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DIPOLE SOURCE ESTIMATE FOR LAPLACIAN DISTRIBUTIONS. F. Babiloni, L. Bianchi, C. Babiloni, F. Carducci, L. Fattorini, P. Onorati and A. Urbano (Human Physiology Institute, University of Rome 'La Sapienza', Rome, Italy).

The estimates of dipole sources for scalp-recorded EEG potentials are affected by errors due to inadequate modeling of the head volume conductor and electrical reference activity. Theoretically, these disadvantages would be strongly reduced if the distributions of Laplacian-transformed potentials are used for source location. Surface Laplacian (SL) of the potential, in fact, attenuates markedly the spatial blur due to head volume conductor, and cancels the effects of the electrical reference. In addition, it is very sensitive to local cortical sources. In this study, we performed dipole source estimates for potential and SL distributions of simulated as well as real EEG data. Simulations were used to evaluate the errors of dipole position and orientation caused by SL estimate and electrical reference (10-100% of the analytic potential distributions generated by single dipoles). The errors of dipole localization produced by head volume conductor were examined before and after the SL transformation of movement-related potentials recorded in normal humans. Results were as follows: (i) a maximum error of 6.6 mm and 28° was observed when computing dipole sources for simulated SL distributions; (ii) for simulated potential distributions the error increased when augmenting the incidence of the electrical reference (up to 6 cm and 86° for 100% electrical reference); (iii) the dipole source estimates for SL distributions were not affected by variations of electrical reference; (iv) when compared to the dipole sources for scalp potential distributions, the dipole sources for the corresponding SL distributions were located more "cortically", and showed less interindividual variability in position and orientation.

ESTIMATE OF THE SURFACE LAPLACIAN OF POTENTIAL DISTRIBUTIONS OVER A REALISTIC MODEL OF THE SCALP. F. Babiloni, C. Babiloni, F. Carducci, L. Fattorini, P. Onorati and A. Urbano (Human Physiology Institute, University of Rome 'La Sapienza', Rome, Italy).

The estimate of surface Laplacian (SL) of scalp potential distributions is generally performed by computing the second spatial derivatives of the potential distributions over mathematical planar, spherical and ellipsoidal models of the scalp. However, these models are inaccurate in approximating the real surface of the scalp, especially over temporal and parietal areas. In the present study, we propose a new SL estimator for potential distributions that uses a realistic mathematical model of the scalp. This estimator, which is based on the definition of the SL through a metric tensor, uses the function 3D spline of Duchon to compute the second spatial derivatives of the potential distribution. The mathematical realistic model of the scalp was constructed as follows: (i) the real scalp surface was computed with 15,000 points from Magnetic Resonance Images (MRIs); (ii) 640 out of these points were interpolated with the 2D thin plate spline. The mathematical realistic model was compared with the mathematical spherical and ellipsoidal models that best fitted the same 640 points. The fitting error (RMSE) between the mathematical models and the real scalp was calculated on the remaining 14,360 points from MRIs. It was found that the RMSE values were much lower with the mathematical realistic model (0.0064) than with the mathematical sphere (0.107) and ellipsoidal (0.075) models.

NEURONAL PROCESSES OF PENICILLIN-INDUCED SPIKES DESCRIBED BY ELECTRIC AND MAGNETIC FIELDS. *Eiselt, M., *Wagner, H., *Zwiener, U., **Nowak, H., **Huonker, R., **Gießler, F. (*Institut für Pathologische Physiologie, **Biomagnetisches Zentrum, Friedrich-Schiller-Universität, Jena, Germany).

Neuroelectric processes: The involvement of cortical areas surrounding a spike focus (induced by 50 I.E. penicillin; layer II/ III) was investigated in 6 rabbits by intracortical Current Source Density analysis (CSD). The electric field was measured simultaneously with two 16-channel micro-electrodes, one within the focus and the second at decreasing distance to the focus starting at 5 mm. Selective spike-averaging was performed using a correlation algorithm. Results: During the negative deflection of spikes, current dipoles were located within the focus between the boundary of layer I/II (intracortical depth 300 µm) and layer IV (600 µm) with volume current directed toward cortical surface. After a time delay of 30-50 ms, dipoles with volume currents directed toward the depth were measured at the same layers. Within the surrounding area (2-4 mm), current dipoles were frequently directed in contrary direction. At a distance of 5 mm current dipoles related to the spike were infrequent. *Neuromagnetic processes*: A 3-dimensional distribution model of the abovementioned current dipoles

Temperature Laboratory, Helsinki University of Technology, Espoo, Finland, and +Department of Psychology, Harvard University, Cambridge, USA).

We recorded spontaneous MEG signals during visual imagery from 11 healthy adults with a whole-head neuromagnetometer. The parieto-occipital 9 - 12 Hz alpha activity was suppressed more strongly during a visual imagery task than in a control task that did not require visual imagery. A similar suppression occurred in the 15 - 25 Hz range for two subjects. The act of forming a visual image caused a smaller suppression than did inspection of the imaged pattern for a named property. The maximum suppression was approximately proportional to the baseline alpha strength, with no systematic hemispheric asymmetry. Sources for the reactive alpha activity, modeled with equivalent current dipoles, clustered in the occipital and parietal lobes.

STEADY STATE VISUALLY EVOKED POTENTIAL TOPOGRAPHY AND TASK AUTOMATIZATION. R.B. Silberstein*, J.G. Wallace, A. Pipingas* and K. Bluff** (*Centre for Applied Neurosciences, **Information Technology Institute, Swinburne University of Technology, Melbourne, Australia).**

This study reports, for the first time, changes in the steady state visually evoked potential (SSVEP) during the automatization of a cognitive task. Sixteen male subjects performed an alphabet arithmetic task which required them to indicate, by a left or right hand button press, if equations of the type (B+3=E, i.e., E is 3 letters after B) were correct or not. Subjects were repetitively exposed to equal proportions of correct and incorrect versions of 6 different equations over a period of four, 8 minute intervals. Over the duration of the experiment, mean reaction times dropped from 3.05 to 1.12 second, for a typical equation. All subjects reported using a demanding "algorithmic approach" at the beginning outset which became "automatic" and "effortless" by the end of the experiment. Brain electrical activity was recorded from 64 scalp sites with respect to linked earlobes, filtered (-3dB at 1Hz and 26Hz) and digitized to 12 bit accuracy at 200Hz. The SSVEP was elicited by a 13 Hz uniform visual flicker. The SSVEP topography demonstrated, task specific changes, which varied over the duration of the experiment. Early in the experiment, the SSVEP amplitude in the prefrontal and temporal regions, was attenuated in the interval between equation presentation and motor response. By contrast, in the last part of the experiment, when automatization was consistently reported, the dominant changes in the SSVEP were a transient reduction following the motor response. These data support the notion of prefrontal cortical activation during the "algorithmic" phase of the experiment and the reduction of prefrontal activation with automatization.

GAMMA-BAND OSCILLATIONS INDUCED BY COHERENT VISUAL STIMULI IN HUMAN. C. Tallon, O. Bertrand, P. Bouchet and J. Pernier (Brain Signals and Processes Laboratoty, INSERM, Lyon, France).

We tested the hypothesis of a role of 40 Hz oscillations in feature binding by recording evoked potentials from 12 subjects to three visual stimuli. Two coherent stimuli (a Kanizsa triangle and a real triangle) were used; the non-coherent stimulus was a Kanizsa triangle in which the inducing disks had been rotated so that no triangle could be perceived.

Two bursts of oscillations could be observed, a first one around 100 ms and a second one around 240 ms. The evoked potentials were analyzed by convoluting the signal for each subject and each stimulation type by Gabor wavelets centered at 28, 30, 32, ..., to 46 Hz, yielding a continuous measure of frequency-specific power over time. The first burst of oscillations was maximal at 38 Hz, the second one at 34 Hz. The power of the first burst differed from noise for each stimulation type, but did not exhibit any variations with stimulation type. The second burst differed from noise only in case of a coherent stimulus. The power of the responses elicited by the two coherent stimuli were not statistically different.

The amplitude of the low-frequency responses were analyzed on the same time windows : no stimulus effect could be found around 100 ms. A difference in amplitude was found around 240 ms: the illusory triangle elicited a stronger response than the two other stimuli. This effect was thus different than the one found on γ-band signal; moreover, it appeared on different electrodes. Low and high frequency responses would thus corespond to different physiological phenomenon.

We thus found that the power of γ-range oscillations correlates with stimulus coherency, which supports the hypothesis of a functional role of high-frequency oscillations in feature binding.

REALISTICALLY SHAPED MODELS OF THE HEAD IN EEG SOURCE LOCALISATION. F. Zanow and M.J. Peters (University of Twente, AE Enschede, Holland).

Inverse solution techniques based on electroencephalographic (EEG) measurements have become a powerful means to gain knowledge on the functioning of the brain. A model of the head and a potential computation method are necessary to describe the EEG problem mathematically. The generation of realistically shaped three-compartment models of the head is discused. The isolated-problem approach for the boundary element method (BEM) is applied to develop a fast and reliable numerical solution of the EEG forward problem. Accuracy studies with this approach show that dipole positions can be reconstructed within a distance of 3 mm from the original positions. Inverse simulations indicate that the incorporation of the individual head shape may significantly influence the reconstructed dipole position but not its magnitude and orientation, in comparison with the commonly used three-sphere model. However, the presence of noise in the simulated potential data affects the solutions based on realistically shaped models more than those of the simple three-sphere model. This effect is investigated more in detail by means of visualising the objective function of the dipole optimization. The locally optimal dipole is estimated in a dense grid of scan points in the region of interest. This enables us to gain specific information about the steepness of the objective function as well as about possible local minima caused by the realistically shaped head model or by noise in the EEG potentials.

TOWARD BIOLOGICAL CLASSIFICATION IN PSYCHIATRY. E.R. John and L.S. Prichep (Department of Psychiatry, NYU Medical Center, New York, NY, USA).

Neurometric analysis was performed on 2 minutes of artifact-edited EEG samples obtained from 588 psychiatric patients in DSM-III-R categories. After Z-transformation, all variables were evaluated and rank ordered for heterogeneity of variance across the full group. A set of 10 "clustering variables" was selected with highest heterogeneity but intercorrelations < 0.7. Maximum separation of this patient sample from a huge group of normals was achieved when 12 clusters were sought (BMDP, K means).

The 588 patients were separated into two split halves by randomizing those in each of the 7 diagnostic categories. Cluster analysis was carried out on the first split half and the second split half then classified into the 12 clusters thereby obtained.

The distributions of 7 diagnostic categories into the 12 clusters correlated 0.86 between the two split halves of the sample. The patients in each DSM-III-R category were replicably separated into multiple subtypes, containing patients with similar symptoms but different pathophysiology. Each cluster was comprised of patients who had been diagnosed into different DSM-III-R categories, displaying similar pathophysiology but different symptoms. Preliminary data reveal different responses to treatment of patients with the same DSM-III-R label