Proceedings

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Organizer: Wolfgang Skrandies

10 Years German EEG/EP mapping meeting: topics, trends, and future prospects. - W. Skrandies (Justus-Liebig-University, School of Medicine, Gießen, Germany).

This year the 10th consecutive meeting on EEG and EP mapping takes place, and this contribution will give a summary of the main topics discussed. This meeting attracts mainly researchers from Germany, Austria, and Switzerland, but there were also contributions from the US, England, The Netherlands, Poland, and the Czech Republic. There were 20 review lectures, 51 poster presentations, and 266 oral papers on a wide range of topics. About half of the contributions were concerned with spontaneous EEG, and about 50% were on evoked and event-related activity. There were many papers on methodological development focussing on analysis different methods (microstates, coherence, oscillatory activity, mathematical modelling), and about 12% of all methods papers were related to intracranial source localization. In addition to basic research topics (58%) stemming from brain research, physiology, and psychology, there was a wide range of clinical studies (42%). Most of these were related to psychiatry but electrical brain mapping is also applied in the fields of neurology, neurosurgery, ophthalmology, and pediatrics.

This illustrates that EEG and EP mapping is an active field of research comprising wide areas of basic brain research and clinical applications.

EEG-mapping: methods, implications and results. - T. Koenig (University Hospital of Clinical Psychiatry, Bern, Switzerland).

To discuss and extend different methodogical approaches to EEG data, a general mathematical model is proposed. It describes brain electric data as a combination of a set of wave shapes (the dictionary) and a set of topographies. Dictionary and topographies are related through a weighting matrix (the coefficients). Most existing methods (e.g. wave shape analysis, wavelet analysis, power maps, FFT approximation, microstates, principal component analysis, topographic time-frequency decomposition) fit this framework. They all make specific, a-priori assumptions about dictionary and topographies; the coefficients are treated as dependent variables. The validity and implications of these assumptions can be discussed within the model and separately for the different dictionaries and topographies. This allows deducing the validity and properties of the corresponding methods. It becomes obvious that there is a shift from older methods that are a priori unique because their dictionaries and topographies are composed of orthogonal elements to newer methods that require additional, physiological constraints because they use non-orthogonal elements. The advantage of these new methods is that while being objective, quantifiable, and mathematically well-defined, they still produce a data-driven phenomenology that is adequate to describe the actual physiological events.

Hemispheric asymmetry of cortical generators of the median nerve somatosensory evoked potential. - P. Jung, U. Baumgärtner, W. Magerl and R.-D. Treede (Institute of Physiology and Pathophysiology, Johannes-Gutenberg-University, Mainz; Germany).

Whereas tibial nerve somatosensory evoked potentials (SEP) show smaller amplitudes coming from the left hemisphere, median nerve SEP amplitudes appear larger over the left hemisphere compared to the right hemisphere. The causes of this cortical asymmetry were analyzed using EEG source analysis (BESA2000). The right and left median nerves of 16 healthy subjects were stimulated with a frequency of 2 Hz. EEG recordings were digi-

tized at 2.5 kHz (32-channels; MR-verified electrode coordinates). Dipoles for P14, N20 und P22 were fit for each subject and mean source locations and dipole strengths were compared between hemispheres. In the left hemisphere, generators of the early cortical components (N20, P22) were located significantly more medially (about 5 mm). The N20 source was significantly stronger in the left compared to the right hemisphere (15.7 ± 1.5 versus 10.6 ± 5.8 nAm, mean ± SD). The stronger N20 generator In the left hand area leads to larger SEP-amplitudes following right sided stimulation of the median nerve. The functional displacement toward midline inside the left hemisphere may be the reason for the deeper location of the foot area along the interhemispheric fissure.

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Visual field related topography of stereoscopic evoked potentials and perception. - Ch. Kirr., A. Jedynak and W. Skrandies (Justus-Liebig University, School of Medicine, Giessen, Germany).

Periodical motion-in-depth of dynamic random-dot stereograms can be perceived only up to a certain frequency. The cortical correlate of such thresholds was studied by recording stereoscopically evoked brain activity. In a group of 23 adults we investigated the influence of motion frequency and visual field location on psychophysical thresholds and the topography of brain activity evoked by 3D stimuli. Stereoscopic checkerboards were presented in random order in the center or in the left or right visual field with horizontal disparities changing at 2.74, 4.12, 5.49, 8.24 or 16.48 Hz. During the experiment, subjects had to indicate whether and where stimuli moved in depth. Simultaneously, electrical activity was recorded from 30 electrodes over the posterior brain areas. The psychophysical thresholds in the right visual field were significantly higher that in the left half field or in the center. In all subjects, also with stimulation frequencies below threshold, there was stimulus related activation. Field strength was significantly influenced by temporal frequency and stimulus location. With stimuli moving at 2.74 Hz, centroids were located significantly more anterior on the scalp than when higher temporal frequencies were used.

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Subjective time alterations and EEG spectral changes induced by photic driving. - J. Wackermann and M. Miener (Psychophysiology Laboratory, Institut für Grenzgebiete der Psychologie und Psychohygiene, Freiburg i.Br., Germany).

20 paid volunteers (12F+8M) participated in a time-reproduction task. A visual target was used for time interval presentations/reproductions, and a flickering checkerboard background for photic driving. Target durations varied from 2.8 s to 16 s; three photic stimulation conditions (N=none, S=7/s, F=14/s) were used during the presentation and/or reproduction phase. A session consisted of 54 reproduction trials. EEG (19 channels), ECG and respiration curve were recorded continuously. Deviations from individual time reproductions under the no-driving condition NN were used to measure subjective time alterations; log-ratios of FFT power at photic driving frequency and its harmonic multiples, relative to the no-driving baseline, were used to measure EEG photic driving effects. Four photic stimulation conditions, FN, SN, NS and NF were evaluated. Photic stimulation affected time reproduction significantly (alpha=.05) only in FN and SN conditions (prolonged reproductions); effects in conditions NF and NS were, on the average, not significant. Topographies of correlations between photic driving effects and subjective time alterations showed highest values ($|r|>.5$) in left fronto-central and right centro-parietal regions.

Electrical source localization of a visual oddball paradigm as revealed by LORETA. Effects of the methodological proceedings on the stability of the results. - M.J. Herrmann and A.J. Fallgatter (Psychiatric Neurophysiology, Department of Psychiatry and Psychotherapy, University Hospital of Wuerzburg, Germany).

This study investigated the question whether LORETA, a new method of source localization of EEG data, reveals replicable sources of ERPs in two independent samples of healthy subjects ($n_1 = 49$, $n_2 = 38$) and how the results are influenced by different methodological procedures. The ERPs of the rare primer and the frequent distractor-condition of a visually presented Continuous Performance Test were analyzed with LORETA for both samples, and the similarity of the sources was compared voxel by voxel with Pearson correlation coefficients. The normalization of the data was useful to get similar sources independently from the time point of the source localization. The sources were most similar between the two samples if they were calculated at the time point of individual GFP maximum without preprocessing of the data. For that particular procedure we found significantly higher activation for the primer-condition in the anterior cingulum, the precuneus (parietal lobe), in the insula and the fusiform gyrus (temporal lobe).

Changes of brainstem reflexes and evoked potentials during mass-shift of the brain caused by chronic subdural haematomas. - P. Christophis, D. Reiter and A. Woszczyk (Neurosurgical Clinic of Justus-Liebig-University, Giessen, Germany).

Chronic subdural haematomas lead to a lateral and cranio-caudal brain-shift along the brainstem axis. To de-

tect the irritation of the brain tissue due to this shift 50 patients with chronic subdural haematomas were examined via brainstem reflexes and evoked potentials before and after evacuation of the subdural haematoma. The R1 response of blinking reflex (BR) was changed bilaterally in 38% of the patients. The R2 and R2c responses of BR were also bilaterally changed in 65% of the patients. The jaw-reflex (MR) was altered in 88% of the cases, in most of them bilaterally. In 92% of the patients slight changes of brainstem acoustic evoked potentials (BAEP) was shown. 70% of these were changes of wave III. The cortical signal of the somatosensory evoked potential elicited via stimulation of median nerve (MSEP) was pathological in 40%, ipsilaterally to the haematoma. The visual evoked potential (VEP) was changed in 60% of the patients bilaterally. Present findings indicate not only an irritation of cortical and mesencephalic brain structures, supratentorial, but also an irritation of the pontine brainstem infratentorial. The main irritation point seems to be localised in the cerebello-pontine region demonstrated by changes of wave III and of R1.

Prediction of outcome using MSSEP and BAEP in patients with aneurysmal subarachnoid hemorrhage (SAH). - D. Reiter, P. Christophis, A. Woszczyk, T. Wolter and D.-K. Böker (Neurosurgical Clinic of Justus-Liebig-University, Gießen, Germany).

In 138 patients with aneurysmal SAH were derived the acoustic (BAEP) and the somatosensory evoked potentials (MSSEP). 76% of the patients were attached to grade I-III of Hunt and Hess, and 24% to grade IV and V. MSSEP and BAEP were daily recorded during the first week after bleeding or surgery. Central conduction time (CCT), and cortical amplitude N1/P1 of MSSEP and inter-peak latencies I-V, I-III and III-V were determined. Clinical outcome was assessed by Glasgow outcome scale and correlated with the electrophysiological parameters. Statistical analysis showed that the CCT were significant prolonged in grade IV and V patients. In contrast there were no significant differences of the inter-peak latencies I-V, I-III of BAEP between the different Hunt and Hess grades. Inter-peak latency III-V was highly prolonged in those grade IV and V who died in further clinical course. The CCT and BAEP inter-peak latency III-V showed a good correlation with the clinical outcome while BAEP inter-peak latency I-III did not. The CCT in MSSEP and the inter-peak latency III-V in BAEP correlate with the clinical outcome. The addition of BAEP in patients with aneurysmal SAH grade IV and V of Hunt and Hess improve the prognostic value of MSSEP.

Interhemispheric differences of visually evoked potentials (VEP) represented with mapping in children with benign epilepsy. - D. Dralle, A. Portisch and J. Toeller (Dept. of Neuropediatrics, Justus-Liebig-University, Gießen, Germany).

In 10 children (7-14 years) with benign epilepsy (rolandic epilepsy) flash induced VEP were recorded from 19 electrodes. The amplitude mappings were performed by linear interpolation. 4 of the 10 children had a unilateral negativity at the temporal leads with a peak latency of 200 ms. Two of these patients were seizure free for only 3 months and one of them showed centro-temporal sharp waves in the EEG. In a second step we calculated the amplitude differences between each of two corresponding electrodes of both hemispheres. Maps of these interhemispheric differences were analysed and even small differences became detectable. A unilateral temporal negativity was unmasked 200 ms after the stimulus and 100 ms later contralaterally in 8 children. Only three of them showed sharp waves in the EEG. One of the two patients without any temporal negativity had been the longest time seizure free. In conclusion, we suspect that VEP mapping shows a negativity at the temporal leads as a symptom of hyperexcitability even in normal EEG. The long latency of 200 ms agrees to the benign prognosis in rolandic epilepsy. The method of VEP difference mapping is more sensitive than conventional VEP mapping.

Spatiotemporal modelling of EEG/MEG. - A. Hutt (Max Planck-Institute for Mathematics in the Sciences, Leipzig, Germany).

Components of evoked electro- and magnetoencephalograms (EEG/MEG) are supposed to represent functional processes on the scalp. The presented work aims at detecting and modelling these components. The well-known segment structure of EEG/MEG is derived in this work by concepts of nonlinear dynamics and complex systems. Temporal cluster segments are gained by the K-means algorithm with an additional novel probability measure for existing clusters. The ard problem of the number of clusters is modified and solved partly. The temporal borders of clusters distinguish transition parts and cluster centers. In a second step, the spatiotemporal dynamics of cluster segments are modelled by a nonlinear spatiotemporal analysis method. It determines few static spatial intensity maps and ordinary differential equations for their corresponding temporal projections. The combination of both the segmentation and the latter modelling method allows the dynamical description of nonstationary spatiotemporal signals by a sequence of single models, separated by well-defined transition parts. Applications to visual and auditory event-related potentials (grand-average and single-subject) illustrate single steps of the method and the introduced probability measure.

EP classification with a new type of neural networks. - H. Witte*, L. Leistritz*, M. Galicki*, K. Hoffmann* and E. Kochs+ (*Institute of Medical Statistics, Informatics and Documentation, Friedrich Schiller University Jena, Germany; + Department of Anesthesiology, Technical University, Munich, Germany).

A new type of artificial Neural Networks has been introduced which is characterized by time-varying weights of the connections between the neurons. The network is called generalized dynamic neural network (GDNN) and has been used for classification tasks in evoked potential (EP) analysis. The fundamental advantage of the classification by means of a GDNN is the simplicity and objectivity: no parameter estimation, no feature extraction and no a priori definition of a latency range is required, i.e. GDNN learns time-varying external input signals. Two applications in the field of EP classification can be presented: the identification of left and right hemifield single trial pattern-reversal visual evoked potentials (PVEP) and the classification of inadequate anesthetic levels on the basis of middle latency auditory evoked responses (MLAER). The results of PVEP and the MLAER identification have been compared with those of state-of-the art-methods. It can be demonstrated that the quality of identification can be increased by using a GDNN.

Changes in brain functional dynamics in Alzheimer disease. - T. Koenig*, L. Prichep#+, V. Jelic^, D. Hubl*, L.O. Wahlund^, T. Dierks* and E.R. John#+ (* University Hospital of Clinical Psychiatry, Bern; Switzerland; # Brain Research Laboratories, NYU School of Medicine, NY, USA; + Nathan S. Kline Psychiatric Research Institute, Orangeburg, NY, USA; ^Karolinska Institute, Stockholm).

EEG of two large samples of patients with cognitive decline and/or Alzheimer type dementia was analyzed to describe the spatio-temporal dynamics of brain electrical activity in relation with the disease. Two methods were applied that illuminate different aspects of EEG data. First, using microstate analysis, short epochs of stable EEG field topography were identified, which assumingly correspond to basic building blocks of human information processing. It was found that with increasing dementia, some types of microstates (defined by a specific topography) became more frequent, while others became less frequent. Second, using another, frequency domain measure of global, zero phase-lag synchronization (GFS), it was seen that the EEG of Alzheimer patients was less coordinated in the Alpha and Gamma band. The findings seem to be replicable, since they were found in two completely independent patient samples from Stockholm, Sweden and New York, USA. Comparing these findings with existing developmental data on microstates and GFS, it seems that at least in the parameters described here, progressing dementia resembles a neurofunctional regression to earlier developmental stages.

Physiological bases of EEG and MEG mapping and topography: exploring dipolar models of on-going activities. - F.H. Lopes da Silva (MEG-Center Free University, University of Amsterdam, The Netherlands).

The interpretation of whole-head EEG or MEG signals implies assuming specific models of the physiological sources and of the volume conductor. The most common source models are equivalent dipolar layers or related models. These are based on cortical physiology and anatomy most often derived from the analysis of stationary evoked fields. However an important part of the EEG/MEG signals of interest in clinical neurophysiology and in psychophysiology are not stationary, rather dynamic rhythmic activities. For some of these activities the cortical sources have been determined, namely for alpha rhythms. In order to estimate physiological sources within the brain of these activities, whether stationary or not we have to solve the inverse problem of electro(magneto)encephalography. However the inverse problem, i.e. the estimation of these sources from a surface map, is an ill-posed problem that has no unique solution. In practice we may approach such a solution in a variety of ways. We have explored the method recently developed in our group by Jan de Munck et al (2001) with the aim of obtaining reliable solutions for the physiological sources of different types of on-going rhythmic activities, namely the classic visual alpha rhythm, the mu rhythm and sleep spindles, based on a limited set of assumptions, in order to test whether these different activities had similar cortical topographic distributions or not. The method is completely automatic and makes it possible to study simple generators of large MEG and EEG data sets on a routine basis. We found different distributions of sources for alpha rhythms, mu rhythms and sleep spindles both for whole-head MEG and EEG recordings. In addition using the same methodology it was also possible to localize (Meeren et al. in prep.) deep lying sources (hippocampal formation) for event related MEG activity associated with verbal and/or visual memory tasks.

de Munck, J.C., de Jongh, A. and Van Dijk, B.W. The localization of spontaneous brain activity: an efficient way to analyze large data sets, IEEE Trans. Bio-Med. Eng., 2001, in press.

Mapping mismatch negativity in kindergarten children with and without risks for dyslexia. - K. Bucher, S. Brem, U. Maurer and D. Brandeis (Department of Child and Adolescent Psychiatry, University of Zürich, Switzerland).

Dyslexia has a sizable familial component, and poor

phonological skills reflect a core deficit in dyslexia. Both the familial risk and phonological deficits may be useful for early prediction and intervention. 26 Kindergarten children from families with dyslexia, and 29 controls (mean age: 6.6 years) were tested for phonological skills using a test (BISC) validated for predicting future reading problems. Mismatch-Negativity (MMN) was recorded from 42 EEG-channels for frequency-mismatch (standard: 1000Hz; deviants: 1030Hz, 1060Hz) and phoneme-mismatch (standard: ba; deviants: da, ta) in passive paradigms. Children were grouped by familiar and phonological (BISC) risk. For phonemes, significant group differences were found between children with elevated (3 or more risk points) versus low phonological BISC risk. Children with higher phonological risk had a reduced late (350-700ms) MMN amplitude at F4. For tones, reduced MMN was found for children with a familial risk. Global Field Power analysis indicated additional significant differences. The results indicate that the automatically elicited Phoneme-MMN reflects specific phonological deficits rather than a general familial risk. future longitudinal analyses will clarify whether this MMN reduction in Kindergarten improves the prediction of reading acquisition or dyslexia.

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Brainstem reflexes and evoked potentials in chronic space occupying lesions at the cranio-spinal junction. - P. Christophis, D. Reiter and A. Woszczyk (Neurosurgical Clinic of Justus-Liebig-University, Giessen, Germany).

In thirty-three patients with chronic space occupying lesions there were derived the electrical (BR) and mechanical (GR) elicited blinking reflex, the jaw reflex (MR), the acoustic (BAEP), the somatosensory (elicited via stimulation of median nerve) (M-SEP) and the visual (VEP) evoked potentials. While the R1-response of the BR was slightly pathological in 36%, the R2- and R2C-response showed extensive or severe bilateral changes in 85% of the patients. The changes in R1 and R2 of the GR were seen less often (21% and 61% respectively) and less extensively developed as in BR. The MR was slightly changed in 45% of the patients. BAEP were clearly pathological in 85% of the cases. Usually, the waves I and III were markedly changed. The VEP was mostly (61%) normal or only slightly pathological, bilaterally, while the M-SEP proved to have extensive changes in 94% of the cases. Here, the pathologies were in the central conduction time (CCT), the cortical (N20), and the cranio-cervical (N14) registered signal. In cases of intra-axial tumours the N14-signal was severely pathological. This experience seems to indicate that brainstem reflexes and evoked potentials allow to verifying the bulbo-pontine origin of the neurological deficit in lesions at the cranio-spinal junction.

Verification of brain dysfunctions in injuries at the cranio-spinal junction through the use of evoked potentials. - P. Christophis, D. Reiter and A. Woszczyk (Neurosurgical Clinic of Justus-Liebig-University, Giessen, Germany).

Twenty-five patients with cranio-spinal injuries were investigated by determining of acoustic (BAEP), visual (VEP) and somatosensory stimuli (MSEP and TSEP). While neurological symptoms were evident in twenty patients, there were only transient symptoms in the remaining five. The BAEP was altered in 22 patients. In eight cases the potential was changed markedly or extensively at least on one side. In another three cases the BAEP was absent after wave II bilaterally. The MSEP was extensive pathological in 11 and markedly or slightly changed in further 11 cases. Here, the cortical signal was changed more often and more extensively than the cervical signal. The TSEP was markedly or extensively pathological in 20 cases. Here also, the cortical signal was changed more often and more extensively than the corresponding cervical signal. VEP changes were found in 23 patients, but only in one case was the cortical signal slightly pathological. In the other cases the changes of these signal was marked to extensive in 19, and absent in three cases, bilaterally. These findings allow the conclusion that an injury at the cranio-spinal junction is able to cause additional irritations or damages of the brainstem which are verifiable by determining of evoked potentials.

EEG source locations during ganzfeld, sleep onset and waking. - P.L. Faber*, D. Lehmann*, P. Pütz+, L.R.R. Gianotti*, I. Strauch*, J. Wackermann+ (*The KEY Institute for Brain-Mind Research, University Hospital of Psychiatry, Zurich, Switzerland; +Psychophysiologie Labor, Institut für Grenzgebiete der Psychologie, Freiburg, Germany).

The "ganzfeld" state induced by a homogeneous perceptual field has been hypothesized to be close to the state at sleep onset (Schacter 1976). 19-channel EEG-data was recorded from 9 female subjects in 3no-task conditions: waking (day dreaming), ganzfeld, sleep onset. Brain electric model source locations in the frequency domain (for the 2-30 Hz band) were computed (FFT-Dipole-Approximation) for each 2-second epoch. The 3-dimensional difference vectors between mean locations of condition pairs were computed, and the single subjects' source positions (orthogonally projected onto the vectors) were tested for location differences between conditions. These global tests showed that the model source locations during sleep onset differed significantly from those during waking ($p<.002$) and during ganzfeld

(p<.02). Post-hoc t-tests revealed: source locations during sleep onset were more anterior than during both ganzfeld (p<.03) and waking (p<.004). There were no source location differences between ganzfeld and waking (p<.13). These results are in line with the EEG power spectral findings obtained from the same dataset by Wackermann et al. (2000), where extracted spectral parameters during ganzfeld were close to those during waking and differed from those during sleep onset.

Cannabis-induced topographic changes in pre/post EEG activity during rest and music perception. - J. Fachner (University Witten/Herdecke, Institute for Music Therapy, Witten, Germany).

In scientific literature cannabis is found to change or enhance time-, space-, body- and movement perception, emotion, imagery and association patterns. Presented here is an explorative study on Cannabis and Music Perception, conducted in a qualitative and quantitative way in a habituated setting. EEG-Brainmapping Data (rest; pre/post listening; 28 EEG traces; smoked Cannabis ϕ20 mg Δ9 THC) were averaged and treated with a T-test and a visual topographic schedule. Compared to pre-THC-rest and pre-THC-Music in the post-THC-Music-EEG a rise of Alpha percentage and power was observed in the parietal cortex on four subjects, while other frequencies decreased in power. Decreased amplitudes could represent a decreased cell-firing mode caused by cannbinoidreceptor mechanism. Comparing pre/post music EEGs, differences (p<0.01) were found in the right frontotemporal cortex on Theta and on Alpha in the left occipital cortex. Changes in temporal and occipital areas and increasing a-signal strength in parietal association cortex seem to represent a neural correlate of altered music perception and hyperfocusing on the musical time-space. Alpha amplitude changes remind on 'reverse Alpha' findings in studies with gifted individuals.

Event-related brain microstates when reading emotionally positive, negative and neutral words. - L.R.R. Gianotti, P.L. Faber and D. Lehmann (The KEY Institute for Brain-Mind Research, University Hospital of Psychiatry, Zurich, Switzerland).

33-channel ERP's were recorded from 23 normals while reading 74 words of three emotion classes: positive, negative and neutral; each word was screen-presented for 450 msec (8 times, random-sequence, 2000 msec intervals). Of the 4 ERP microstates between 80-408 msec, the first (80-128 msec, negative polarity centroid anterior, positive centroid posterior) differed in topography between word classes: The (anterior) negative centroid for negative words was more right than for positive (p<.02) and neutral (p<.08) words; the (posterior) positive centroid for negative words was more left than for positive (p<.03) and neutral (p<.10) words; also, this centroid for negative words was more posterior than for positive (p<.04) and neutral (p<.06) words. These results imply different gravity centers (more posterior for negative than positive words, p<.07) and angles of electric field orientation (more clock-wise rotated for negative than positive (p<.08) and neutral (p<.03) words). Neutral and positive words did not differ in these tests. Our left-right differences between centroids of positive and negative words in this ERP microstate confirm Skrandies' (1998) report; intriguing are the clock-wise microstate field rotations, comparable to those during abstract thoughts versus visual imagery in spontaneous EEG (Lehmann et al. 1998) and word-ERP's (Koenig et al. 1998).

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Dissociation of processing of duration information and pitch information: evidence from evoked potentials. - H. Gibbons, S. Brandler and T.H. Rammsayer (University of Goettingen, Germany).

Twelve participants performed both a temporal and a pitch generalization task, with EEG recorded simultaneously. After repeated presentations of a standard tone (200ms for duration, 1,000 Hz for pitch), participants had to decide in a subsequent test phase whether a given tone matched the standard tone, or not. Identical sets of stimuli were presented in both the duration, and the pitch task. Psychophysical generalization functions were obtained, plotting the number of "Standard"-responses against the various levels of duration and pitch, respectively. These functions peaked at the standard, and rapidly decreased with increasing difference from the standard, testifying to the validity of the tasks. Auditory evoked potentials (AEPs) were analyzed as a function of task (duration and pitch generalization). Between 200 and 400 ms, fronto-central AEPs were more negative for the duration task, as compared to pitch. Between 600 and 1,000 ms, frontal AEPs were again more negative for duration than for pitch, but this pattern was reversed at occipital sites. For pitch, in addition, AEPs to standard and deviant tones differed early (0-200 ms) at frontal sites, whereas for duration, standard-deviant differences occurred later (250-550 ms) at parietal sites. These results support the notion of temporo-spatial dissociability of brain functions involved in processing of pitch and duration information.

Investigation of nonlinear changes during interictal and ictal surface brain electrical activity. - K. Hoffmann*, M. Feucht+, K. Schwab*, F. Benninger+, U. Möller* and H. Witte* (* Institute of Medical Statistics, Computer Sciences and Documentation, FSU Jena, Germany; +University-Hospital for Neuropsychiatry of Children, University Wien, Austria).

In recent years it has become manifest that in the EEG recorded during, and even between seizures, one can find

typical features of nonlinear dynamics which may give useful information in the presurgical evaluation of patients with drug-resistent epileptic seizures. In our study, the point prediction error (PPE) estimated on the basis of the largest Lyapunov exponent was used as a measure of the "chaoticity" of the EEG in its time course. Based on this parameter we extracted features predictive of epileptic seizures and characterising their spatiotemporal spread. 24 multichannel EEGs of 8 patients were investigated (2-4 seizures per patient). We studied selected epochs of interictal and ictal activity of 10 min duration starting about 60 min and 5 min before seizure onset, respectively. In result, each patient had an individual "history" of seizure onset in the EEG which was characterised by an individual PPE time course at all electrodes. 7 patients showed significant lower PPE values during the seizure than the interictal epoch. Furthermore, the spatial distribution of low PPE values was found to be correlated to the side of the epileptic focus, thus, providing a reliable estimate of its lateralization.

Stereoscopically evoked brain activity in patients with microstrabism. - W. Skrandies (Justus-Liebig University, School of Medicine, Giessen, Germany).

Since more than 100 years, random-dot stereograms are employed in vision research. We studied stereoscopically evoked brain activity in 18 patients with normal vision (normal visual acuity, visual field, color vision) but stereo vision deficiency. In all patients we determined psychophysical thresholds, and visual evoked potentials were recorded in seven channels over the occipital areas. For control a conventional checkerboard reversal VEP was obtained which was normal in all patients. Dynamic random-dot stereograms were presented on a monitor as a stereoscopic checkerboard pattern that moved in depth. Stimuli were shown in the center or in the left or right half field. Different disparity values ranging from 7 to 24.5 minutes of arc were used. Time locked evoked brain activity was analyzed, and we determined electrophysiologically stereo thresholds as well as the disparity where maximal responses were observed. There was a significant correlation between threshold determined psychophysically and with VEP recordings. In addition, clinical parameters like squint angle had some significant influence on electrophysiological thresholds with lateralized 3-D stimuli.

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Transcranial direct current stimulation modulates EEG in the human. - J. Stumpf, M.A. Nitsche, H.-J. Bittermann, F. Tergau, D. Liebetanz and W. Paulus (Dept. of Clinical Neurophysiology, Georg-August-University Goettingen, Gießen).

Transcranial direct current stimulation (tDCS) induces changes in motor cortical excitability during and after stimulation. We looked for tDCS-elicited changes in EEG-spectra. tDCS was applied for 5 or 10 minutes in 10 subjects over the motor cortex and contralateral prefrontal cortex. Spontaneous EEG was recorded before, and up to two hours after stimulation. Frequency analyses were conducted. 10 minutes cathodal tDCS of the motor cortex enhanced the relative power of the delta band, anodal stimulation diminished it. These changes were significant 10 minutes after the end of stimulation, but were reversible within 2 hours. 10 minutes tDCS of the prefrontal cortex as well as 5 minutes tDCS of both cortices did not change frequency spectra. The increased power of the delta band after cathodal and its diminished power after anodal tDCS parallels enhanced cortical excitability after anodal and diminished cortical excitability after cathodal tDCS. Missing changes after short stimulation durations correspond to short excitability changes elicited by this stimulation scheme. Missing changes after prefrontal stimulation may be caused by anatomic preconditions.

EEG frequency band sources from alertness to sleep stage2 in old and younger subjects. - N. Tsuno*, M. Shigeta*, K. Hyoki+, T. Kinoshita^, S. Ushijima*, P.L. Faber~, D. Lehmann~ (*Department of Psychiatry, Jikei University School of Medicine, Tokyo, Japan; + EEG Laboratory, Kawamuro Memorial Hospital, Niigata, Japan; ^ Department of Neuropsychiatry, Kansai Medical University, Moriguchi, Osaka, Japan; ~ The KEY Institute for Brain-Mind Research, University Hospital of Psychiatry, Zurich, Switzerland).

Intracerebral EEG model source localization was examined from alertness to sleep, in healthy old and younger people. Two features were analyzed: (1) the change of the locations, and (2) the magnitude of the fluctuation of these locations. Multichannel EEG from alertness to onset of sleep stage 2 was analyzed in 7 old and 10 younger subjects (60-79 and 18-41 years, respectively), using FFT Dipole Approximation to compute single source model localizations in the frequency domain for the seven EEG frequency bands (MANCOVA's for global tests). In both subject groups, delta and theta EEG sources shifted towards posterior areas from alertness to sleep, and sources of fast alpha and of the three beta bands towards anterior areas. Locations of the fast alpha and beta sources were more anterior and superior in the old compared with the younger subjects, alert and asleep. Superior-inferior fluctuations of location of delta and beta EEG sources were larger in the old than younger subjects. - Aging is associated with a changing spatial organization of EEG-generating neurons, and affects the temporal dynamics of this organization; this may be one reason that older people are at risk for consciousness disturbances such as delirium.

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On the interpretation of EEG and ERP analysis results. - D. Lehmann (The KEY Institute for Brain-Mind Research, University Hospital of Psychiatry, Zurich, Switzerland).

Four aspects of EEG/ERP interpretation are reviewed: (1) EEG frequencies: The high time resolution of EEG permits computation of polarity reversal frequencies/second, reflecting different functional states. Delta: inhibitory/reconstituting activity; high theta and the alpha bands: routine functioning/relaxation; beta bands and gamma: excitation/facilitation. The concept of significance of absolute Hz contrasts with relative changes showing comparable behavior correspondences across subjects, and with grossly varying resting frequencies in normals. – (2) Localization: EEG/ERP scalp power/potential values cannot be ascribed to perpendicularly underlying generators (cf. VEP P100), because electric fields possess orientations. Source localization requires computation. This issue has serious consequences, e.g. for interpreting coherencies. – (3) Brain work occurs in subseconds, and is distributed in space. Identifying basic brain work units in this time range needs comprehensive, temporal/spatial approaches such as parsing into EEG/ERP microstates. - (4) Electric activity versus blood flow/metabolism: EEG can differentiate fMRI and PET "activations" as to functional significance (inhibitory-routine-excitatory), but relations between voxel-wise EEG/ERP functional tomography (LORETA) versus fMRI and PET imaging are complex. In rCBF-PET and EEG-LORETA from simultaneous recordings (cf. A. Gamma et al.), not all regional activations are detected by both methods, some only by PET, others only by EEG. These correspondences and non-correspondences need clarification.

Mapping plasticity and risks for dyslexia before children learn to read. - D. Brandeis, K. Bucher, U. Maurer, S. Brem and H.-Ch. Steinhausen (Department of Child and Adolescent Psychiatry, University of Zürich, Switzerland).

Learning to read requires a specialization of print processing, and links visual processing to pre-existing language functions. This is presumably reflected in the print-specific occipito-temporal N170 in adults, and represents a typical plastic reorganisation during development. In children with developmental dyslexia, learning to read is selectively impaired. To clarify the role reduced plasticity and of pre-existing risks and deficits, the specialization of visual word processing and the development of auditory and phonological processes during reading acquisition was examined in an ongoing longitudinal study. At baseline, 42 channel ERPs were recorded from Kindergarten children with (N=28) and without (N=29) a familial risk for dyslexia. For visual word-evoked ERPs, better letter knowledge alone (i.e. without word reading skills) led to enhanced occipito-temporal N1 peak amplitudes. Familial risk had no effect. For phoneme ERPs, an enhanced MMN to the *ta-ba* contrast was found for children with better phonological skills, or with better letter knowledge. Together, the findings suggest that early plasticity leading to specialized visual print processing precedes reading acquisition, and that early letter knowledge and phonological skills both enhance automatic phoneme discrimination.

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Mapping early plasticity: word-N200 and letter knowledge in kindergarten children. - U. Maurer, S. Brem, K. Bucher and D. Brandeis (Department of Child and Adolescent Psychiatry, University of Zürich, Switzerland).

Printed words elicit larger occipito-temporal N170 than symbols (Bentin 1999). This suggests fast activation of visual modules specialized for orthographic stimuli. Assuming that this specialization reflects plastic changes that develop during learning to read, illiterate kindergarten children should not show such a difference. Kindergarten children (N=57, mean age=6.6y, screened for phonological abilities and early reading) were shown blocks of words, pseudowords, symbols and pictures during 42 channel ERP recording (0.1-70Hz). They pressed a button for immediate repetitions (20%). Contrary to our hypothesis, illiterate Kindergarten children already showed an ERP difference between words and symbols due to a larger occipito-temporal N220 for words (peak amplitude at T5/6, $p<0.001$). Comparing children with low (up to 6 letters, N=25) vs high letter naming knowledge (above 6 letters, N=32) revealed a significant group × condition × hemisphere interaction (peak amplitudes at T5/6, $p<0.05$), explaining part of the difference in word and symbol processing. The results suggest that plastic changes which underly specialized visual print processing start before the children learn to read. This differential response is coded early and automatically, and might reflect increased familiarity with letters.

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Task performance and intelligence in a recognition paradigm. An EEG study. - M. Doppelmayr, W. Klimesch, P. Sauseng and W. Gruber (University of Salzburg, Salzburg, Austria.

It has been repeatedly shown that specific memory processes differentially influence the human EEG. While episodic memory demands are reflected by changes in the theta band, semantic or stimulus-specific processes are represented in the upper alpha band (Klimesch 1999, Brain Research Reviews, 29, 169-195). Furthermore the slower alpha frequencies are

related to different aspects of attention. Beside these studies there are several experiments investigating the influence of intelligence on the EEG (e.g. Neubauer et al. Intelligence, 1995, 20: 249-266). In this study we have combined these two aspects by dividing a sample 36 of subjects into four groups with either high or low intelligence and high or low memory performance. The experiment consisted of a study and a recognition phase. Event-related desynchronization (ERD) has been calculated for the individually adjusted Theta, Lower-1 Alpha, Lower-2 Alpha and Upper Alpha band. Depending on the respective time interval and electrode position there are several high significant differences between high and low IQ subjects in all of the analyzed frequency bands. Furthermore especially in the theta band there are significant interactions of memory performance and intelligence showing a weaker synchronization for more intelligent persons but a stronger synchronization for subjects with high memory performance.

Synchronisation and time relation between cortical regions during memory processes. - W. Chromecek and P. Rappelsberger (Brain Research Institute, Division of Cellular and Integrative Neurophysiology, University of Vienna, Austria).

The aim of this study was to explore the electrophysiological processes during the encoding and memorisation of digits and numbers. Main emphasis was laid on the time dependence and time course of the processes within and between different cortical regions. Furthermore, differences between good and poor memory performers were investigated. Participants were selected according to the results of a sub–test taken from an established intelligence–test due to good and poor memory. EEG of 6 female participants was recorded while they had to memorize digits and numbers. Stimuli were presented in four blocks and had to be recalled immediately after presentation. In Delta band subjects with good memory show higher coherence between frontally and parietally than subjects with poor memory. Furthermore, subjects show less higher coherence in the fourth trial then in the first trial. This difference was bigger in the group of bad performers than in the group of good performers. Since coherence may be considered as a measure for functional relationships between different cortical regions, the results may be interpreted that good performers seem to find an "ideal neuronal strategy". Moreover, they find this within shorter time than poor performers.

Depends the habituation of the Auditory Evoked Field Component N100m on stimulus duration? - T. Rosburg*, J. Haueisen+ and H. Sauer* (* Department of Psychiatry; + Biomagnetic Centre, Friedrich-Schiller-University Jena, Jena, Germany).

The aim of our study was to clarify whether the habituation of the auditory evoked field (AEF) component N100m depends on stimulus duration. For this purpose 15 subjects underwent left- and right-hemispheric magnetoencephalographic recordings with a 31-channel system (Philips). Subjects were stimulated monaurally in three blocks of sinusoidal 1000 Hz tones with an interstimulus interval of 2000 ms. The stimulus duration differed between these blocks (50, 100, 200 ms), but the order of blocks was counterbalanced within the total experiment. After these blocks always a single block of 1200 Hz tones was applied. The N100m was compared within and between the blocks and between hemispheres, and the effects of block order were analysed. We observed a pronounced decrease of N100m mean global field power and an increase of its latency, both within blocks and in the course of the experiment. In contrast, stimulus duration had no and hemisphere only a slight impact on habituation. Within blocks, habituation had also an influence on dipole location in inferior-superior direction. The change in tone pitch (1200 Hz) led to a slight response recovery and affected the dipole orientation, indicating tonotopic organisation of the auditory cortex.

Consolidation and perceptual learning: electrophysiology and psychophysics. - W. Skrandies, I. Ludwig and A. Jedynak (Justus-Liebig University, School of Medicine, Gießen, Germany).

Perceptual learning in the peripheral visual field was studied in 24 adults using vernier targets. The aim was to relate perceptual improvements to changes of electrical brain activity. Thresholds were measured before, during, and after a training session, and on the next day. During training, the subjects passively looked at suprathreshold targets, and EEG activity was recorded from 30 electrodes over the occipital brain areas. Mean evoked potentials were computed for the first and second block of 1200 stimulus presentations, and the scalp topography of VEP activity was analyzed. In the periphery, thresholds were significantly higher than at the fovea. With training, psychophysical thresholds first increased but were significantly lower on the next day resulting in an overall improvement. These effects were specific only for the trained half field. Perceptual training also affected parameters of electrical brain activity that displayed smaller field strength and altered topography after training. Some of the effects were caused by habituation to the training stimuli resulting in less efficient neurophysiological processing. The topographical changes indicate that different neuronal elements were activated after perceptual learning.

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