 1997. **5**(4 PART II).

Summary:

782. Merica, H., R. Blois, R.D. Fortune, and J.M. Gaillard, *Evolution of delta activity within the nonREM sleep episode: A biphasic hypothesis*. Physiology and Behavior, 1997. **62**(1): p. 213-219.

Summary: The time course of delta activity within nonREM (NREM) episodes is measured for 24 healthy subjects with normal REM latencies. The first two NREM episodes in particular, show two very clearly separated peaks for about 35% of the subjects. Another 25% show two less well separated peaks. These double peak patterns are also prevalent in the literature, but there has been a tendency to dismiss them as a skipped REM effect. They are, however, still evident even when the data are averaged over the 24 subjects, indicating a systematic phenomenon. These averaged data are well fitted by an analytic function given by the sum of two consecutive overlapping Gaussian curves. The well-behaved residuals also, are an indication that a biphasic model of this kind is statistically appropriate. The model proposed is simple, with parameters related to physiological phenomena, and it suggests that there may be an underlying process with delta waves emanating from two separate signal sources. Recent neurophysiological findings suggest that delta oscillations are generated both in the thalamus and in the cortex and show that excessive synchronization of slow oscillations may lead to seizures. Hence the speculation that the biphasic process may emnanate from cortical and thalamic sources and be protective in the sense that it permits smaller delta amplitudes at each source while retaining the integral delta energy necessary to satisfy sleep pressure. It is significant that the two peaks are most evident in the first two NREM episodes where delta power is high.

783. Lazeyras, F., C.M. Michel, X. Golay, O. Blanke, C. Gericke, S. Morand, J. Ives, J. Delavelle, N. De Tribolet, and M. Seeck, *Localization and propagation of seizure foci analyzed with simultaneous recording of fMRI and 3D-EEG mapping*. NeuroImage, 1997. **5**(4 PART II).

Summary:

784. Lantz, G., C.M. Michel, R.D. Pascual-Marqui, L. Spinelli, M. Seeck, S. Seri, T. Landis, and I. Rosen, *Extracranial localization of intracranial interictal epileptiform activity using LORETA (low resolution electromagnetic tomography)*. Electroencephalography and Clinical Neurophysiology, 1997. **102**(5): p. 414-422.

Summary: Besides the standard clinical methods of EEG waveshape analysis, mathematical models for reconstruction of dipolar sources from the digitized surface EEG have been introduced in epilepsy research. Although useful for localizing focal sources, these methods are inadequate for analyzing widespread epileptiform activity. A recently introduced alternative method called LORETA (low resolution electromagnetic tomography, Pascual-Marqui et al., 1994), directly computes the current distribution throughout the full brain volume, assuming thai neighboring neuronal populations are simultaneously and synchronously activated. In mathematical terms the method selects the smoothest of all possible 3-dimensional current distributions, inherently introducing a certain amount of dispersion. In 7 patients, undergoing simultaneous EEG recording from 10 intracranial (subdural) and 22 extracranial electrodes, III subdural discharges (61 subtemporal and 50 lateral temporal) were identified. The exact time point of maximal intracranial activity was automatically identified, and the LORETA solution at that timepoint was computed from the surface EEG. Statistical comparison revealed significantly higher LORETA current density in the area corresponding to the subdurally recorded spike compared to other areas, and a more anterior and more medial LORETA location for subtemporal compared to lateral temporal spikes. This study indicates that the LORETA technique may become a useful method to localize electrical activity in the brain.

785. Ioannides, A.A., J.G. Taylor, and H.W. Müller-Gärtner, *The relation between MFT, FOCUS and LORETA*. NeuroImage, 1997. **5**(4 PART II).

Summary:

786. Harmony, T., A. Fernández-Bouzas, E. Aubert, P. Valdés, R. Casanova, J. Silva, T. Fernández, F. García, J. Riera, M. Martínez, F. Barrios, R. Rojas, and O. Quiroz, *Volumetric anatomically restricted distributed inverse solution of auditory and visual N1 components*. NeuroImage, 1997. **5**(4 PART II).

Summary:

787. Green, J.B., Y. Bialy, E. Sora, and R.W. Thatcher, *An electroencephalographic study of imagined movement*. Archives of Physical Medicine and Rehabilitation, 1997. **78**(6): p. 578-581.

Summary: Objective: Determine the generator sources for actual and imagined (simulated) movements of fingers and toes. Design: Observational Setting: Electroencephalography laboratory. Subjects: Ten asymptomatic adult volunteers. Main Outcome Measure: Comparison of cortical electrical fields and their dipole sources in actual and imagined movements. Results: Cortical electrical fields tend to be contralateral with actual movements and midline with imagined movements. Dipole sources of actual movements include a contralateral contribution from the frontal (primary motor) area. Sources of imagined movements are midline or ipsilateral. Conclusions: (1) The motor networks underlying the generation of actual and imagined movements are different. (2) Imagined movements lack a primary motor area source, but involve medial and ipsilateral structures. (3) The effectiveness of imagined movements in rehabilitation may stem from activation of premotor or supplementary motor areas.

788. Grave De Peralta Menendez, R., O. Hauk, S.G. Andino, H. Vogt, and C. Michel, *Linear inverse solutions with optimal resolution kernels applied to electromagnetic tomography*. Human Brain Mapping, 1997. **5**(6): p. 454-467.

Summary: This paper discusses the construction of inverse solutions with optimal resolution kernels and applications of them in the reconstruction of the generators of the EEG/MEG. On the basis of the framework proposed by Backus and Gilbert [1967], we show how a family of well-known solutions ranging from the minimum norm method to the generalized Wiener estimator can be derived. It is shown that these solutions have optimal properties in some well- defined sense since they are obtained by optimizing either the resolution kernels and/or the variances of the estimates. New proposals for the optimization of resolution are made. In particular, a method termed 'weighted resolution optimization' (WROP) is introduced that deals with the difficulties inherent to the method of Backus and Gilbert [1967], from both a conceptual and a numerical point of view. One-dimensional simulations are presented to illustrate the concept and the interpretation of resolution kernels. Three-dimensional simulations shed light on the resolution properties of some linear inverse solutions when applied to the biomagnetic inverse problem. The simulations suggest that a reliable three-dimensional electromagnetic tomography based on linear inverse solutions cannot be constructed, unless significant a priori information is included. The relationship between the resolution kernels and a definition of spatial resolution is emphasized. Special consideration is given to the use of resolution kernels to assess the properties of linear inverse solutions as well as for the design of inverse solutions with optimal resolution kernels.

789. Fernández-Bouzas, A., R. Casanova, T. Harmony, P. Valdés, E. Aubert, J. Silva, T. Fernández, E. Marosi, J. Bernal, M. Rodríguez, and A. Reyes, *Frequency domain distributed inverse solutions in brain tumors*. NeuroImage, 1997. **5**(4 PART II).

Summary:

790. Clark, C.R. and R.E. Greenblatt, *Working memory imaged from event related potentials*. NeuroImage, 1997. **5**(4 PART II).

Summary:

791. Bidaut, L.M., *Multifunctional imaging and fusion*. Physica Medica, 1997. **13**(SUPPL. 1): p. 178-182.

Summary: A system (Integrated Multisensor Imaging and Processing System - IMIPS) is described which consists of techniques and protocols which have been implemented in Geneva to combine (through registration, visualization, navigation and processing) various multidimensional biomedical imaging sensors, including Electro-Magnetic Tomography (EMT), for studying, assessing, and localizing neurological (dys-)function for both clinical and research applications. The already well described interest for this combination stems from the broad variety of complementary information brought out by modern biomedical imaging modalities. In this context, the input of volumetric EMT permits direct sighting, in near real-time, of any EM (dys-)funcfional behavior. Besides allowing morphology, metabolism and function to be studied simultaneously and from different points of view, the global combination permitted by IMIPS is expected to show its best value when studying pathologies reflected by metabolic or electrophysiologic dysfunctions.

792. Bidaut, L., J. Delavelle, J.G. Villemure, J. Favre, B. Rilliet, M. Seeck, D. Schomer, and N. De Tribolet, *Multidimensional integration of non-invasive and invasive multisensor measurements for the assessment of brain function*. NeuroImage, 1997. **5**(4 PART II).

Summary:

793. Anderer, P., B. Saletu, H.V. Semlitsch, and R.D. Pascual-Marqui, *Electrical sources of P300 event-related brain potentials revealed by low resolution electromagnetic tomography*. Neuropsychobiology, 1997. **37**(1): p. 28-35.

Summary: In a double-blind, placebo-controlled study the effects of Actovegin® on frontal and parietal electrical P300 sources revealed by low resolution electromagnetic tomography (LORETA) were studied in age-associated memory impairment (AAMI) patients. Actovegin is a protein-free metabolically active hemoderivative improving oxygen and glucose utilization. Each patient had, in randomized order, a treatment of 2 weeks with 250 ml 20% Actovegin and 250 ml placebo daily. Auditory ERPs were recorded before and 5 h after drug administration on day 1 (acute effect) and on day 15 (subacute and superimposed effect). Compared to age- and sex-matched normal controls, AAMI patients showed a trend towards P300 latency prolongation and a significantly reduced P300 global field power (GFP). Maximal LORETA source strength did not differ from controls. After Actovegin parietal P300 scalp amplitudes increased, while frontal and temporal amplitudes decreased as compared to placebo. This increase in hilliness, measured by the GFP, was significant. Moreover, the parietal P300 source strength increased after acute, subacute and superimposed infusion of Actovegin as compared to placebo. This may reflect improved availability of

cognitive processing resources in the parietal cortex, an area that on the one hand plays an important role in fundamental aspects of attention and on the other hand has been found to be functionally impaired in dementia.

794. Anderer, P., R.D. Pascual-Marqui, H.V. Semlitsch, and B. Saletu, *Electrical sources of P300 event-related brain potentials revealed by low resolution electromagnetic tomography*. Neuropsychobiology, 1997. **37**(1): p. 20-27.

Summary: The P300 event-related potential (ERP) is considered to be closely related to cognitive processes. Previous reports regarding major generators contributing to the scalp-recorded P300 suggested widely distributed multiple sources. Based on ERPs recorded in 172 normal healthy subjects aged between 20 and 88 years in an auditory oddball paradigm, electrical activity in the brain corresponding to N1 and P300 components was localized by means of low resolution electromagnetic tomography (LORETA). The N1 LORETA generators, located in both auditory cortices, did not change over age. On the other hand, the P300 LORETA generators, located predominantly in the frontal neocortex and less pronounced in the posterior parietal cortex, decreased over age both in frontal and parietal source strength.

795. Van Drongelen, W., M. Yuchtman, B.D. Van Veen, and A.C. Van Huffelen, *A spatial filtering technique to detect and localize multiple sources in the brain*. Brain Topography, 1996. **9**(1): p. 39-49.

Summary: An algorithm for localization of electromagnetic activity in the central nervous system is explored. This algorithm generates a neural activity index map within the brain by passing surface recordings through a set of spatial filters. The covariance matrix of the surface recordings is used to optimize the spatial filters' responses. This approach is studied in simulated situations and in real data. The simulations show the method's capability to detect areas of activity without prior knowledge of the number of sources. The resolving power of the method increases with number of electrodes and signal-to-noise ratio, and it decreases with depth. The analysis of the electrophysiological data indicates that the method can distinguish simultaneously active areas in a realistic fashion. The analyzed recordings are bilateral median SEP responses, an epoch of spike activity showing several active regions and a recording with eye movement superimposed on spike activity. The method and the results are discussed in relation to current localization techniques.