Proceedings

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Young Scientist Section

Neurophysiological functional tomography in multiple sclerosis and quantification of cognitive impairments - Mientus, S.*, Valdes-Sosa, P.^, Pascual-Marqui, R.# and Haas, J.* (*Jewish Hospital Berlin, Dept. of Neurology, Germany; ^Cuban Neuroscience Center Havana, Cuba; #KEY-Institute for Brain Mind Research, Zurich, Switzerland).

Background: Cognitive impairment in Patients with Multiple Sclerosis (MS) due to the demyelinating process is a frequently mentioned problem. We set out to elucidate the possibilities of neurophysiological data for quantifying extent and functional background of cognitive handicaps. Methods: 22 MS patients prior to interferon beta (IFN) treatment (mean age 31 years) and 18 normal controls (matched in age and sex) underwent examinations of EEG and ERP (Event Related Potentials) during a visuo-spatial cognitive test paradigm. Localization and characterization of ERP and the respective anatomical generators as well as functional organization of brain electric activity, evaluated by means of correlation analysis, were based on the data of a neurophysiological tomography (LORETA/VARETA). Results: Compared to normal controls patients showed different generator-configuration for the P3-wave, the wave that is related to task complexitry and performance. While we could specify two focussed generators for normal controls, one parietal and one frontal, patients showed parallel to the parietal one a more diffuse frontal generator. In patients P3-latencies were longer and P3-amplitudes were higher than in normal controls. The N1, related to selective attention, was less pronounced in patients. Correlation in brain electric activity of cortical areas was much less and unspecific developed for patients and showed no sensitivity to repetetive trials of cognitive ...

The difference in early information processing for auditory sensory input in vascular dementia and Parkinson's disease. - Hodumi, A., Hirata, K., Arai, M., Kubo, J., Yamazaki, K. and Tanaka, H.* (Department of Neurology, Dokkyo University School of Medicine; *The KEY institute for Brain-Mind Research, University Hospital of Zurich).

The purpose of the present study is to investigate whether early information processing for auditory sensory input would be different in vascular dementia (VaD) and Parkinson's disease (PD). Method: The study was carried out on 19 patients with VaD, 23 patients with PD and age matched 20 normal individuals. Four-tones paradigm was given for the subjects. Twenty percent of the tones had pitch of 1000 Hz for the target condition, and 70% of the tones had pitch of 2000 Hz for the frequent condition. In addition, 10% of the tones had pitch of 125 Hz and 500 Hz for the non-target condition. Tones were presented in a regular sequence via earphones at 1.5 sec intervals at 80 (500, 1000 and 2000Hz) and 90 (125Hz) dB SPL. The subject's task was to count mentally the target stimuli. Difference waveforms were constructed by subtracting the average response to standard stimuli from the average response to non-target stimuli (N-S), standard stimuli from target stimuli (T-S), non-target stimuli from target stimuli (T-N). Results: In N-S wave, although both normal subjects and VaD patients showed a negative-going component (N2a) peaking about 196 msec, the latency of N2a in PD patients was prolonged. On the other hand, in T-S wave, there was ...

Estimation of the locations of seizure onset in the scalp EEG. - O'Neill, N.S., Agapov, V.E., Javidan, M. and Koles, Z.J. (University of Alberta, Edmonton, AB, Canada).

Determination of the onset and focus of an epileptic seizure based on a visual examination of the scalp EEG is usually very imprecise. To facilitate this process, we have developed a quantitative method that enables both the onset of the seizure to be clarified and the locations of the responsible sources inside the brain to be estimated. The method consists of band-pass filtering the EEG to eliminate baseline shifts and artifacts and data dependent spatio-temporal filtering to suppress pre-ictal background and extraneous ictal activity. It also consists of a generalized form of the MUSIC algorithm, applied to the filtered EEG, to estimate the locations of the sources responsible for the seizure. The head model used in the localization algorithm is of a realistic geometry designed using the method of finite volumes. This presentation will illustrate both the validation of the method using simulated EEGs and its application to seizure data obtained from a patient EEG in which the seizure onset was obscure. It is shown that, after filtering, the seizure onset is clarified significantly and that plausible estimates of the locations of the multiple sources underlying the seizure inside the brain can be obtained. In addition, it is also shown that examination of the waveforms associated with these sources can suggest how the seizure activity might propagate from one source location to another.

ERPs to lexical and object decision tasks: Source localization using VARETA and LORETA methods. - Silva, J.*, Harmony, T.*, García, L.#, Aubert, E.^, Bosh, J.^, Fernández, T.# and Fernández-Bouzas, A.# (*Centro de Neurobiología, Campus UNAM-UAQ Juriquilla; ^Centro de Neurociencias, La Habana Cuba; #Proyecto de Neurociencias, ENEP Iztacala UNAM).

This paper tries to answer the question whether pictures and words that name them access a common conceptual representation or a dual-code representation for pictures and words. Reaction times and ERPs were recorded in 15 males young students during lexical and object decision tasks. With the purpose to eliminate subject's strategies associated to the lexical and object decisions, mediated pairs were used. Mediated pairs are those words or objects that have an indirect relation through a third one (e.g., summer and snow are mediated related through winter). The grand averages of ERP to related and unrelated pairs were computed. A latency window of 400-450 ms over 20 leads of the 10-20 International System was used for source localization. VARETA and LORETA were computed for each point of this window. VARETA solutions were projected onto the averaged brain provided by the Montreal Neurological Institute. The solutions from both methods were very similar. There were no differences between the solutions for related and unrelated word-pairs or object-pairs. However the regions activated during lexical decisions (occipital and left temporal regions) and object decisions (right temporal, occipital and left frontal) were different. These results support the dual-code hypothesis.

Symposium One

Spatial Analysis of Brain Electrical Fields in Psychiatry

Cognitive evoked potentials in psychiatry: relevance of topographical analysis. - Strik, W.K., Fallgatter, A.J. and Muller, T.J. (Dept. of Psychiatry, University Hospital Wurzburg, Germany).

The middle and long latency event-related potentials (ERPs) are considered to be generated by the summary activity of extended and/or multiple cortical dipole sheets. The quantification of the spatio-temporal brain electrical field patterns proposed by Lehmann (see: Gevins and Remond, EEG-Handbook, Vol. I; Elsevier 1987: 309-354) allows a robust and meaningful description of the different brain electrical field configurations related to cognitive processes (e.g., Fallgatter et al., Brain Top., 1997, 9: 295-302) and to subgroups of psychiatric patients (e.g., Strik et al., Psychiat. Res: Neuroimaging, 1994, 55: 153-166). Furthermore, the reference independent parameters and quantification procedures are free from interactions between amplitude measures and topographical map features (Strik et al., Biol. Psychiat., 1994, 35: 850-856), and unique for the determination of latencies. The interpretation of these parameters, however, largely relies on indirect validations, such as source localisation methods in comparison with previous brain imaging studies (Strik et al., Electroencephal. Clin. Neurophysiol., in press), or correlations with regional specific neuropsychological tests (Heidrich and Strik, Biol. Psychiat., 1997, 41: 327-335). The application of the topographical analysis of the auditory P300 was succesful to identify distinctive features of psychotic subgroups in a series of investigations of our group. The results indicate that different neurophysiological mechnisms are at the basis of schizophrenic subgroups, cycloid psychoses and mania (Strik et al., Acta. Psychiat. Scand., 1993, 94: 471-476; 1996, 87: 179-183; 1998, in press).

Left temporal P300 amplitude reductions in schizophrenia: specificity and relation to cerebral morphology. - McCarley, R.W., Salisbury, D.F., Hirayasu, Y., Yurgelun-Todd, D.A., Tohen, M. and Shenton, M.E. (Har-

vard Medical School/Brockton VA Medical Center, Department of Psychiatry, Brockton, MA 02401).

Magnetic resonance (MR) measures in schizophrenic (SZ) subjects have revealed structural brain abnormalities, including temporal lobe cortical and limbic structures. We have shown reduced left superior temporal gyrus (STG) cortical gray matter in chronic SZ, that is associated with a reduced left temporal scalp region voltage of P300, an event-related potential (ERP) index of the cognitive processing of novel stimuli. However, since the contribution of chronicity effects to these abnormalities is unknown, and the specificity to SZ vs. affective (bipolar) psychosis (AF) is unknown, we have repeated this study in first psychotic episode (FE) patients (first hospitalization) with AF and SZ. We used high resolution MRI (SPGR, 1.5 mm contiguous slices) and an oddball P300 ERP paradigm in first episode patients with schizophrenia (FE SZ) or affective psychosis (FE AF), and age-, handedness-, and sex-matched control subjects. FE SZ, but not FE AF or controls showed a left temporal scalp region reduction of P300 amplitude (Group x Side interactions, N=14 in each group; Arch. Gen. Psych., 1998, 55: 173-180.) FE SZ (N=17) showed a reduction in both left posterior and total left STG gray matter volume compared with FE AF (N=16) and controls (N=18) (Am. J. Psychiat., in press). In the FE SZ (N=14) there was a significant correlation between total ...

EEG microstates in acute, neuroleptic-naive schizophrenics. - Lehmann, D., Koenig, T., Kochi, K., Hell, D. and Koukkou, M. (The KEY Institute for Brain-Mind Research, University Hospital of Psychiatry, CH-8029 Zurich; *EEG-Brain Mapping Laboratory, University Hospital of Psychiatry, CH-3000 Bern 60, Switzerland).

Brain-electric field (EEG) recordings allow the non-invasive measurement of rapidly changing, global brain functional states. Using cluster analysis, momentary EEG field topographies can be sorted into few classes according to their different spatial configurations. While still explaining most of the variance, this classification reduces the data to a string of reoccurring, non-overlapping brain functional states, each showing a stable landscape for a short period of time (microstate). Statistics on classified microstates of spontaneous EEG thus describe the repertory of brain functional states used during the recording period. For each class of microstates, a mean duration, a mean number of occurrence per second and a mean spatial configuration is obtained. Under the assumption that schizophrenics differ in their repertory of brain functional states already during rest, we analyzed brain field data from 9 first-break, acute, neuroleptic-naive schizophrenic patients and from two groups of 9 matched controls during rest, using four classes of microstates. While during three classes of microstates (80% of the time) no group differences were observed, a forth class showed a significantly different mean spatial configuration and shorter duration in the patients, the duration of this deviant class was systematically shorter with more pronounced paranoid symptomatology. The deviant class occurred about 3 times per second and covered about ...

Treatment response prediction in psychiatric disorders: using quantitative EEG (QEEG). -Prichep, L.S.*^, John, E.R.*^, Chabot, R.*, Alper, K.* and Mas, F.* (*New York University Medical Center, Brain Research Laboratories, Dept. Psychiatry, New York, NY, USA; ^Nathan S. Kline Institute for Psychiatric Research, Orangeburg, NY, USA).

Distinctive profiles of quantitative EEG (QEEG) abnormalities have been reported in many psychiatric disorders. The sensitivity and specificity of QEEG features have been further demonstrated through the exploration of the electrophysiological heterogeneity within clinically homogeneous diagnostic categories. QEEG features were extracted from 2 minutes of eyes closed resting, artifact-free EEG recorded from 19 regions, referenced to linked ears. All features were Z transformed relative to age appropriate normative values. Only a selected subset of extracted features were submitted to the analysis. Using cluster analysis, subtypes were identified within several populations with DSM-III-R diagnoses including: Obsessive Compulsive Disorder (OCD), Attention Deficit Hyperactivity Disorder (ADHD), Cocaine Dependence, and Dementia. In each of these disorders, subtype membership was found to be significantly related to subsequent treatment outcome and/or evolution of the disorder. In most instances, subtype was independent of clinical/demographic features and uniquely related to the electrophysiological characteristics of the subtype. Knowledge of the pathophysiological profiles related to treatment responsiveness may have predictive value across of range of neuropsychiatric disorders.

Spatial patterns of EEG changes in dementia and their relation to disease severity. - Dierks, T.*, Jelic, V.^, Pascual-Marqui, R.D.#, Wahlund, L-O.^ and Maurer, K.* (*Clin. Neurophysiology, Dept. of Psychiatry I, Univ. of Frankfurt/Main; ^Alzheimer Research Center, Karolinska Institute, Sweden; #The KEY Institute for Brain-Mind Research, University Hospital of Psychiatry).

Many parameters of EEG like peak frequency, the amount of slow wave and alpha activity are abnormal and correlate with the severity of cognitive functions in Alzheimer Disease (AD). However, due to technical limitations conventional frequency analysis does not allow to

draw any conclusions about spatial pattern of brain physiology. We have quantified spatial EEG alterations in around 60 patients suffering from Alzheimer disease and cognitive impairment using a relative novel analysis method in the frequency domain (FFT-approximation). In AD patients, a shift of alpha- and beta-EEG generators towards frontal brain regions was observed. The amount of this shift correlated with the degree of dementia. The anteriorization of EEG-generators reflect the pathological spatial pattern of glucose metabolism in AD. A similar spatial pattern of EEG-alterations could be found in asymptomatic family members with genetic AD, suggesting that the spatial distribution of EEG may be used in early detection of AD.

A topography for anxiety? Distinct maps for different disorders. - Gerez, M., Tello, A., Nicolini, H. and Serrano, C. (Hospital Espanol de Mexico).

Background: Panic, phobic, obsessive-compulsive (OCD) and generalized anxiety (GAD) disorders constitute discrete diagnostic entities under current psychiatric classifications. Yet, comorbidity exists and some authors conceptualize them within a single framework. Purpose: To study anxiety disorders looking for 1) evidence of brain dysfunction, 2) neurophysiological heterogeneity, 3) clinical correlations. Methods: 192 unmedicated patients were grouped by DSMIV diagnosis. EEGs were classified as normal, diffusely abnormal, focal slowing/epileptiform. QEEGs were inspected for whole-head delta decreases, slow-band increases, or focal wide-band changes, P300 for abnormal latencies, amplitudes, or focal voltage changes. A focally abnormal record was defined by focal changes in at least two of the following: 1) epileptiform, 2) wide-band power, 3)P300 voltage. MANOVA was conducted. Findings: Epileptiform activity was highly prevalent (35%), and unrelated to group. Slowing and P300 latency abnormalities were infrequent (8%). Delta decrease was found in 64% of the GAD group and 54% of the OCD. Focally abnormal records were seen in 78% of the patients. Prevalence and location were differentially distributed across diagnostic groups: panic (85%) and GAD (35%) in temporoparietal areas, OCD (89%) in frontobasal areas predominantly right. Phobic showed less changes, inconsistently localized. Conclusions: These findings support the hypothesis of brain dysfunction in anxiety disorders. They also suggest distinct involvement of brain areas and physiopathogenesis for different types of anxiety disorders. Results will be discussed in relation to the anatomofunctional literature.

Symposium Two

Pharmaco-EEG

Low Resolution Electrical Tomographic Images of QEEG subtypes of psychiatric disorders with differential treatment responsiveness. - John, E.R.*^, Prichep, L.S,*^, di Michele, F.*# and Valdes-Sosa, P.~ (*Brain Research Laboratories, Dept. Psychiatry, New York University School of Medicine; ^Nathan S. Kline Institute for Psychiatric Research, Orangeburg, NY; #Department of Psychiatry, University of Rome, Tor Vergato, Rome, Italy; National Scientific Research Center of Cuba, Havana, Cuba).

In multiple international studies, the power spectrum of the EEG has been shown to be predictable and independent of ethnic background, changing systematically throughout the human life span. This pattern appears to be genetic, regulated by a complex homeostatic system mediated by many different neurotransmitters. In the current study we applied low Resolution Electrophysiological Tomography (LORETA) to selected data from subtypes of Obsessive Compulsive Disorder, Attention Deficit Disorder, Cocaine Dependence and Dementia patients with different outcomes of treatment or evolution of illness. LORETA enables a representation of the generators within the brain which most plausibly account for the QEEG results. The resolution of this distributed inverse solution is estimated to be a voxel about 8 mm or each dimension. An average MRI atlas was constructed from 300 normals at the Montreal Neurological Institute and the electrode locations defined for QEEG have been placed in spatial registration with that atlas. Thus, it is possible to display the inverse solutions obtained using LORETA on slices from the MRI atlas. Using this method, the pathophysiological functional neuroanatomical systems underlying subtypes with different treatment outcome ...

Smoking and the brain function: Combined ERP and PET studies. - Nagata, K., Yaguchi, K., Kanno, I. and Matsuoka, S. (Research Institute for Brain and Blood Vessels, Akita, Japan; School of Education, Akita University, Akita, Japan; Showa Hospital, Shimonoseki, Japan).

Combined event-related potential (ERP) and positron emission tomography (PET) studies were carried out before and after cigarette smoking in normal young volunteers during the continuous performance task (CPT) in which the subjects were requested to discriminate a single Hiragana. After the abstinence for more than 12 hours, the CPTs for the low-demand (LD) or high-demand (HD) paradigms were repeated 6 times. During

the CPT, cerebral blood flow (CBF) was measured repeatedly according to the H215O intravenous bolus injection method, and normalized CBF images were analyzed by the 3 dimensional statistical method. Based on 32-channel EEG data, ERPs were averaged and the results were subtracted between the baseline and smoking conditions. In the HD paradigms, the amplitude of the positive SEP components at 260-330 msec became greater after smoking as compared with the baseline, whereas there was no significant difference in the earlier components before 200 msec. When HD was compared with LD, the CBF increase in the anterior cingulate gyrus became smaller after smoking whereas CBF increased in the retrosplenial cortices including cuneus. The enhancement of the "P300" components after smoking may indicate an activation effect of nicotine.

Low-Resolution Electromagnetic Tomography (LORETA) after representative drugs of the main psychopharmacological classes. - Saletu, B.*, Anderer, P.* and Pascual-Marqui, R.D.^ (*Department of Psychiatry, University of Vienna, Austria; ^The KEY Institute for Brain-Mind Research, University Hospital of Psychiatry, Zurich, Switzerland).

In a double-blind, placebo-controlled study, EEGs were recorded in 20 normal subjects aged 23-34 years. They received at weekly intervals in random order single oral doses of placebo, the neuroleptic haloperidol (3mg), the antidepressant citalopram (20mg), the anxiolytic lorazepam (2mg) and the psychostimulant methylphenidate (20mg). A vigilance-controlled EEG was recorded from 19 EEG leads before and 1,2,4,6 and 8 hours after drug administration. For the classical frequency bands, electrical activity in the brain was localized by means of low-resolution electromagnetic tomography (LORETA) (Pascual-Marqui et al., International Journal of Psychophysiology, 1994, 18: 49-65), developed further according to realistic head geometry based on the Talairach brain atlas. Thereby the solution space was restricted to cortical gray matter, amygdala and hippocampus, which resulted in 2394 current density values. Statistical evaluation was based on exploratory t-values. Differences between drug and placebo within a Brodmann area (BA) were considered significant at a global p.05 if at least 50% of the t-values were significant at p.025 (Rueger procedure). Citalopram, for instance, most typically augmented beta sources, predominantly in the right hemisphere with maximal changes in the temporal (BA 20-22) and frontal lobe (BA 6); lorazepam reduced theta and alpha rather globally and increased beta locally in BA 6, an area involved in motor functions. Thus, ...

Frontal lobe - motor cortex disconnection syndromes of childhood, and the role of methylphenidate in ADHD. - Niedermeyer, E. (Sinai Hospital, Baltimore, Maryland, USA).

On the basis of earlier clinical - EEG studies, it has been assumed (Niedermeyer et al. 1997; Niedermeyer and Naidu 1997), that - during childhood and early adolescence - the motor cortex requires inhibitory influences emanating from the frontal lobe. This concept was first presented in view of the rare Rett syndrome with mental deficiency, hypermotility (typical wringing hand movements) and, in 30-40%, epileptic seizures. Massive spiking or theta rhythms over the central region are thought to represent motor cortex dyscontrol due to an insufficient (anatomically small) frontal lobe. In the course of adolescence, the frontomotor disconnection loses its significance and some improvement occurs. On a completely nonstructural-dysfunctional basis, frontomotor disconnection is also assumed to exist in ADHD (attention deficit hyperkinetic disorder) which is quite common (mainly in boys). EEG findings are insignificant; regional blood flow studies have shown decreased frontal lobe perfusion improving after methylphenidate, unfortunately interpreted as vascular disorder (Lou et al. 1984) rather than as secondary phenomenon. There is reason to presume that, in ADHD, the frontal lobe is not diseased but just "lazy" and in need of a stimulant which improves both inhibition of motor cortex and prefrontal selective attention. The methylphenidate effect is hence logical and not "paradoxical". In Rett syndrome, the frontal lobe is structurally impaired and hence unable to respond to methylphenidate. Cases of ADHD have to be "pure" and not marred by mistakes ...

Submitted Papers

Word emotional valence influences Steady State Visually Evoked Potential (SSVEP) amplitude and latency topography. - Silberstein, R.B.*, Robb, D.*, Stanley, R.^, Burrows, G.^ and Pipingas, A.* (*Brain Sciences Institute, Swinburne University of Technology, Melbourne; ^Department of Psychiatry, University of Melbourne, Melbourne).

We report for the first time, changes in SSVEP topography in the "Emotional Stroop" (ES) task where subjects identify the colour of words describing emotional states. Twenty-four right-handed female subjects viewed a series of words that were emotionally negative, positive, or neutral. The words were presented in one of five possible colours (red, green, blue, white, purple) and subjects verbally identified the word colour. Brain electrical activity was recorded from 64 scalp sites and digitized to 16-bit accuracy at 500Hz. EEG was band-pass filtered 0.5Hz-80Hz. The Steady State Visually Evoked Potential (SSVEP) was elicited by a 13Hz uniform visual flicker

superimposed over the visual fields. Subtracting the neutral word responses from happy and sad word responses revealed the SSVEP changes associated with the specified emotional valence. Following positive word presentation, there was a transient SSVEP amplitude reduction at right temporal sites. This effect was larger and extended to left prefrontal and left parietal sites for negative words. Positive words were associated with a transient right prefrontal SSVEP latency reduction of 10 msec while negative words yielded a transient right prefrontal SSVEP latency increase of 12 msec. These results point to differences in right temporal and right prefrontal processes that differentiate between positive and negative words.

EEG source reconstructions using fMRI constraints. - Wagner, M., Fuchs, M., Wischmann, H.-A., Theissen, A. and St. Willemsen (Philips Research, Hamburg, Germany).

The combination of functional MRI with EEG source reconstruction promises to yield both high spatial and temporal resolution. However, several problematic constellations may occur: EEG sources that do not show up in the fMRI images; fMRI hotspots without a corresponding EEG source; and a slight displacement between fMRI hotspot and source location. To overcome these problems for a multiple equivalent current dipole source model, dipoles are loosely fixed to the fMRI hotspots. This is achieved by using the hotspots as seeds and keeping the dipole locations within a maximum distance from the seedpoints. Dipole components, timecourses, and exact locations are fitted. In addition, an unconstrained dipole is fitted to account for EEG data unexplained by the fMRI activity. For distributed source models, source locations and normals are constrained to the cortical sheet segmented from anatomical MRI. A current density reconstruction is performed. In addition to depth resp. lead field normalization, source locations are weighted according to their fMRI-induced significances. Different weighting functions may be used, e.g., derived from thresholded and dilated fMRI hotspots, or continuous functions of the fMRI maps themselves. Locations without hotspots are downweighted by a factor of not more than three, else current sources that do not show up in the fMRI images cannot be reconstructed. The performance of the proposed methods is demonstrated.

Retest reliability of 3D-LORETA estimates of neural generators of classical frequency bands and changes after 5HT1A-agonists (alnespirone and buspirone) - Anderer, P.*, Saletu, B.* and Pascual-Marqui, R.D.^ (*Department of Psychiatry, University of Vienna, Austria; ^The KEY Institute for Brain-Mind Research, University Hospital of Psychiatry, Zurich, Switzerland).

Electrical activities in the brain, corresponding to delta (1.5-6Hz), theta (6-8Hz), alpha-1 (8-10Hz), alpha-2 (10-12Hz), beta-1 (12-18Hz), beta-2 (18-21Hz) and beta-3 (21-30Hz) power of the vigilance-controlled EEG (eyes closed), were estimated by means of low-resolution electromagnetic tomography (LORETA) (Pascual-Marqui et al. Int. J. Psychophysiol. 1994). In the new implementation developed by Pascual-Marqui, LORETA is based on a realistic head geometry and solution space is restricted to the cortical gray matter and hippocampus, resulting in 2394 current density values. For data reduction, LORETA values were averaged within Brodmann areas (BA), amygdala and hippocampus. LORETA was applied to 19-channel EEG data, recorded in a double-blind, placebo-controlled study. Twenty young healthy subjects received randomized in weekly intervals single oral doses of placebo, 1.5, 10 and 20 mg alnespirone, a novel selective 5HT1A-agonist, and 20 mg buspirone as reference drug. Retest reliability between pre-drug recordings was similar for LORETA and for EEG-mapping values (e.g., alpha power: .61-.87 in different BA; .75-.88 at different electrodes). At the pharmacodynamic peak time (1st hour), alnespirone and buspirone increased theta sources most pronouncedly in BA 37 (fusiform gyrus), and decreased beta sources most pronounced in BA 10 (superior frontal gyrus). While the theta increase ...

Event-related synchronization in Parkinson's disease. - Diez, J., Ortmayr, B., Pichler-Zalaudek, K., Pfurtscheller, G. and Reisecker, F. (Krankenhaus der Barmherzigen-Brder, Department of Neurology, Graz, Austria; Department of Medical Informatics, Institute of Biomedical Engineering, University of Technology, Graz, Austria).

To study dysfunctions of the cerebral motor system, such as Parkinson's disease (PD), bioelectrical potentials associated with the activation of motor areas are of special interest. The aim of this study was to research differences in the EEG between PD patients and healthy subjects with respect to the post-movement beta event-related synchronization (ERS), which is supposed to be an appropriate additional measure in order to investigate motor dysfunctions. ERS after self-paced, voluntary brisk movement of the right and left thumb was studied in 17 patients with PD and 17 age-matched control subjects. The movement-offset triggered EEG data were analyzed in the 12-16 Hz, 16-20 Hz and 20-24 Hz bands for 8 time intervals after termination of movement. Significant results were observed in all three frequency bands, indicating notable group differences concerning the magnitude of post-movement beta synchronization with a strongly remarkably smaller beta ERS in PD patients. This was found as a significant overall main effect for the groups as well as in interactions concerning side of movement

and electrode positions. When the beta ERS is explained as a measure of the recovery of the primary motor area after the termination of movement, our results indicate a dysfunction or impairment of the motor area in the ability to recover in patients with PD.

Symposium Three

EEG Generators and Brain Anatomy

How the topology of brain areas affects the characteristics of locally generated field potentials (EPs, EEG). - Lopes da Silva, F.H. (Institute of Neurobiology, University of Amsterdam, Institute of Epilepsy Meer en Bosch, Heemstede, The Netherlands).

To understand how field potentials are generated and how their characteristics can be interpreted it is useful to construct models of the populations of neurons properly activated by adequate synaptic inputs. Using these models the forward problem can be solved, i.e., how a given neuronal population causes a specific field potential distribution, in contrast with the inverse problem, of how to estimate the neuronal sources given a field distribution. With a forward model, where one simulates the geometry of the neuronal components and the corresponding synaptic activation functions, it is possible to compute the resulting field potentials, or magnetic fields, at different sites in the surrounding volume conductor. In such models the topology of the cortical layers may be constructed according to realistic anatomical constraints. Several configurations of dipole layers result in a range of different distributions of field potentials from typical closed fields to several configurations of open fields. The specific properties of these fields measured within the concavity, such as within a cortical fissure, or from the surface of the convexity of a dipole layer, such as from the crown of a gyrus, can be studied in this way. The biophysical properties of these different configurations can be studied by explicit models with characteristic topology as developed in our group by van Rotterdam ...

Functional mapping of eloquent cortex prior to Neurosurgery - do inverse solutions of single equivalent dipoles work? - Harding, G. and Furlong, P. (Clinical Neurophysiology Unit, Aston University, UK).

Magnetoencephalography (MEG) offers the opportunity to map the functions of the cortex on a millisecond to millisecond basis. Of all the imaging techniques only electroencephalography (EEG) has similar temporal resolutions. However it is thought that MEG has greater spatial accuracy than EEG and requires simpler assumptions with regard to the head models. We have carried out pre-surgical assessment on 13 patients undergoing neurosurgery at Frenchay Hospital, Bristol, England. For 12 of the patients' assessment of somatosensory and motor locations were required. All patients underwent assessment using a 20 channel 2nd order gradiometer MEG system within a magnetically shielded room. A bite bar was used for head restraint during evoked potential acquisition and also during M.R.I. investigation to allow accurate co-registration (Singh et al. 1997). All patients subsequently underwent neurosurgery utilising the ISG wand system this providing accurate feedback of M.R.I. location at surgery. In one patient's location of visual cortex centres VI & V5 were required. Localisation was determined pre-operatively using an inverse solution of single equivalent dipole with Monte Carlo analysis providing a 95% probability ellipse. In all 12 patients requiring somatosensory/motor location accurate prediction of the central sulcus (confirmed at surgery) was obtained even when unilateral abnormalities required transition of Talairach co-ordinates from the other hemisphere. M.R.I. anatomical location produced locational errors in 20% of the patients. Electrocorticography of motion VEPs confirmed the accuracy of pre-surgical MEG location of area V5 in one patient.

Importance of dipole orientation in the evaluation of focal epilepsy. - Ebersole, J.S. (Yale University School of Medicine New Haven, CT).

Although equivalent current dipoles are a simplistic model of epileptogenic brain sources, they can provide important clinical information that is not easily obtained by traditional inspection of EEG traces. Proper interpretation of dipoles does require an appreciation of the effects of modeling assumptions. A number of factors contribute to dipole location inaccuracies, including source area, synchrony and propagation, and the head model. Dipole orientation is more robust and can often differentiate sublobar sources in brain regions with more complex cortical geometry, such as the temporal lobe. The orientation of dipoles also differentiates sources on the cortical convexity (principally radial orientation) from sources at the brain base or in major fissures (principally tangential). Without dipole modeling (and its precursor, voltage topography) basal or fissural sources can be difficult to identify because field maxima do not overlie the generator region. This can lead to false localization and even false lateralization with standard EEG review. In summary, dipole modeling is a useful technique for localizing and characterizing spike and seizure foci, however, dipole orientation must be taken into consideration in order to interpret the model correctly.

Different epileptogenicity in gyral & fissural sources - Wong, P. (Dept. of Paediatrics, UBC, Vancouver, Canada).

There is evidence to suggest that epileptic generators have different characteristics dependent upon their location within the cortical layer. That is, the epileptogenicity of a focus is different whether it is located on the gyrus or within the fissure. The evidence to support this is from a study done on central-temporal spikes in children (Gregory and Wong, Epilepsia, 1992, 3(1): 36-44). From 4900 consecutive children, 366 age-matched cohorts were identified, 99 of whom had a tangential dipolar spike field, while 267 had non-tangential-dipolar field, i.e., a predominantly radial field. The tangential group was found to have fewer seizures than the radial group (p001). As well, other clinical parameters were more benign in this group (p001): lower incidence of developmental delay, higher intelligence or school performance, lower incidence of neurological deficits. The question was why the tangential group would have lower frequency of seizures: conversely, why spike topography would affect seizures. If the reasonable assumption is made that a radial source originates from the (exposed) crown of the gyrus, and a tangential source originates from the wall of the fissure, then our data suggest exposed gyrus is more epileptic than fissural wall. Other observations including cortical mapping for speech control, evoked potentials, direct optical reflectometry from cortical surface, as well as sensory-motor organization (homunculus) etc. all suggest topographic organization of cortical function being adequately and continuously represented on the cortical surface alone. As the cortical ...

Special Lecture

Working memory, intelligence, and three brain signals. - Gevins, A. (EEG Systems Laboratory and SAM Technology, San Francisco, CA, 94105).

Current theories of cognition prescribe a close relationship between working memory ability and general intelligence. In recent high-resolution EEG studies, we found that increasing working memory load in an n-back style working memory task affects a variety of EEG spectral features (Gevins, Smith, McEvoy and Yu, Cerebral Cortex, 1997, 7: 374-385) and evoked potential components (Gevins, Smith, et al., Electroencephalogr. Clin. Neurophysiol., 1996, 98: 327-348). To test the hypothesis that these neural signals of working memory relate to general intelligence, sixty young adults with average to superior scores on a standard intelligence test (WAIS-R) performed working memory tasks concurrent with EEG recordings. Reaction times were negatively correlated with test scores. The amplitude and reactivity of an EEG spectral feature in the theta band from frontomesial cortex were positively correlated with test scores, as were signals in the lower portion of the alpha band. The peak latency of the P3 evoked potential associated with stimulus categorization was negatively correlated with test scores, with a weaker positive relation between P3 amplitude and test scores. Combinations of working memory task behavioral and neuroelectric variables predicted intelligence test scores with a high degree of accuracy (multiple r = .82). These results indicate a close relationship between general intelligence and the neural mechanisms of sustained, controlled attention used to maintain representations in working memory.

Symposium Four

Music and the Brain

Music and the brain: Evidences from PET and EEG studies of normal subjects. - Nagata, K., Yoshida, T. and Matsuoka, S. (Research Institute for Brain and Blood Vessels, Akita, Japan; National Institute of Bioscience and Human Technology, Tsukuba, Japan; Showa Hospital, Shimonoseki, Japan).

Although music does not directly serve biological function, a certain functional organization of brain structures has been suggested for the perceptive and/or expressive musical function based on the evidences from patients with brain lesions. To elucidate the perceptive musical function in normal subjects, positron emission tomography (PET) and quantitative EEG were used in the activation studies music stimulation. By using PET, cerebral blood flow (CBF) was measured in normal volunteers during verbal and non-verbal auditory stimulation. The narration of Sherlock Holmes story was presented binaurally as a verbal stimulus, while Mozart's Horn Quintet was given binaurally as a non-verbal stimulus. White noise was given during the baseline condition. During verbal stimuli, CBF increased in both temporal lobes (transverse and supratemporal gyri) with a left-side dominant fashion, whereas more symmetrical activation was observed in the transverse gyri for the non-verbal music stimulation. In the analysis of background EEG activity, the 1/f function of the alpha rhythm was compared in normal volunteers during listening to the various kinds of music. There was an increase of 1/f function when listening to the music including classic music, whereas no significant change was seen in the 1/f function when listening to rock music.

Effects of musical training and gender on adolescent P300. - Coburn, K., Jocoy, E., Arruda, J., Estes, K. and Yagi, Y. (Mercer University School of Medicine, Macon, GA, USA).

Problem: The empirically measured musical ability of musically trained males has been reported to decrease

significantly during adolescence. This decrease is not seen among musically trained females or among musically untrained individuals of either gender. Methods: To study possible neural underpinnings of this phenomenon, auditory P300's were recorded from musically trained and untrained adolescent males and females performing oddball (pitch discrimination) and missing stimulus (rhythm discrimination) tasks. Results: P300 latency showed significant effects of task (longer latencies in missing stimulus task), musical training (longer latencies with musical training), and a task x training interaction (longer latencies in missing stimulus task, especially with musical training). P300 amplitude showed significant effects of task (larger P300's in oddball task) and musical training (larger P300's with musical training), and a training x gender interaction (especially among females). Conclusions: Musically trained adolescent males failed to show any evidence of P300 amplitude enhancement compared to their untrained cohorts, though musically trained adolescent females showed the effect clearly. The absence of P300 amplitude enhancement among musically trained adolescent males may correspond to their diminished ability to benefit from formal musical training that has been reported by others.

Comparative EEG mapping story: Saint Exupery versus Beethoven. - Etevenon, P. (Labortatoire de cartographie EEG INSERM U320 Caen, France).

Successive 2.56s epochs of EEG recordings and mappings during verbal and musical auditory stimulations have been obtained. We recorded 16 students in psychology, females, right handed, high alpha subjects, during rest, hearing a phrase from Saint Exupery and, after that, the beginning of the larghetto movement of concerto in D major of Beethoven. Recordings of 19 EEG channels (10/20 system, linked ears reference) together with polygraphy (EOGs, EMG) and sound tracks were sampled and quantified after artifact rejection based on neural network. These data were analyzed by FFT spectral analysis and EEG mappings were computed. Dynamic sequences were recorded on CDROM for multimedia display of examples of results of one subject. Averaged results of a sub-group of 6 subjects were statistically compared after spectral analysis by Fisher's exact probability tests. Functional activations during verbal stimulation were observed when compared to musical stimulation. Lower spectral amplitude densities (in microvolts/Hz) were statistically significant (p.05) in alpha (Fp2, Fz, Cz, P4) alpha1 (Fz, Cz, Pz, F4), beta 1 (Cz), beta (Cz, P4) and all over the scalp on theta frequency band (except Fp1, Fp2). Comparisons with previous ERD and AM-EEG results obtained with the same group of subjects will reveal advantages and inconveniences of increasing time resolution.

Submitted Papers

Magnetoencephalography

Attention selectively synchronizes neural responses to competing visual stimuli. - Srinivasan, R., Russell, D.P., Edelman, G.M. and Tononi, G. (The Neurosciences Institute).

Selective attention is manifested as the capacity to focus a "spotlight" on a spatial location or feature of a visual scene. In order to investigate neural correlates of selective attention among competing visual stimuli, we "frequency-tagged" a vertical grating and a horizontal grating by flickering each grating at a distinct frequency. At random intervals (2.5 sec), the thickness of the central bars of both gratings independently increase or decrease for 3000 ms. The subjects were instructed to attend to one or the other grating and indicate the direction of change of thickness with a keypress. On other trials, the subjects attended to both stimuli, and indicated whether the thickness change of the two gratings was the same or different. The steady-state magnetic field was recorded during the trials with a 148 sensor whole-head magnetometer. Power was detected at both flicker frequencies over occipital, temporal and frontal cortex. When attending to one of the gratings, the power at the attended frequency increased while the power at the unattended frequency decreased. The phase coherence of the MEG signals with the attended stimulus was selectively enhanced at the flicker frequency. When attending to both stimuli, the phase coherence of the MEG increased at different sensors for each stimulus. The results suggest that attention selectively enhances the synchronization of distinct populations of neurons that respond to each of the competing visual stimuli.

P300 and M300; response changes with probability of infrequent stimuli. - Boeijinga, P.H., Soufflet, L., Liogier d'Ardhuy, X., Toussaint, M. and Macher, J-P. (FORENAP, Research Institute in Neuroscience, Neuropharmacology and Psychiatry, Centre Hospitalier, 68250 Rouffach, France).

Counting infrequent acoustic stimuli among repetitive standard tones evokes a P300 scalp potential. We investigated whether the magnetic component of the intracerebral sources can be detected and localised. MEG and EEG responses were recorded in 10 healthy volunteers in an auditory oddball paradigm using a whole head magnetometer (Magnes, BTI, San Diego, USA) and 3 scalp-electrodes. Tone-bursts of 2000 Hz were presented randomly, with variable occurrences of 15, 30 or 40%, in a sequence of standard (500 Hz) tones. The subjects were asked to count silently the infrequent stim-

uli. Averaged sensor-signals equivalent to 28 locations issued from the international 10-20 system were projected on a 2-D plane and subjected to statistical analysis. P300 response-amplitudes (between 300-350 ms) were reduced by about 16% with increasing probability. MEG responses can be characterized by transient deflections between 70-130 ms, followed by sustained fields between 200-600 ms with maximal values on the decaying phase of the P300; its topographic distribution shows negative left and positive right, possibly coming from structures underneath lateral parietal or temporo-central cortical regions. The left negativity was significantly reduced for the 40% condition, compared to that at 15%. The results indicate that changes in mental activity related to differences in expectancy of infrequent events are clearly reflected in the evoked magnetic responses.

Symposium Five

Vision and the Brain

Learning to see stereograms: Electrophysiology and psychophysics. - Skrandies, W., Jedynak, A. and Meyer, M. (Physiological Institute, Justus-Liebig University, 35392 Giessen, Germany).

As we know from our previous studies, the repeated presentation of visual stimuli can be followed by lowered perceptual thresholds. We investigated this kind of perceptual learning with stereoscopic stimuli presented near threshold in a combination of psychophysical and electrophysiological experiments. Different visual patterns were presented as dynamic random dot stereograms (dRDS) in a forced-choice design in order to determine the thresholds of 16 young normal adults. In addition, steady state VEPs were recorded from a dense array of 30 electrodes over the occipital areas. In the first half of the experiment the disparity of the dRDS was below threshold and changed with 6.7 Hz. In the second half of the experiment the stimuli were above threshold. A final psychophysical threshold determination proved that perceptual learning had occurred. In more than half of the subjects the thresholds decreased within 30 minutes of stimulation. In these subjects the center of gravity of the topographical distribution of evoked activity showed a significant shift towards the right hemisphere. The other subjects did not show any topographic effects. In summary, we can show that in most of the subjects a decrease of the threshold of dRDS perception occurs within a short time of stimulus presentation accompanied by changes in the pattern of activation of neural elements in the human visual cortex.

Visual evoked potentials and fields: Clinical applications. - Harding, G. (Clinical Neurophysiology Unit, Aston University, UK).

Electrophysiological studies of the visual system allow identification of both ongoing potentials such as the Electrooculogram (EOG) and electroencephalogram (EEG), as well as responses evoked by light flashes or pattern changes; electroretinogram (ERG), visual evoked subcortical potential (VESP) and visual evoked potential (VEP). These potentials have allowed us to study each level of the visual system, either in isolation or as a combined and integrated study of the entire visual system's response to stimuli. This latter capability has often proved critical in disease or infancy to identify the site of the lesion. Recently developments such as the pattern ERG and the multifocal ERG (or VERIS system) have allowed more detailed studies of both function and topography of the retina in both normal subjects and patients. The vast studies of the visual evoked potentials of the 70's and 80's continue but are now joined by the source localisation power of magnetoencephalography (MEG) in studies of the visual cortex. The VESP, first reported by ourselves and Cracco at the beginning of the 80's is now, in general, accepted as being of subcortical origin but remains difficult to record, so relatively few studies have been performed to utilize its ability to reflect activity at lateral geniculate level.

Symposium Six

Standards for Brain Electrophysiology

Standards for EEG, QEEG, and Evoked Potentials. - Duffy, F. (Children's Hospital, Harvard Medical School Boston University).

Progress in the application of scalp derived electrical signals to clinical and research issues demands pooling, not only of scientific expertise, but also muticenter data. Standing in the way of this are the multiple potential incompatibilities that arise from the many options that present themselves to each investigator as data are collected and analytically processed. The development of an international data collection standard for preliminary analysis is overdue. The problems and suggested solutions will be presented.

Standards for pharmaco-EEG. - Saletu, B. (Department of Psychiatry, University of Vienna, Austria).

Pharmaco-EEG involves the description and quantitative analysis of effects of substances on the central nervous system (CNS) by electroencephalography (EEG) and related electrophysiological methods (e.g., ERP, sleep). Typical questions include if, how, when and in which dose a substance acts on the target organ - the

human brain. Trials may be carried out in phase I in healthy volunteers and in phase II-IV in patients. In order to distinguish between drug-effects and phenomena caused by mere random variation, a careful planning of the design, recording procedure and analysis of the study is necessary, as described by several IPEG (International Pharmaco-EEG Group) guidelines. Design and planning issues concern the description of the study subjects and patients (inclusion/exclusion criteria), goals of the study (e.g., efficacy/safety), data sources (times, locations, variables), study design (parallel group, cross-over etc.), multiplicity problems (times, locations, variables, treatments), statistical analysis (confirmatory, descriptive, exploratory), sample size determination, methods to avoid bias (blinding and randomisation). As many factors may affect CNS function, environmental, situational and personal variables have to be considered and documented. Within the latter the medical status (state of health, history of prior illnesses, use of drugs, sleep/wake cycle) plays an enormous role. A medication-free baseline condition is needed (e.g., wash-out period of at least 5 times the half-life of the last psychoactive compound used). Analysis issues such as sample distribution, problems of multiplicity, missing values and protocol violations must be included in the final report.

Standards for dipole localization and alternative approaches. - Lopes da Silva, F.H.*^, Ossenblok, P.#, Pijn, J.P.^, Velis, D.^ and Fuchs, M.~ (*Institute of Neurobiology, University of Amsterdam; ^Institute of Epilepsy Meer en Bosch, Heemstede; #Epilepsy Center Kempenhaeghe, Heeze, The Netherlands; ~Philips Research Laboratory, Hamburg, Germany).

The sources of electrical or magnetic activity, recorded at the scalp, are commonly represented by equivalent current dipoles (EDs). This is an abstraction, since the real brain sources never consist of simple current dipoles. In the simplest cases they may form dipole layers. The possibility of estimating EDs holds only for brain sources that are rather simple and involve relatively small cortical areas. Examples of these sources are some early components of evoked potentials (EPs) and the initial transient deflections of epileptiform spikes. In practice such sources can only be estimated with suficient accuracy in those cases where rather regular dipolar-like scalp maps are recorded. However, a common problem encountered in EEG/MEG analysis of brain sources is that the latter may involve a number of cortical areas not necessarily contiguous, i.e., multiple cortical areas may be active at overlapping time epochs. Examples of these are the late components both of EPs and of epileptiform spike-wave complexes, and, in general, event-related potentials. An analysis of these cases has to go beyond the computation of simple EDs and it must apply alternative methods to estimate the sources distributed over the cortex. This can be done using linear estimation methods applying ...

Symposium Seven

New Technology

Frequency domain VARETA for the localization of EEG sources during attentional tasks. - Harmony, T.*, Fernández, T.^, Bosch, J.#, Silva, J.*, Aubert, E.# and Galán, L.# (* Center of Neurobiology and ^ENEP Iztacala of the National Autonomous University of Mexico; #Cuban Center of Neurosciences).

In this study we look for differences between EEG sources computed from EEG segments recorded during different attentional conditions. Narrow band frequency analysis of the EEG segments a) previous to the presentation of the stimuli and b) during the task, were performed for two conditions: 1) Task: a difficult mental calculation operation was visually presented, and 2) Control condition: the stimuli have the same physical characteristics as the arithmetical symbols, but the subjects had nothing to do. These two conditions were presented in random order. Ten subjects were recorded. The sources for each 0.39 Hz were calculated using frequency domain Variable Resolution Electromagnetic Tomography (VARETA). Sources were projected onto the Average Brain provided by Montreal Neurological Institute. Repeated measurement ANOVAs for 3 factors (pre or post EEG segment, condition and the interaction) were computed for each pixel. Significant differences were observed between EEG segments and condition. The interaction was very significant at 1.56, 2.34, 3.12, 4.68 and 5.46 Hz. These differences were located in frontopolar regions and in the left hemisphere in frontotemporal, Sylvian, temporo-occipital and angular gyrus respectively. These areas correspond to those that may be activated during verbal tasks. This is in agreement with what may be expected during mental calculation.

Estimating regional neural activity with the Expectation-Maximization algorithm. - Kiyuna, T., Kamijo, K. and Yamazaki, T. (C&C Media Research Laboratories, NEC Corporation).

A new method of estimating regional neural activity is proposed and investigated using computer simulations. The method estimates probabilities assigned to divided regions within which neural activity is located. The estimation is conducted by estimating a mixture of probability density function (MPDF). The MPDF is defined as the product of regional probabilities of neural activity and Gauss' error function which is calculated by solving the inverse problems at each region. Because the

regional probabilities are not directly observable, we employed an algorithm called the Expectation-Maximization (EM) algorithm to estimate them. The algorithm consists of two steps: (1) Calculate the MPDF by solving the inverse problems at each region (Expectation step, or E-step). (2) Update regional probability using Bayes' formula (Maximization step, or M-step). Finally, the MPDF is maximized by repeating these steps. Computer simulations using a three-layered (the brain, skull, and scalp) realistic head model showed that during the EM sequence, two peaks were found in the probability distribution corresponding to two neural activity regions modeled by discrete multiple dipoles. On the other hand, the conventional least-squares method can not find two dipoles because the estimated parameters are completely disturbed by noise (20% of Gaussian noise was added to the data in both simulations). These results indicate that the proposed method has noise-robustness and can provide clear source images using the probabilistic representation of neural activities.

Topographic study of sleep spindles and SWA by Matching Pursuit - Zygierewicz, J.*, Blinowska, K.J.*, Durka, P.J.*, Szelenberger, W.^ and Niemcewicz, S.^ (*Warsaw University; ^Warsaw Medical Academy, Warsaw, Poland).

Transient EEG structures elude the typical methods of stationary signals analysis. Matching Pursuit offers high resolution time-frequency description of transient and long-lasting EEG components in one framework. The method relies on decomposition of signals into basic waveforms chosen from a large and redundant dictionary. Waveforms are fitted to the signal in an iterative procedure starting with the function, which accounts for the highest rate of the signal energy. We have applied MP decomposition to the 21 - channel whole night sleep EEGs of 6 normal subjects and 6 patients with insomnia. As a result of the decomposition procedures all signal structures were parameterized in terms of frequency, time occurrence, time span and amplitude. Desired structures were selected by setting the parameters ranges according to accepted definitions. Then for each derivation different kinds of statistics and distributions were constructed e.g. amplitude of spindles as a function of frequency, histograms of frequencies, time evolution of spindles and SWA amplitudes etc. We have tested the relationship between SWA and spindles and hypothesis of two topographically different spindles generators, not only on the basis of the average spectral properties of the structures, but taking into account coincidences in their time occurrence in different derivations and their time-frequency characteristics. The method allows for separation superimposed spindles by accounting for their spectral and topographical differences. Statistically significant differences between studied groups were found.

Automatic registration of MR-images with digitized head contours. - St. Willemsen, Fuchs, M., Wagner, M., Wischmann, H.-A. and Theissen, A. (Philips Research, Hamburg, Germany).

An important aspect of multi-modal neuroimaging is the localization of EEG/MEG sources in relation to anatomical structures extracted from MR-images. Therefore the accuracy of source localization depends on the quality of matching the different coordinate systems. Whereas most common methods use anatomical landmarks our method works without any predetermined markers or a priori knowledge. Instead the unknown parameters of the coordinate transformation are determined by fitting the head contour obtained by scanning the subject with a 3D-digitizer to the skin surface segmented from MR-images. During the fit the overall distance between these contour points and the surface is minimized using a downhill Simplex algorithm. The lack of given point correspondences and the almost symmetric shape of the head lead to some difficulties: Determining the minimum distance between the contour points and the surface; and the existence of multiple local minima where the optimization algorithm may be trapped. The first problem is solved by using a distance map containing the minimum distance to the surface for each image voxel. To overcome the more difficult second problem an initial guess for the minimization parameters is estimated from a coarse exhaustive search over the rotation angles regarding a subset of the digitized points. Furthermore a decoupling of rotation and translation parameters is applied. The performance of this automatic procedure is demonstrated with different datasets.

Posters

Brain Fields in Psychiatry

Electrophysiology of visual data processing in schizophrenia - Basinska, A. (Medical University of Warsaw, Poland).

Visual potentials evoked during Continuous Attention Task (CAT) were examined in 50 schizophrenic patients and 50 healthy volunteers. Adaptive segmentation revealed six microstates following either non-target or correctly detected target stimulus. For non-target condition the patients, compared to healthy subjects, revealed lower amplitude of posterior potentials: a positive left-sided and a negative bilateral in segment I (49-138ms) and II (138-224ms), respectively, and of a positive central potential in segment V (350-472ms). The latter feature, as well as delayed microstates III-V (224-472ms), correlated

with CAT errors. Global field power (GFP) in patients was significantly lower in segments I-II and V in non-target condition, but significantly increased after target stimulus, while in healthy subjects GFP increased only in segment VI (398-676ms). In patients an increase of GFP after target (repeated) stimulus in segment II correlated with CAT errors. Detection of target in healthy subjects involved a shift of positive potential in segments IV-V (268-398) from central towards prefrontal area, while in patients positive potential persisted in central area and additionally emerged in frontal but not in prefrontal location. Those data confirm hypotheses related to schizophrenia: either of hyperarousability on the automatic level or diminished activity in prefrontal regions during conscious phase of processing. However, an increase of GFP and more posterior location of positive centroid in segment V during target detection in patients correlated with shorter reaction time, which suggests coexistence of compensatory features resulting from engagement of...

Brain function differences between relapsing and abstaining alcohol-dependent patients, visualized by EEG-mapping and tomography. - Saletu-Zyhlarz, G.M.*, Saletu, B.*, Lesch, O.M.*, Walter, H.*, Oberndorfer, S.*, Anderer, P.*, Pascual-Marqui, R.D.^ and Boening, J.# (*Department of Psychiatry, University of Vienna, Austria; ^The KEY Institute for Brain-Mind Research, University Hospital of Psychiatry, Zurich, Switzerland; #Department of Psychiatry, University of Wuerzburg, Germany).

The aim of the present study was to compare EEG maps of drug-free, detoxified alcoholics with those of normal controls and to describe differences between patients relapsing or abstaining during 6 months of relapse prevention therapy pharmacologically supported either by flupentixol decanoate 10 mg or by placebo i.m. every two weeks. Methods: 22 detoxified, drug-free patients (15 males, 7 females) aged 41.5 ± 8.1 years, diagnosed as alcohol-dependent (DSM III-R: 303.9; ICD-10: F 10.23) were included in the study and matched with normal healthy controls. Abstaining patients (n: 12, 9 m, 3 f, age: 39.1 ± 7.6 years) were matched likewise (39.3 ± 8.5 years) as were relapsing patients (n: 10; 6 m, 4 f, age: 44.3 ± 8.0 years; controls: 44.2 ± 7.8 years). A 3-minute vigilance-controlled EEG was obtained and analyzed off-line utilizing EEG mapping and LORETA. Results: Detoxified, drug-free alcohol-dependent patients showed, as compared with controls, aberrant brain function characterized by a decrease of delta and slow alpha and an increase of beta activity as well as an acceleration of the total centroid. Most likely these changes reflect a hyperarousal of the central ...

Child Psychiatry, Development

EEG coherence in Attention-deficit Hyperactivity Disordered and normal children. - Murias, M.*, Swanson, J.* and Srinivasan, R.^ (*Child Development Center, University of California, Irvine; ^The Neurosciences Institute, San Diego, CA).

Attention-deficit Hyperactivity Disorder (ADHD) is a childhood psychiatric disease affecting between 3-8% of school-aged children. Previous research has demonstrated cortical (including frontal lobe) and sub-cortical (including basal ganglia) abnormalities associated with dopamine transmission pathways in ADHD populations. We investigated whether these abnormalities result in changes in the synchronization of EEG. The spatial structure of the alpha rhythm in a group of refined phenotype (ICD-10) attention deficit disordered children aged 9-11 was examined with dense electrode arrays and compared to age, gender, IQ and socio-economic status matched controls. EEG recordings from 128 channels were used to determine whether spatial properties of the alpha rhythm are demonstrably different in the patients vs. normal controls. Measurements of coherence between frontal and occipital sites of each hemisphere were used to measure the correlation resulting from long-range cortico-cortical fibers oriented along the anterior-posterior direction in each hemisphere. Comparisons with adults have suggested that these coherences increase in late childhood, and are associated with the emergence of reciprocal (feedback) connections from anterior to posterior brain areas. These feedback projections are believe to functionally modulated by the activity of the dopaminergic system. The results suggest that the abnormalities of the dopamine transmission pathways in ADHD populations influence the development of functional interactions between frontal and sensory cortices.

Auditory Evoked Fields in fetal and neonatal magnetoencephalography - Investigations into maturation of cortical neuronal function. - Olbertz, D.*, Wagner, K.*, Schleussner, E.^, Schneider, U.^, Huonker, R.#, Michels, W.^, Scheidt, B.*, Schramm, D.* and Seewald, H.-J.^ (Friedrich Schiller University of Jena, Germany; *Dept. of Neonatology, Jussuf Ibrahim Children's Hospital; ^Dept.of Gynecology and Obstetrics; #Biomagnetic Centre).

The most sensitive period for brain development and maturation begins at midpregnancy and continues until the first month of live. Auditory stimulation activates neurons along the auditory pathway and the cortex. The latency of auditory evoked response represent the maturity of neuronal functions. Magnetoencephalography is the only non-invasive method to detect such func-

tional maturation processes. Great methodical problems exist in the registration of the very weak fetal biomagnetic fields. In this study we registrated auditory evoked magnetic fields (AEF) of the fetus in the third trimenon of gestation and preterm delivered neonates of the same age of conception (CA). During neonatal or fetal sleep phase we applicated 500 acoustic signals (1000 Hz, 100 dB, 50 ms, interstimulus interval 1 sec) on the neonatal head respectively maternal wall directly above the fetal head. AEFs were recorded over the contralateral hemisphere in a magnetic shielded room using a 31-channel-SQUID-magnetometer (Philips). After signal processing (average and principle component analyses) we could registrate cortical AEFs from fetuses (CA 35 weeks) or preterm babies in the same CA. The latency of the AEF decreased from 260 ms to nearly ...

Cognition and Emotion

The effects of divided and focused attention on the evoked and emitted auditory P300 - Arruda, J.E.*^#, Jocoy, E.L.*, Estes, K.M.*, Yagi, Y.*^ and Coburn, K.L.*^ (*Brain Research Center, Medical Center of Central Georgia; ^Mercer University College of Liberal Arts; #Mercer University School of Medicine, Macon, GA, USA).

The purpose of the present investigation was to examine the relationship between the evoked and the emitted auditory P300 under conditions of divided and focused attention. Eleven right handed participants (6 male and 5 female) who reported being free of any neurological or psychiatric illness performed both an auditory oddball task and a missing stimulus task under conditions of divided and focused attention. In the divided attention condition, participants were required to simultaneously perform the Sternberg visual memory task. The task required participants to correctly identify those "probe" images that had been presented previously. Participants in the focused attention condition were asked to passively view all images, without making a response. Despite finding differences in the anterior-posterior distribution of the waveforms, the results of this study suggest that the evoked and the emitted auditory P300 are manifestations of the same underlying neuronal processes. Although systematically smaller, the emitted P300 amplitudes, like their evoked counterparts, were greatly reduced by increased task difficulty. The anterior distribution of the evoked P300 waveform may be due to the presence of a frontal P300a component reflecting the attentional capture by the rare auditory targets during the active visual task.

Cognitive event related potentials during a learning task. - EL-Bab, M.F. and Sedgwick, E.M. (Clinical neurological sciences, University of Southampton, UK).

Event related potentials were recorded 34 subjects (age 21-34 yr., 19 male and 15 female) who were trying to differentiate 200 computer generated patterns into type A or B. 18 learned better 70% correct judged from the last 50 trials. 16 did not learn to perform better than 55%. Ten other subjects passively observed the patterns. Recordings were from 16 scalp electrodes with linked mastoids as reference, bandwidth 0.03-30.00 HZ. After the initial visual evoked potentials there was a widely distributed long lasting positively, beginning at 200 msec, more marked frontally and on the right which was not seen in the passive observers. We averaged the last 25 correct responses from the learners and not-learners and the mean amplitude of the positivity 300-500 msec after the stimulus is shown from the FZ electrode in the table.

Mean Amplitude at Fz 300-500 msec post stimulus.

Observers (n=10)	Non-learners (n=16)	Learners (n=18)
1.52 ± 2.32	5.26 ± 2.21	7.39 ± 3.33
	p0.002	p0.000
		p0.004

Independent t-test.

The learning process is associated with scalp positivity which is greater in successful compared with unsuccessful subjects.

A high resolution ERP and PET investigation of verbal working memory. - Clark, C.R.*, Egan, G.F.^#, McFarlane, A.C.~, Morris, P.$, Weber, D.* and Sonkkilla, C.#+ (* The Flinders University of South Australia, Adelaide; ^Austin Repatriation Medical Centre, Melbourne; #Howard Florey Institute, Melbourne; ~University of Adelaide, Adelaide; $Heidelberg Hospital, Heidelberg; +Swinburne University of Technology, Melbourne, Australia).

Imaging studies have shown the various involvement of frontal and parietal structures in working memory function. In this study, PET was used to identify the regions associated with the storage of verbal working memory codes. High-resolution ERPs were used to compare the processing dynamics associated with the updating of these codes and their use in selecting action. Ten normal, right-handed subjects detected visuoverbal targets under fixed and variable target conditions. In the fixed target block, only a single target had to be memorised. In a variable target block, the target to be remembered was updated frequently. Head and brain structure was determined using MRI. PET was collected using H215O and analysed using SPM. 124-channel ERPs were collected DC at 250Hz.

The updating of working memory targets was associated with bilateral activation of the medial frontal and supramarginal gyri. Scalp activations associated with the updating of these targets and their use for initiating action showed similar frontal and parietal topographies. The processes could be distinguished by key differences in their temporal and energy dynamics over successive time intervals in the 100-900ms post-stimulus window.

EEG source differences between correct and incorrect performance. - Fernández. T.*, Harmony, T.^, Bosch, J., Silva, J.^, Fernández-Bouzas, A.*, Díaz-Comas, L. and Galán, L. (*ENEP Iztacala and ^Center of Neurobiology of the National Autonomous University of Mexico).

Several authors have analyzed the relationship between EEG frequency and the performance on different tasks. In general, a lower EEG frequency has been related to poor performance. The most common hypothesis was that EEG- performance relationship was modulated by alertness level. However, we are interested in EEG-performance relationship when alertness has been maintained throughout the task. This paper shows that in this condition, incorrect responses are preceded by different EEG frequencies than correct responses, and that these differences appear in specific brain regions that participate in each particular task. EEGs were recorded in children during three different tasks: Color Discrimination (CD), Verbal Working Memory (VWM), and Word Categorization (WC). EEG segments previous to the presentation of the stimulus were analyzed. To corroborate the localization of the EEG activity in each frequency, the distributed sources were calculated by frequency domain VARETA, and the spatial distribution of the sources of the EEG previous to correct and incorrect responses were compared by paired t tests. Incorrect responses were preceded by lower EEG power values at 7.8 Hz in posterior temporal and right parietal areas in CDT, 8.59 and 9.36 Hz in frontal areas in VWM, and 10.72 Hz in the left Sylvian region in WC. In the former task greater 1.56 Hz power in frontal areas previous to ...

Local modulation of alpha rhythm and ERP reflecting awareness of changes in perceived images in binocular rivalry - Kobayashi, T. and Kato, K. (Research Institute for Electronic Science, Hokkaido University, Sapporo, Japan).

In an attempt to detect cortical activities related to binocular rivalry (BR), we have measured and analyzed ERDs (event-related desynchronizations) in the alpha band and also ERPs (event-related potentials). Six healthy subjects participated in the measurements. Vertical and/or horizontal gratings were presented to the left and right eyes separately. Subjects were instructed to press a button when perceived images were changed from one image to the other, which triggered data acquisition. As a control experiment, identical vertical (or horizontal) gratings were presented to both eyes continuously. In this experiment, subjects pressed a button voluntarily at random moments. EEG data of 100 trials were measured at 20 electrode positions on the scalp in each experiment. A clear ERD, i.e., attenuation of variance, in the alpha band was observed at -250 ms in the left parietal, left posterior-temporal and left occipital areas in BR. A broad negative ERP component beginning from -400 ms and lasting until 0 ms was also observed in the same areas in BR. On the other hand, no corresponding ERD and ERP could be observed in the control experiment. These findings suggest that the ERD and ERP observed in BR may reflect cortical activities related to awareness of changes in perceived images.

Selective visual discrimination tasks induce different cortical activation patterns in dyslectic children. - Lagae, L., Vervisch, J., Hutsebaut, B., Peeters, J. and Verhelle, B. (University Hospital Gasthuisberg, Department Paediatric Neurology, Catholic University Leuven, Belgium).

Recent studies have produced conflicting data on a possible magnocellular visual pathway deficit in dyslectic children. In most studies, only low level visual performance was tested, giving little information about higher cortical visual processing. We examined if visual discrimination tasks that activate magno- and parvocellular cortical visual areas, generate different cortical spatio-temporal activation patterns in dyslectic children. Event related potentials were measured using standard procedures (32 electrodes) in 14 children with dyslexia, aged between 8 and 16 years. In a 'form (parvo) discrimination' and a 'position (magno) discrimination' task, children had to select, by pushing a button, a pre-defined visual target (20% present) in a series of target and non target stimuli. Latency and location of the late positive peak were calculated in the event related potential to the target stimulus. In all children, task performance was 90%. Latency of the event related positive peak was not statistically different for the 2 tasks (median parvo 343msec, magno 335msec). Location of the peak was clearly different. In the form task, the medial central parietal region was activated, while in the position task, the posterior parietal region was activated. We conclude that our magno- and parvo visual discrimination tasks selectively activate different cortical regions in dyslectic children, making these tasks highly suitable for comparison with normal children.

Influences of exercise on information processing in different sensory modalities. - Yagi, Y., Estes, K.M.* and Coburn, K.L.* (Seinan Jogakuin Junior College, Ki-

takyushu, Fukuoka Japan; *Mercer University School of Medicine Macon, GA USA).

Visual reaction time (RT) has been reported to decrease during moderate exercise, and this has been interpreted as reflecting an enhancement of information processing. This study examined changes in several independent measures of information processing (P300, RT, accuracy) during exercise, and their relation to visual or auditory modalities. 24 healthy volunteers (mean age 20 ± 2 years) performed auditory and visual "oddball" tasks during resting control periods, aerobic exercise periods, and recovery periods. As expected from previous studies, visual RTs during exercise were significantly shortened compared to control and recovery periods (which did not differ from each other). We now report a highly similar shortening of auditory RTs under these same conditions. P300 latencies offer independent measures of the speed of information processing unrelated to motor output. Paralleling the RT changes, auditory and visual P300 latencies were decreased during exercise, indicating faster information processing in both sensory modalities. However, both auditory and visual P300 amplitudes were decreased during exercise, suggesting diminished attentional resource allocation. Also, error rates were increased during exercise. Taken together, these results indicate that the enhancement of information processing speed during moderate aerobic exercise, although operating across sensory modalities, is not a global facilitation of cognition, but is accompanied by decreased attention and increased errors.

EEG Analysis

Human head conductivity estimation using a Boundary Element Model. - Eriksen, K.J., Ferree, T.C. and Tucker, D.M. (Electrical Geodesics, Inc., Eugene, OR 97403).

Accurate individual subject head conductivity estimates are necessary for accurate realistic source modeling results. In order to obtain such estimates we have designed a conductivity measurement technique that may prove effective for non-invasive measurement of scalp, skull, and brain conductivity. The basic principle involves measuring the impressed scalp potentials from scalp current injection of a microvolt level constant current source. To test this method we have applied it to both physical models and three human subjects for which boundary element method (BEM) models were constructed. Simulated annealing was used for optimization of the unknown conductivity model parameters in order to increase the chances of finding the global minimum. For the three compartment physical model with 128 measurement electrodes, our method recovered the conductivity of the scalp, skull and brain with 1%, 3% and 10% errors respectively. BEM models are currently being constructed for the human subjects. Future work will extend the method with finite element models that can accommodate anisotropies, which are known to influence the conductivities of the skull and white matter.

Effect of the numerical forward problem solution errors on linear inverse solutions. - Phillips, C., Maquet, P. and Luxen, A. (Cyclotron Research Centre, University of Liege, Belgium).

The 3 sphere shell head model offers an analytical solution for the forward problem. Realistic head model base on MR images could be more anatomically accurate but the forward problem can only be solved numerically (e.g., by the boundary element method, BEM): this implies errors depending on the tessellation and numerical approximation adopted. To solve the inverse problem, the linear inverse solutions (e.g., Loreta, Minimum Norm [MN], B&G) have been largely used on the 3 sphere shell model. These solutions are usually characterised by a blurred reconstructed source distribution and a better accuracy for superficial sources. On the other hand, the maximal errors of the BEM are found for superficial sources. With a 3 sphere shell model, the analytical and numerical (with 2 levels of tessellation and 3 BEM approximations, "linear and constant vertex" and "centre of gravity" approaches) forward solutions were computed for a set of 29 electrodes (10-20 system + intermediate). For each forward solution, the inverse solutions (Loreta, MN, Weighted MN and B&G) were calculated. The characteristics of these solutions were then studied and compared by means of the analytical forward solution (error free). In general, the less error in the forward problem solution (better BEM approximation and tessellation), the less disturb is the inverse solution. The MN, Weighted MN and B&G solutions are much more sensitive to the forward solution errors than ...

Epilepsy

Video-EEG mapping - Chavdarov, D., Radionova, M. and Kojuharov, I. (Alexandrov University Hospital Sofia, Bulgaria).

Video-EEG is a modern trend in epileptology, but in some cases it is difficult to survey simultaneously the patients' behaviour and to analyse the ongoing EEG. To facilitate this process was introduced a simultaneous recording of Video-EEG Mapping. In the EEG Mapping were used different techniques for better differentiation of the topographic properties of the discharge from the background activity: series of momentary maps; series of power spectra maps; 1st derivative EEG mapping, etc. The developed mixing programme permits coupling in

real sequence of time the video and EEG mapping. A slow motion projection affords an opportunity for better estimation of: 1. The beginning of the discharge and the corresponding motor activity; 2. The potential distribution and the respective behaviour; 3. The focal activity masked in the EEG by the bilateral synchronous 3/s complexes, corresponding to adverse movement in patients with atypical absences; 4. The relation between discharge area and degree of consciousness (VHS demonstration).

The influence of cortical geometry on the brain maps from close neuronal sources. - Goncalves, S.*, Silva, C.*, Foreid, J.P.^ and Ducla-Soares, E.* (*Institute of Biophysics and Biomedical Engineering; ^Neurophysiology Service, Portuguese Institute of Oncology, Lisbon, Portugal).

Brain maps are currently used to study epilepsy and, although they give very accurate information in the time domain, they don't give quantitative information on the location of the neuronal sources that are responsible for the epileptic activity. For that, we need source localization techniques, either with spherical or preferably realistic head models. In this communication, we process EEG data for three interictal spikes from a patient with epilepsy, using a dipole model for the source and realistic head geometry. Both the position and orientation of the first source (located in a region of the cortex with few foldings) were very stable in time. With respect to the two other sources, although the corresponding brain maps were very different, suggesting independent sources, their positions were very close and their orientations varied with time. Moreover, these sources were located in a region of the cortex with many foldings. Since the dipoles that simulate the neural sources are perpendicular to the local surface of the cortex, it is suggested that the stable orientation of the first source and the important differences in the brain maps of the other two sources are due respectively to the local existence of few or many foldings (as observed in MRI scans). These results show the importance of dipole localization models in ...

Magnetoencephalography

Time-frequency analysis of somatosensory evoked 600 Hz activity in MEG. - Haueisen, J., Heuer, T. and Nowak, H. (Biomagnetic Center, Clinic of Neurology, Friedrich-Schiller-University Hena, Germany).

The origin of the somatosensory evoked 600 Hz activity is still discussed controversially. The aim of this study is to investigate the distribution of the 600 Hz activity in the time-frequency domain. Neuromagnetic fields were recorded with a 31 channel Philips biomagnetometer after electrical median nerve stimulation (0.2 ms square pulse, 6000 averages, 4 Hz stimulation rate, 5 kHz sampling rate) in 12 healthy volunteers. Time-frequency analysis was based on Gabor distributions with a frequence resolution of 20 Hz and a time window width of 8 samples. Dispersion curves were defined by connecting maximum amplitude points in the time-frequency domain. Our main finding was that the 600 Hz activity increases in frequency as time moves on in all 12 subjects. Latency analysis of the single 600Hz activity peaks confirmed this result. The latency difference between earlier peaks is higher than between later peaks in the 600 Hz activity. Also, dispersion curves bifurcated in 7 out of 12 subjects, indicating two subcomponents in the 600 Hz activity. An increase in frequency with progressing time for a single generator structure producing the 600 Hz activity is somewhat contrary to the intuitive understanding of the entropy law. Thus, our conclusion is that these results support the hypothesis that the somatosensory evoked 600 Hz is produced by a heterogeneous generator structure.

Localization of equivalent dipole sources of sleep spindles recorded with whole head MEG system. - Manshanden, I., van Dijk, B.W., Kemp, B., Simon, N. and Lopes da Silva, F.H. (MEG Centre KNAW, Free University Hospital, Amsterdam and Graduate School of Neurosciences Amsterdam, The Netherlands).

From animal studies it is known that sleep spindles are generated by neuronal networks consisting of thalamo-cortical excitatory neurons and inhibitory neurons of the reticular nucleus. Through reciprocal connections between thalamic nuclei and corresponding cortical areas, EEG spindle oscillations are generated in the cortex. There is however very little known about the distribution of cortical sources of sleep spindles in man. In order to investigate this, we used a whole-head 155 channel CTF MEG system. To estimate the functional generators of sleep spindles we applied, whenever possible, the equivalent dipole source model in spherical and realistic models of the head. Several types of spindles were distinguished, with frequency components around 13-14 Hz. In most cases the corresponding sources were symmetrically placed in the two hemispheres and formed clusters on the central, parieto-occipital or parieto-temporal regions.

Non-invasive presurgical identification of central sulcus in patients with brain tumors: Comparative MEG and ECoG investigations. - Nowak, H., Steenbeck, J.*, Haueisen, J., Huonker, R., Hochstetter, A.*, Haberland, N.*, Kalff, R.* and Weiller, C.^ (Biomagnetic Center, Department of Neurology, University of Jena, Germany; *Department of Neurosurgery, University of

Jena, Germany; ^Department of Neurology, University of Jena, Germany).

Magnetoencephalography (MEG) is a non-invasive method to measure evoked cortical activity with a high spatiotemporal resolution. Especially in surgery of space-occupying pericentral lesions and neoplasms the localization of the central sulcus is of interest. Dipole source analysis of somatosensory evoked fields combined with MR imaging appears to be a valuable tool to plan an operation with minimum risk. We recorded SEF in 20 patients suffering from intracranial tumors. MEG-recordings were performed using a 31-channel biomagnetometer (Philips). We measured SEFs after Median and Tibial nerve stimulation contralaterally to the lesion. We localized dipole sources within the early answers of SEF. Digitally scanned headshapes of patients were fitted and SEF dipole localization's superimposed on MRI-slices. It was possible in all patients with brain tumors to indicate the postcentral gyrus by the SEF dipole as well as to check the ECoG during surgery. Magnetoencephalography in combination with MRI was shown to be a valid and reliable method to localize the somatosensory cortex. A precise determination of the relationship between tumor and somatosensory cortex was shown preoperatively. The combination of magnetoencephalography with the MRI guided neuronavigation system SMN (Zeiss) leads to an optimal planning of operations especially in ...

Music

Music Effects on Event Related Potentials. - Arikan, M.K.*, Demiralp, T.^, Inan, S.^, Oran, O.#, Elhih, M.^ and Uysal, O.~ (Departments of *Psychiatry and Consultation-Liaison Psychiatry, Cerrahpasa Medical Faculty; ^Physiology, Istanbul Medical Faculty; #Psychiatry, Istanbul Medical Faculty; ~Biostatistics, Cerrahpasa Medical Faculty, Istanbul University).

Music was hypothesized to exert a calming effect, and thus reduce distractibility and enhance cognitive functioning. Musically naive subjects were instructed to pay attention to one of two different tones. ERPs were recorded from Oz, O1, O2, Pz, P3, P4, Cz, C3, C4, T3, T4, Fz, F3, F4, Fp1, and Fp2 in response to task-relevant and irrelevant tone bips superimposed on either white noise, or on instrumental voice of ney (a reed flute played especially in Mevlevi music). The latencies and amplitudes of four peaks (N1, P2, N2 and P3) were obtained. The results were tested by a MANOVA design for repeated measures with two factors, background sound (2 levels: white noise, ney) and lead (16 levels: Oz O1 O2 Pz P3 P4 Cz C3 C4 T3 T4 Fz F3 F4 Fp1 and Fp2). The amplitudes of both P2 (factor: background sound: $F(1/4)=6.84$; p 0.05) and P3 waves (factor: background sound: $F(1/4)=8.34$; p.05) increased significantly during listening the ney music. There were no significant topographic differences between the two background conditions. Other ERP waves (N1 and N2) did not show any significant change between the two conditions. Considering the increase of the amplitude of P3 wave that reflects cognitive processing of the sensory input in ...

Pharmaco-EEG

Is information processing mantained during propofol/fentanyl general anesthesia? An ERP topographic study. - Chiaramonti, R., Ragazzoni, A., Tonelli, M.V.*, Cecchi, M.^ and Zaccara, G. (Unit of Clinical Neurophysiology, Anesthesiology *and Vascular Surgery ^Nuovo S. Giovanni di Dio Hospital, Florence, Italy).

Event-Related Potentials (ERPs) were recorded during carotid endoarterectomy (CEA) in order to investigate the efficacy of propofol and fentanyl in inducing and maintaining a condition of light general anesthesia presumably unassociated with intraoperative awareness and/or mnesic processes. Auditory ERPs (oddball paradigm) were obtained the day before surgery and during CEA in 15 consecutive patients (age range 52-83 yrs), without neurological deficits, fulfilling the criteria for CEA. 19-channel ERP spline voltage maps were computed off-line in the two conditions and compared. ERP components N1, P2, P3 were identifiable preoperatively in all the patients. Intraoperative ERPs showed increased latencies and reduced amplitudes of all the components: a clear N1 with a frontal-central distribution was detectable in 60 percent of the patients, whereas an anterior positive component was observed in response to the rare tones in 35 percent of the individuals. The scalp topography and the latency range of this positivity resembled that of a P3a component. A clear central-parietal P3b was never detected. Based on these findings, a suggestion is made that during the light anesthesia performed in the current study the auditory information processing was not entirely suppressed and that the electrophysiological counterpart of an early alerting/attentive process (N1/P3a) was maintained.

CBZ induces slow EEG activity in patients with epilepsy. - Radionova, M. and Patroneva, A. (Alexandrov University Hospital Sofia, Bulgaria).

The data about the degree and extent of distribution of the slow activity induced by CBZ are rather controversial in the different investigations. In our examination were included 73 patients with simple or complex partial seizures with or without generalisation, treated with CBZ (Finlepsin - "Asta Medica", Germany). EEG was regis-

tered before and twice during the treatment - on the 30th and 90th day of the steady state. For quantitative evaluation of the induced changes is used EEG mapping. The EEG mapping investigation included the distribution of the normalised power spectra in the standard bands and their maximal values and the power distribution of the focal and paroxysmal activity. In some patients was used the statistical probability mapping (SPM). In the patients with diffuse slow activity in the initial investigation no significant slowing could be stated during CBZ, and those with severe abnormalities showed even reduction. From the group of 59 patients with initially normal EEGs or with slight diffuse changes 35 (63.6 %) show well expressed increase of the slow activity. The EEG mapping reveals decrease of the alfa power and increase of the theta power (absolute and normalised). In some patients the SPUME shows differences up to 6.5 SD localised in the frontal and temporal regions. From the 54 patients with focal (or regional) slow activity in 22 there was reduction during the treatment. The EEG mapping reveals decrease of the power of ...

Predicting treatment response in narcolepsy using the P300. - Sangal, R.B, Sangal, J.M. and Belisle, C. (Sleep Disorders Institute, Troy, MI).

In patients with Attention Deficit-Hyperactivity Disorder, P300 auditory amplitude topography predicts treatment response to stimulants, whereas visual P300 latency predicts response to tricyclics. To evaluate the hypothesis that visual P300 latency (VL) predicts treatment response to modafinil (a new wake-promoting agent) in patients with narcolepsy, data was analyzed from a nine week double-blind randomized trial. Patients were 18 to 65 years old men and women with a current diagnosis of narcolepsy. 21 patients participated. 14 were randomized to active treatment. All completed the study. Auditory and visual P300 testing using 31 evenly spaced scalp electrodes, and baseline polysomnograms and objective and subjective tests of daytime sleepiness, were followed by modafinil treatment.. Tests of sleepiness were repeated at the end of the trail. Good response was defined as a final Maintenance of Wakefulness Test (MWT).7.3 min (normative sample mean - 3 SD), plus an increase 1 SD (3.6 min) over baseline MWT. A cut-off of 0.5 SE from normal regression constant was used to separate patients with longer (not necessarily abnormal) and shorter age-adjusted visual P300 latency (VL). Poor responders had longer age-adjusted 31-electrode mean VL (448.4 ms vs 410.8 ms, p = 0.024). Poor and good responders did not differ on any other baseline clinical variable. Shorter age-adjusted VL predicted good modafinil response, with specificity of 0.71 and sensitivity of 0.86.

Source Localization

EEG source spectra in brain lesions. - Fernández-Bouzas, A.*, Harmony, T.^, Silva, J.^, Bosch, J.#, Aubert, E.#, Fernández, T.*, Valdés, T.#, Marosi, E.* (*ENEP Iztacala and ^Center of Neurobiology from the National Autonomous University of Mexico; #Cuban Center of Neurosciences).

In previous papers we have provided some experimental support for the hypothesis that in the presence of brain lesions, delta and theta activities are mainly related to the volume of the lesion and the edema respectively. VARETA is a variant of Distributed Solutions to the inverse problem, which imposes different amounts of spatial smoothness for different type of generators and restricts current sources to gray matter. In this paper we report the results obtained with VARETA in 13 patients with space occupying lesions and 13 patients with brain infarcts, in order to: 1) Test the accuracy of VARETA for the localization of brain lesions, and 2) To provide further support for the origin of delta and theta components in presence of lesions with vasogenic and cytotoxic edema. In all patients, log transformed source spectra were compared with age matched normative values, defining the Z source spectrum. Maximum Z values were found within the delta band (1.56 to 3.12 Hz) in 10 patients with space occupying lesions and in 9 patients with brain infarcts. The spatial extent of the sources corresponded with the locations of the lesions. In patients with large volumes of edema maximum Z values were between 4.29 and 5.12 Hz. Those patients in whom the maximum abnormality was in ...

Error analysis for multisphere approximation in EEG forward and inverse problems - Greenblatt, R.E. (Source Signal Imaging, Inc., San Diego CA USA).

Multisphere approximations (which assume a different equivalent sphere for each electrode or magnetometer) have been proposed as a method to improve the accuracy of M/EEG forward calculations by incorporating head shape information in a computationally efficient manner. Because the sphere radius is used explicitly in the electrical case, brain regions distant from an electrode site may be excluded from the sphere interior for that electrode. Using a 3 shell boundary element model (BEM, 512 triangles/surface) derived from an individual MRI and a uniformly distributed dipole array (n=552, 2cm spacing) restricted to the brain volume, we obtained the BEM lead field matrix. The multisphere approximation was calculated as the effective sphere origin for each of 128 electrodes by a least squares fit to the lead field. Using this multisphere approximation, we found that nonlinear dipole fitting to the same dipole set resulted in

a mean localization error of 8mm rms (range 0.4 - 41 mm). The largest errors were attained with dipoles near the center of the head and close to the inner skull boundary, although these regions were overlapped by all equivalent spheres.

P300 source localization using LORETA. - Soufflet, L., Boeijinga, P., Toussaint, M. and Macher, J-P. (FORENAP, Centre Hospitalier, 68250 Rouffach, France).

LORETA (Low Resolution Tomography) is one of the most promising source localization techniques. Developped by Pascual-Marqui since 1994, the method is a generalized minimum norm algorithm with smoothness properties working without any a priori assumptions about the sources. We have used this technique in order to localize the sources of P300 auditory component on a large database of 160 healthy volunteer subjects (aged 18-41 years (25.5 years ± 4.9); 152 men (142 right-handed and 10 left-handed), 8 women), selected for presenting well defined P300 peaks above 10 mV. Recordings have been made using 28 EEG electrodes including the 19 electrodes from the 10-20 system. Calculations were performed using a 3 spherical shell model of the head with a grid of 1021 regular points located inside the brain. LORETA solutions have been computed for each subject at the latency corresponding to the maximum of the P300 component (315 ms ± 24) and have then been averaged over all subjects. Our averaged results have shown the presence of 4 sources, a deep source (frontal and slightly shifted to the left), one mid-occipital source and two lateral and symmetrical sources (the left source being predominant). The deep source could correspond to the source located in the hippocampus postulated by many investigators such as Tarkka et al. (1995). The lateral sources could be explained as a residual of bilateral auditory sources. The occipital source is not yet ...

Dipole model-based detection of focal interictal EEG events. - Van Hoey, G.*^, Vanrumste, B.*^, Boon, P.*, D'Hav, M.* and Lemahieu, I.^ (*Epilepsy Monitoring Unit, Department of Neurology, University Hospital of Ghent; ^Electronics and Information Systems Department, University of Ghent).

Introduction: We present a method for the detection of interictal epileptic EEG spikes, based on a dipole model of the underlying source. The aim is to detect only those interictal phenomena originating in a focal irritative zone, while imposing as few constraints as possible on the precise shape of their waveforms. Additionally, the method will provide an estimate of the corresponding source location for each detected event. Methods: For each position of a moving time window the validity of a single spatio-temporal dipole model is evaluated by calculating a RRE (relative residual energy) measure. A detection is made for each window position yielding a RRE lower than a certain percentage. The corresponding EEG is then considered to have a focal underlying source of which the dipole parameters provide an estimate of location and orientation. The method was applied to the EEG of epilepsy patients during long-term video-EEG monitoring, using both a three-shell spherical head model and a finite difference realistic head model. Results and discussion: The method is capable of detecting and localising most of the focal epileptic spikes present in the EEG, while the number of false-positive detections remains acceptable. Furthermore, the detected spikes can be distinguished from false detections (e.g., eyeblink artifacts) on the ...

Reciprocity and lead fields used in the numerical inverse procedure of EEG source analysis. -Vanrumste, B.*^, Van Hoey, G.*^, Boon, P.*, D'Hav, M.* and Lemahieu, I.^ (*Epilepsy Monitoring Unit, Department of Neurology, University Hospital of Ghent; ^Electronics and Information Systems Department, University of Ghent).

Introduction: In EEG source analysis numerical methods utilizing volume elements instead of surface elements have been difficult to use in the inverse procedure due to the large number of nodes and the number of forward calculations needed to perform a dipole fit. Yet the possibility to incorporate several tissues with a specific conductivity can lead to more precise localization of the electrical activity. Furthermore the potentials at depth electrodes can also be studied. We present a method to perform the inverse problem with only a limited number of forward calculations using lead fields, the reciprocity theorem and the finite difference method (FDM). Method: The potentials at the scalp electrodes are obtained using the analytical expression in a three-shell concentric spherical head model (with radii of 100, 90 and 80 mm) for dipoles located on the line connecting the center of the spheres and the right ear and orientated along the three axes. These potentials are brought into the inverse procedure. In the inverse procedure the forward evaluations will be performed numerically using lead fields generated between the two lead electrodes and the reciprocity theorem introduced by Helmholtz. The number of forward calculations is reduced to the number of electrode pairs ...

Localization of the epileptic focus in patients with known (MRI) lesions with Low Resolution Electromagnetic Tomography. - Worrell, G., Brinkmann, B., Busacker, N., Lagerlund, T., O'Brien, T. and Sharbrough, F. (Division of Epilepsy and Department of Neurology, Mayo Clinic, Rochester MN 55005).

Patients with medically intractable patrial epilepsy and well defined MRI lesions were studied using Low Resolution Electromagnetic Tomography (LORETA) to investigate the potential of this method for accurate intracerebral ictal source localization. Patients admitted to the epilepsy monitoring unit with MRI lesions and partial epilepsy were studied using 31-electrode scalp EEG. A finite element model of the scalp, skull and cortex was obtained from the patients MRI. The scalp electrodes and patients head shape were digitized, and then co-registered with the MRI. The co-registration of scalp electrodes and MRI renders the precise location of scalp electrodes relative to brain parenchyma and provides a realistic model for the electromagnetic inverse problem. The compressed special array of the ictal EEG was used to identify the dominant ictal frequencies. Phase encoded FFT spectral analysis was used to obtain a scalp potential map (Lehmann et al. 1990). The scalp potential map was then analyzed using LORETA to obtain tomographic maps of the generations of the ictal EEG discharge. A commercially available package (Source Single Imaging) that utilizes a finite element solution was used for the inverse solution. The correspondence of the LORETA derived ictal current sources with the patient's MRI lesion was determined by co-registration of the current source tomograms and the MRI.

Classification of the scalp EEG during normal cognitive activity based on the locations of equivalent dipole sources. - Lind, J.C.*, Flor-Henry, P.* and Koles, Z.J.^ (*Alberta Hospital Edmonton; ^University of Alberta, Edmonton, AB, Canada.

Knowledge of the source distributions underlying the EEG during normal cognitive activity would help to clarify functional organization of the brain. To test this hypothesis, 43-channel EEGs were recorded from 70 female volunteers during eyes open and eyes-closed (passive) conditions and during word-finding and dot-localization (active) exercises. EEGs were Fourier transformed, divided into training and test sets and classified using the complex frequency domain generalization of the classical two-group quadratic discriminant function. Inputs to the classifier were obtained by factoring the spatial cross-spectral matrix into patterns common to the two passive EEGs and to the two active EEGs. Using only two spatial patterns, 84% of the passive test-set EEGs were correctly classified while using six common spatial patterns, 74% of the active test-set EEGs were correctly classified. The MUSIC algorithm was used to estimate the locations of the equivalent dipole sources that best accounted for the spatial patterns in each classification. Using the potential scalp images generated by these sources, 82% of the passive and 57% of the active EEGs were correctly classified. Sources that distinguished the passive EEGs were focused and located in the central posterior - right frontal regions while sources that distinguished the active EEGs were diffuse and located in right posterior - left frontal regions.

Visual and Sensorimotor Systems

The characteristics of two negative peaks on visual evoked potentials with depth perception. - Miyawaki, Y., Hayashi, R., Yanagida, Y., Maeda, T. and Tachi, S. (Department of Mathematical Engineering and Information Physics, The University of Tokyo, Japan).

It has been known that the peak latency of the negative potentials in occipital region evoked by random-dot stereogram stimuli was about 200msec. Generally, in these experiments, stimuli were displayed in small visual field (about 14.3 X 11.1 degree) using devices such as CRT. We used wider visual field of about 40 degrees with a LCD projector and screen and found out the two negative peaks whose latencies were 180 msec and 280 msec, respectively. To identify the main factor of these peaks, we controlled two features of shape and disparity, which are essential for depth perception by random-dot stereogram stimuli. It was suggested that the first peak mainly resulted from response on early visual processes, and the second peak mainly resulted from response on higher visual processes related to depth and shape perception. Next, we estimated the effect of stimulus size by changing 3 parameters: background area, target area (part of including disparity) and the ratio of target to background area of stimuli. In Result, each peak showed different response tendency and the above hypothesis was also suggested here. Furthermore, by dipole tracing method, we attempted to localize active sources to explore the transition from the first peak's state (early level) to the second peak's state (higher level).

New Technology

Measurement of EEG electrode lead fields using Current Density Imaging with MR? - Joy, M.L.G., Kusano, M. and Henkelman, R.M. (Institute of Biomedical Engineering, Sunnybrook Health Science Center, University of Toronto, Toronto, Ontario, Canada).

We have developed a technique, Current Density Imaging (CDI), that allows electric currents to be imaged with clinical Magnetic Resonance Imagers. The method has been used in rabbits to image bipolar 40 ms current pulses. It has also be used to image Radio Frequency (RF) currents in phantoms and the human leg. A possible application of these methods is to measure the lead fields of EEG electrodes. Our hypothesis is that Solutions of the inverse problem of the EEG, based on lead fields measured directly by CDI, will be more accurate than those

based on a head model constructed using assumed tissue conductivities and simplified geometry. We will support this hypothesis by showing CD images which demonstrate the significant effect of the CSF and other structures on current pathways in the brain. These images also show the current signal to current noise ratios which are achievable with CDI. We will show how the RF CDI technique could be used to gather 20 lead fields in one hour of imaging. We will also describe work in progress on an electrically accurate MR head phantom with which we plan to test our hypothesis.

Complex permittivity measurements during cortical spreading depression - study for RF-CDI. -Yoon, R.S. and Joy, M.L. (Institute of Biomedical engineering, University of Toronto, Toronto, Canada).

Radio-Frequency Current Density Imaging (RF-CDI) is a new imaging technique which measures changes in current density concomitant with changes in conductivity. RF-CDI could provide a three-dimensional functional data with better spatial and temporal resolution than the currently available techniques such as PET or BOLD imaging. For RF-CDI's to be used as a brain tomography tool, it requires an activity-dependant conductivity change in the brain. To examine the changes in complex conductivity in the brain, we conducted measurements in the rodent neocortex during spreading depression phenomena. Spreading depression was chosen because of relatively well known behavior and its many similarities to migraine headaches and ischemia. The measurements were made using a coaxial probe technique. In almost all cases, spreading depression caused two types of change in the conductivity measurements. An increase in conductivity with a short latency (30~60s; 15~30 mm/min) was followed by a large increase with a longer latency (200~300s; 3~4.5 mm/min). The magnitude of changes were in the range of 3% to 20% in conductivity and 9%~40% change in dielectric constants. Although the exact mechanisms of spreading depression is not well known, these large changes in conductivity measurements show that RF-CDI is a viable approach to the study of spreading depression and other similar brain activities such as ischemia and migraine with aura.