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Coherence Analysis of All-Night Sleep EEG. - P. Achermann and A.A. Borbély (Institute of Pharmacology, University of Zurich, CH-8057 Zurich, Switzerland).

The interhemispheric and intrahemispheric coherence of the EEG may provide information on the functional connectivities between brain regions. The present study was designed to explore state-specific changes of EEG coherence during sleep. The nocturnal sleep EEG of 8 young healthy subjects was recorded. The power spectra (averages of five 4-s epochs) and coherence spectra (20-s epochs) between different bipolar derivations were calculated in the frequency range of 0.25-25 Hz. - Intrahemispheric anterior-posterior coherences in nonREM sleep showed distinct peaks in the frequency range of sleep spindles, in the low delta band, and in the alpha band. Coherence was low throughout the entire frequency range in stage 1 and REM sleep. - Interhemispheric coherences of corresponding sites showed an entirely different pattern. Coherence in nonREM sleep was high in the delta, theta and alpha range, and the distinct peaks of intrahemispheric coherence were also present. They were most prominent in the anterior derivations. The pattern in stage 1 and REM sleep was similar to that of nonREM sleep although the typical peaks were absent and the values in the low delta range were lower. - Our results indicate that a state-specific high coherence is limited to distinct frequencies within the low delta, alpha and sigma band.

Effect of Inter-Target Interval on P300 Source Distribution in Young and Elderly Normal Healthy Subjects. - P. Anderer*, H.V. Semlitsch*, R.D. Pascual-Marqui and B. Saletu* (*Dept. of Psychiatry, University of Vienna, Vienna, Austria; **The KEY Institute for Brain-Mind Research, University Hospital of Psychiatry, Zurich, Switzerland).**

According to the triarchic model, P300 amplitude depends, at given levels of global probability, stimulus meaning and information transmission, on the specific sequence of preceding stimuli. Thus, in an oddball paradigm, P300 amplitude should depend on 1/ITI where ITI is the inter-target interval. - Single potentials evoked by target tone bursts (p=0.10; N=31), were averaged according to their occurrence in the experiment, separately for 58 normal healthy subjects aged 20-29 years, and 41 normal healthy subjects aged 60-79 years. Latencies, amplitudes and electrical activity in the brain localized by means of "low resolution electromagnetic tomography (LORETA)" were evaluated. - P300 latency was strongly related to 1/ITI both in young and elderly subjects, with short latencies for long ITIs (r=0.91 and r=0.89 in young and elderlies, respectively). On the other hand, P300 amplitude at Pz was related to 1/ITI only in young subjects with high amplitudes for long ITIs (r=-0.75), but not in elderlies (r=-0.19). - As shown previously, LORETA revealed frontal and parieto-occiptal P300 generators. In young subjects the parieto-occipital source was predominant for short ITI. With increasing ITI the parieto-occipital source decreased, while the frontal increased. In elderlies, however, frontal and parieto-occipital P300 sources were approximately equal in size and strength, independent of the ITI.

Sex or Pre-Treatment Differences on EEG-Effects of Morphine in Low Concentrations? - M.J. Barbanoj*, G. Salazar*, R.M. Antonijoan*, F. Jane*, P. Anderer and B. Saletu** (*Pharmacological Research Area, Research Institute of Sant Pau Hospital, Dept. of Pharmacology and Therapeutics, U.A.B., E-08025 Barcelona, Spain; **Pharmacopsychiatry Section, Sleep Laboratory, Dept. of Psychiatry, University of Vienna, Vienna, Austria).**

In contrast to the abundant findings on EEG-effects of anaesthetic doses of opiates there are scarce data reporting on low-concentrations.

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Transcranial magnetic stimulation and neuromagnetic measurements using superconducting quantum interference devices (SQUID) and advanced MRI systems have become important tools in functional brain research and clinical diagnosis. The present study is focused on source estimation of neuronal electrical activity associated with motor evoked potentials and higher brain function, where the importance of the inhomogeneities in the head is emphasized. The limitation of source estimation based on dipole models is also discussed. In order to produce images of electrical properties of the body, a new method of impedance MRI is proposed. Also, distributed source models are introduced in connection with a new technique of electric tomographic imaging which is being developed in our laboratory.

Human Short-Latency Cortical Responses To Somatosensory Stimulation. A High Resolution EEG Study. - A. Urbano, F. Babiloni, C. Babiloni, P. Onorati, A. Ambrosini and P. Rossini (Institute of Human Physiology, University 'La Sapienza', Rome, Italy).

In the present study we investigated short-latency responses of human cerebral cortex to right median nerve stimulation at wrist. To this aim somatosensory evoked potentials (SEPs) were spatially-enhanced with a novel high resolution EEG technology including high spatial sampling (128 channels) and surface Laplacian estimate of the potential over a realistic magnetic resonance-constructed subject's scalp surface model. Spatially-enhanced SEP components were estimated over contralateral and mesial scalp regions about 20, 22, 30, 32, and 45 msec following the stimulation. Frontal-lateral P20, N30 (N30fl) and P45 (P45fl), and frontal-mesial N30 (N30fm) and P45 (P45fm) culminated simultaneously with parietal N20, P30 and N45, and central P45 (P45c). With respect to the frontal-lateral components, the central P22 and N32 peaked later. These findings may indicate that the P20-N20, N30fl-P30 and P45fl-N45 originated in the cortex buried into the central sulcus, whilst the N30fm and P45fm were generated from the frontal-mesial cortex (including supplementary motor area), and the P22, N32, and P45c from the crown of the pre- and post-central gyri. Hence, the responses of the central sulcus cortex would anticipate those of the central-crown and frontal-mesial cortices.

The Statistical Analysis of Distributed Inverse Solutions. - P. Valdes*, K. Worsley**, J. Riera*, J. Bosch* and R. Casanova* (*Cuban Neuroscience Center, Habana, Cuba; **Dept. of Statistics, McGill University, Montreal, Canada).

Distributed Inverse Solutions (DIS) such as LORETA (Pascual-Marqui et al. 1991) and VARETA (Valdes et al. 1995) have become increasingly popular since they are true tomographic methods. However, like other tomographic techniques, they comprise a very large number of highly correlated variables, originating difficult statistical problems. Worsley (1994, 1996) has recently developed a unified approach for determining significant signals in images of cerebral activation. Based upon the theory of random fields the method has been applied to PET and fMRI images. This contribution extends the field of application to 4 dimensional spatio temporal DIS. The problem of calculating Resel counts for DIS is discussed. The methods developed are applied to a) Testing for significant deviations in tomographic qEEG images and b) Testing for the significance of generators of difference ERP waves such as the N400 and P300.

Time/Space Regularization of the Inward Continuation Problem in EEG Using the Boundary Element Method. - M. van Burik*,**, F. Zanow*, G. Edlinger**, M. Peters* and G. Pfurtscheller** (*Biomagnetic Centre Twente, University of Twente, The Netherlands; **Dept. of Medical Informatics, Graz University of Technology, Austria).

The inward continuation problem in EEG consists in the computation of the cortical potential distribution from the measured potential distribution on the scalp. Although unique this inverse problem is ill-posed. That is, low-level noise in the scalp potential data or a small error in the geometrical data can lead to unbounded errors in the solution. Regularization techniques have to be used to minimize these effects. The inverse problem is solved in two steps. First Tikhonov regularization is applied yielding a solution of the potential on the inside of the skull surface for every timestep. Than the solution of the first step is used for Twomey regularization. At each moment in time a new solution is found by using as a priori estimate the average of the first solution one timestep prior and one timestep after. This combination of spatial (Tikhonov) and temporal (Twomey) regularization improves the solution and smoothes the solution in space and time. Both simulations and the application to EEG data of a Median Nerve stimulation experiment yield encouraging results. Further comparative studies have to be carried out to evaluate the application of time/space regularization of the inward continuation problem in EEG.

Post-Movement Beta Synchronization Studied with Linear Estimation. - M. van Burik*,**, T. Knoesche**, M. Peters** and G. Pfurtscheller* (*Dept. of Medical Informatics, Graz University of Technology, Austria; **Biomagnetic Centre Twente, University of Twente, The Netherlands).

Event-related desynchronization (ERS) describes a short-lasting and localized amplitude enhancement of specific frequency components. The spatial distribution of a post-movement beta ERS can be visualized by computing the local average reference (LAR). The Linear estimation (LE) method can also be applied to study the spatiotemporal ERS patterns. As source space an hemisphere was used with equally distributed radially oriented current dipoles. The lead field matrix is normalized to make sure that all dipoles have the same average impact on the sensors. A distributed source solution is found for each timestep and for each trial. Event-related Desynchronization calculations are carried out for every dipole (squaring of amplitude, averaging over all trials and time averaging over 16 time points). Both methods were conducted for the study of voluntary hand movement. The results are similar but in contrast to the LAR maps, the LE maps show a better spatial resolution. This is not surprising since the LAR method is limited to the electrode sites whereas with LE the EEG activity is projected onto the source space. Furthermore, the LE method counteracts the deblurring caused by the poorly conducting skull. Linear Estimation depends on several assumptions about the source space, volume conductor and the regularization parameter. Further investigation is needed to evaluate the application of LE for the study of Event-Related EEG phenomena.

Effects of Inhomogeneities within the Brain on EEG and MEG. - S.P. van den Broek, M. Donderwinkel and M.J. Peters (Faculty of Applied Physics, University of Twente, NL-7500 AE Enschede, The Netherlands).

The influence of ventricles and lesions on MEG and EEG is studied. The ventricles have an intricate shape and are filled with cerebrospinal fluid. Lesions can have various shapes and their conductivity is un-

known. A realistically shaped three-compartment model is used, describing the scalp, skull and brain, which includes the realistically shaped ventricles or a spherical lesion. The potential is computed by means of the finite-element method, and the magnetic field by applying the law of Biot-Savart (Broek, S.P.v.d., Zhou, H. and Peters, M.J. 1996, Computation of neuromagnetic fields using finite-element method and Biot-Savart law, Med. Biol. Eng. Comput., 34, 21-26). An influence of the ventricles on the potential is only noticeable for dipoles that are within a few centimetres of a ventricle and on the relatively weak potentials on the opposite side of the head. The 'radial' component of the magnetic field generated by superficial dipoles is not influenced by the ventricles in a healthy subject. The influence on the other components, and on the field generated by dipoles near the ventricles can be large. A lesion has a large effect on the potential for sources near the lesion. The effects on the MEG are smaller, but noticeable. Care should be taken in explaining abnormalities in EEGs and MEGs, as it is possible that they are caused by the presence of an inhomogeneity.

Brain Topography of Positive Rolandic Sharp Waves in Premature New-Borns. - P.C. Viana, S. Marret and D. Samson-Dollfus (Rouen University Hospital, Rouen, France).

Positive Rolandic Sharp Waves (PRSW) are surface positive transients found in premature babies, first described by Cukier et al. (1972) and associated with peri/intraventricular haemorrage or with periventricular leukomalacia (Marret et al. 1986). The present study analyses the PRSWs' topography. We will try to 1) verify if they differ in Quiet Sleep (QS) and Active Sleep (AS); 2) localize their sources using surface EEG data. Special concern was given to fontanella diameter, since currents from various generators have a tendency to flow through skull openings, distorting the potential patterns (Katznelson 1981). Fourteen EEGs were recorded in six infants from 30.5 to 36 weeks of conceptional age. Polygraphy was performed with 11 or 14 EEG electrodes. Data were analysed with common and average references for potential, and source derivation for current density mapping. Inter-electrodes distance was about 2.5 cm. The minimal number of PRSWs averaged in each sleep stage must be determined because of EEG background amplitude variation. In each infant recording, averages were done with 5, 10, 15 and 20 PRSWs. - Preliminary results were: 1) in these premature babies, the signal / noise ratio was better in inter-burst condition of QS than in burst condition and AS; 2) sleep stages seem not to influence PRSWs' localization. In spite of a fontanella hole, it seems that PRSWs are coming from radial dipoles, deep negative and surface positive.

Slow Potential Topography and Musical Cognition: Mental Performance in Piano Playing. - O. Vitouch*,**, H. Bauer*, E. Vanecek**, M. Leodolter* and U. Leodolter* (*Brain Research Lab, Institute of Psychology, University of Vienna, Austria; **Music Psychology Unit, Institute of Psychology, University of Vienna, Austria).

Piano playing is a highly complex task including components like anticipative melodic and harmonic imagery, selective attention, skilled motor behavior, and temporal coordination. From an information processing perspective, it should be helpful to have a tool for identifying such subcomponents and their cortical substrates. - For such a study, we designed a hierarchical sequence of experimental conditions, ranging from simple naming of the notes of a given piece over melodic imagination (with/without visual presentation of the notes) to intentional motor performance and, finally, real performance on a keyboard. minor, skilled piano players had to repeatedly execute this sequence paced by a metronome. Event-related DC potential changes were collected via a matrix montage of 22 Ag/AgCl-electrodes. - Resultant DC potential topographies proved to be a valuable means for real-time cognition monitoring. Evolving topographical patterns can be displayed synchronized with the musical signal. While activity maxima in central and temporal sites during the "real playing" condition corresponded nicely with recent PET findings (Fox et al. 1995), even the separate entry of the left hand at the third bar became clearly visible in experimental conditions involving motor system activation.

From Microstates To Macrostates: Assessment of Electrical Dynamics of the Brain by Global Descriptors. - J. Wackermann (Neuroscience Technology Research, Prague, Czech Republic).

Brain microstates are defined by short periods of relatively stable spatial field configurations and assumed to represent elements of brain's activity (Lehmann 1987, 1990). Brain macrostates can be defined by different levels of functional organization of the brain on a larger time scale. To bridge over the gap between microstates and macrostates, traditional time/frequency descriptors need to be complemented by a space domain based descriptor of complexity of brain's electrical activity. -A system of three global descriptors has been proposed (Wackermann 1996): Ω (spatial complexity), Σ (integral global power) and Φ (generalized frequency). These variables define a 'macrostate space' in which changes of brain's functional states can be visualized, as illustrated by two particular areas of interest. -Vigilance and sleep dynamics: Significant differences in Ω-complexity between sleep stages were found, with lowest complexity during slow-wave sleep (Szelenberger et al. 1996). Macrostate portraits of sleep EEG reveal consistent structure ('sleep shell'); a suitable transformation of macrostate space coordinates allows to isolate two dimensions of sleep processes (Wackermann and Szelenberger 1996). -Brain maturation: Σ and Φ are decreasing and increasing functions of age, respectively. Ω-complexity shows a rapid initial increase, reaching a maximum at about 5-6 years, then decreases again. The relationship between the age of maximum complexity and developmental time constants of Σ and Φ suggests a hypothesis: complexity is proportional to achieved level of maturation x speed of maturation.

Robust Cortical Current Density Reconstruction Using the L1 Norm and a Maximum Source Strength. - M. Wagner, Th. Koehler, M. Fuchs, H.-A. Wischmann, R. Drenckhahn and A. Theissen (Philips Research Hamburg, D-22335 Hamburg, Germany).

When linear estimation theory is applied to the inverse problem of current density reconstruction from EEG or MEG data, the analytical solution can be computed efficiently (Minimum Norm Least Squares). Due to underdetermination and noise, regularization techniques have to be applied. Unfortunately, this leads to an artificial smearing of the solution, which makes it impossible to estimate the true source extent. In addition, as Gaussian noise is implicitly assumed, the method is sensitive to outliers in the data. Systematic errors, which are not captured by a spatiotemporal covariance estimation, like sensor misplacements or oversimplified forward models, may be seen as such outliers. Some important apriori information about the expected source distribution cannot be modeled in such a framework, e.g., the physiological limit for source current density. - We present a new method that overcomes these problems, while still retaining computational efficiency. The robust L1 norm is imposed on the deviation between measured and forward calculated data, after a covariance diagonaliza-