repetitive ("standard") tones with five selected onset frequencies were randomly embedded in the string of rare ("deviant") tones with randomly varying inter stimulus intervals. In the deviant tones one of the frequency components was omitted relative to the deviant tones during the onset period. The frequency of the test partial of the complex tone was intentionally selected to preclude its reinsertion by generation of harmonics or combination tones due to either the nonlinearity of the ear, the electronic equipment or the brain processing.

In the second set of stimuli, time structured as above, standard tones with five selected sustained partial frequency components were embedded in the string of deviant tones for which one of these selected partials was omitted in the sustained tone. The same considerations for selecting the test frequency partial as mentioned above were applied.

Results- By comparing MMNm of the two data sets, the relative contribution to sound recognition of the omitted partial frequency components in the onset and sustained regions has been determined.

Conclusion- The presence of significant mismatch negativity, due to neural activity of auditory cortex, emphasizes that the brain recognizes the elimination of a single frequency of carefully chosen anharmonic frequencies.

1-2-14: Auditory Mismatch Responses in Early Infancy

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Introduction: MEG is a powerful neuroimaging technique that has been used to study the auditory response.

Objective: To determine if newborns are able to discriminate between different stimuli during the first months of life.

Methods: 5 neonates, born at conceptional age (CA) 35 ÷ 39 weeks, were studied in presence of auditory stimulation during several minutes. The stimulation consisted of two stimuli of 0.1 sec 1000 Hz tones (standard tones) and occasional 0.1 sec 1050 Hz tones (deviant tones), presented in an oddball paradigm in a 7:1 ratio. The MEG signals and stimulus trigger were digitalized continuously at 520.8 Hz and digitally filtered using a 0.5 ÷ 20 Hz passband. Finally the signals were analyzed by using independent component analysis (ICA).

Results: The recordings of the deviant response showed bigger amplitude than the standard response. And an extra component for the deviant response was observed at longer latencies (400-600 ms). The latency of this extra component decreased with CA.

Conclusions: Our findings suggest that adult-like mismatch negativity is not present in newborns. On the other hand, the presence of the late component in the deviant response implies that newborns are nonetheless able to discriminate the standard and deviant tones.

1-2-15: Developmental Patterns of Auditory Evoked Magnetic Fields in Healthy Children

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As magnetoencephalography (MEG) is of increasing utility in the assessment of deficits and development delay in pediatric patients, it is essential to build a robust normative database for precise identification of abnormalities in children. The objective of this study was to characterize the development patterns of the auditory evoked magnetic responses in regard to age and gender. 60 children (6-17 years old, 30 female and 30 male) and 20 adults (21-49 years old, 10 female and 10 male) were studied with a 275-channel MEG system. One hundred trials were recorded with binaural tone stimulation. MEG data were recorded at a sampling rate of 6000 Hz. Data were averaged and filtered with a filter of 10-100 Hz for identification of neuromagnetic response (deflections). Two main responses were identified at 70 ms (M70) and 102 ms (M100) in latency for all children (60/60, 100%). To reveal the developmental changes, MEG data from children were divided into three age groups: 6-9, 10-12 and 13-17 years old. The waveform showed that the two components were consistently detectable at least 6 years onward. The waveform morphology of auditory evoked magnetic activity has shown the greatest changes during 6-12 years old. The neuromagnetic responses were fairly stable between ages 13-17. In addition, there were significance differences between girls and boys. Further analyses of the left and right responses revealed clear developmental lateralization patterns in children. The results indicate that there is a clear developmental pattern in the auditory system.

1-2-16: Effect of maternal smoking on the human fetal and neonatal cortical activity

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Objective: To study the effect of smoking by mothers on the fetal and neonatal brain using non-invasive magnetoencephalography technique (MEG).

Materials and Methods: Using fetal-MEG, cortical auditory evoked responses (AER) were measured from 20 fetuses ranging from 27 to 39 weeks gestational age for a total of 69 recordings. 29 measurements were taken from 10 mothers with a history of smoking (SM) and 40 from 10 mothers with no smoking history (NS). After delivery, five SM and five NS newborns had MEG AER measurements twice for a total of 20 recordings. AER was quantified by cross-correlation analysis and its significance was assessed by boot-strap technique.

Results: AERs were detectable in 35 out of 40 fetal recordings in the NS group and 23 of 29 in the SM group. The neonatal response rate was 90% for each group. The latencies were divided into three components: C1 (100-300 ms), C2 (301-600 ms) and C3 (601-900 ms). For the fetuses in NS group, the mean values of the latency in C1, C2 and C3 components were 199, 475 and 736 ms, respectively. For the fetuses in SM group, the mean values of the latency in C1, C2 and C3 components were 205, 432 and 732 ms, respectively. For the neonates in NS group, the mean values of the latency in C1 and C2 components were 237 and 391 ms, respectively. For the neonates in SM group the mean values of the latency in C1 and C2 components were 218 and 353 ms, respectively. In both fetuses and neonates as well, there was a statistically significant difference (p< 0.05) between the two groups in the C2-component. The SM group showed faster AER compared to NS group.

Conclusion: MEG technique provides a non-invasive approach to study the effects of smoking on developing fetal and neonatal brain. The observed decrease in the latency of fetuses and neonates of the smoking mothers could indicate a hypersensitive cortical response to auditory tone.

1-2-17: Evidence for a frontal cortex role in mediating both auditory and somatosensory habituation: A MEG study

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Auditory and somatosensory responses to paired stimuli were investigated for commonality of frontal activation that may be associated with gating using MEG. A paired stimulus paradigm for each sensory evoked study tested right and left hemispheres independently in ten normal controls. For both modalities, the inter-stimulus interval was 0.5 second with 100 trials repeated using an 8 second inter-trial interval. MF-FOCUSS, a current density technique, imaged simultaneously active cortical sources. Each subject showed source localization, in the primary auditory (using a 500Hz tone) or somatosensory cortex (using finger tap), for the respective stimuli following both the first (S1) and second (S2) impulses. Gating ratios for the auditory M50 response, equivalent to the P50 in EEG, were 0.54 ± 0.24 and 0.63 ± 0.52 for the right and left hemispheres. Somatosensory gating ratios were evaluated for early and late latencies as the pulse duration elicits extended response. Early gating ratios for right and left hemispheres were 0.69 ± 0.21 and 0.69 ± 0.41 while late ratios were 0.81 ± 0.41 and 0.80 ± 0.48. Regions of activation in the frontal cortex, beyond the primary auditory or somatosensory cortex, were mapped within 25 ms of peak S1 latencies in 9/10 subjects during auditory stimulus and in 10/10 subjects for somatosensory stimulus. Similar frontal activations were mapped within 25 ms of peak S2 latencies for 75% of auditory responses and for 100% of somatosensory responses. Comparison between modalities showed similar frontal region activations for 17/20 S1 responses and for 13/20 S2 responses. MEG offers a technique for evaluating cross modality gating. The results suggest similar frontal sources are simultaneously active during auditory and somatosensory habituation.

1-2-18: Neuromagnetic responses to audiovisual vowel stimuli

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Neuromagnetic responses were recorded to investigate the hypothesis that auditory N1m responses to vowel sounds were modulated when one observed the other vocalizing and predicted what was said, and that the visually evoked responses in motor cortex were correlated with the amount of N1m amplitude modulation. The apparent motion of articulating vowels and the corresponding sounds were presented with the SOA of 0.5 s. The visuoauditory pairs involved two conditions: the matched pair of visual and auditory stimuli (congruent condition), and the mismatched pair of stimuli (incongruent condition). Visual and auditory evoked magnetic fields were recorded respectively by using a neuromagnetometer VectorView. Visual evoked responses were analyzed by multiple current estimates, placing regions of interest on the surface of the brain areas. Auditory evoked responses were selectively averaged according to the visuoauditory conditions. Furthermore, stepwise multiple regression analysis was performed to clarify the relation between the preceding visually evoked responses and the auditory evoked responses. The visuoauditory congruent...
condition elicited smaller N1m amplitude than the incongruent condition. In both hemispheres, the stepwise multiple regression revealed that the reduction rate of N1m amplitudes between the presented conditions correlated significantly with the source activities in motor and superior temporal areas. The present study suggested that some sensorimotor mediated prediction modulated auditory activity when one observed the other vocalizing. And the correlation between the change rate of N1m amplitudes and the visual evoked responses suggests that the activation of motor areas mediates predictive perception of vowel sounds.

1-2-19: The impact of virtual reality movement on auditory cortical responses: a magnetoencephalographic study

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To investigate changes of auditory perception under virtual reality, we developed a virtual reality image of the inside of the space station and analyzed whether auditory cortex activity is influenced by rotating the image using magnetoencephalography (MEG). We presented 1000Hz pure tone as the auditory stimulus to normal volunteers in four different visual conditions: (1) RR (revolutionary rotation): The virtual images rotated around the center, (2) VR (vertical rotation): The images rotated vertically, (3) HR (horizontal rotation): The images rotated horizontally and (4) ST (Static): The images did not rotate. In the rotation conditions, particularly in RR and VR, all subjects really felt as if they were rotating. Then, we compared the difference in the auditory evoked component among the conditions. The dipoles were estimated to lie in Heschl’s gyrus and the Planum Temporale for all conditions with no significant differences in location among the conditions, but the dipole moment was significantly larger for RR and VR than for ST in the right hemisphere. The dipole moments for RR and VR were significantly larger in the right hemisphere than the left. These results show that auditory function was influenced by rotation of the inside of the space module with microgravity, directly by audio-visual interaction and/or indirectly through vestibular function.

1-2-20: Effects of rise-time of stimulus on auditory N1m to air-conducted, bone-conducted audible and bone-conducted ultrasonic sounds

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The rise-time of the sound stimuli greatly affects amplitude and latency of electrocochleogram and auditory brainstem responses. Several studies have reported that the rise-time of sound stimuli affects on auditory evoked responses. N1/N1m has been shown to decrease in amplitude and increased in latency as rise-time increased. However, the effects of each parameter that vary in accord to rise-time - whole energy, rising-speed (dL/dt), spectrum, and so on - have not been clarified. In this study, N1m amplitudes and latencies were examined with varying rise-times and constant energy or rising-speed. For this, we used air-conducted sound (AC; noise-burst), bone-conducted audible sound (BC; 1-kHz tone-burst), and bone-conducted ultrasound (BCU; 30-kHz tone burst) that are perceived even by the profoundly sensorineural deaf. The results showed that N1m increased in amplitude and decreased in latency as rise-time increased (i.e. energy increased) under the rising-speed-constant condition for all kinds of stimuli. By contrast, N1m amplitudes and latencies did not significantly vary as rise-time increased (i.e. rising-speed decreased) under the energy-constant condition for all kinds of stimuli. These results indicated that sound energy has a greater effect on N1m amplitude and latency than does rising-speed because of the temporal-integration mechanisms that exists in the auditory cortex. It was also suggested that BCU and audible sounds (AC and BC) are processed in a similar manner at the cortical level, while there are some difference in the inner-ear mechanisms.

1-2-21: Temporal-integration mechanisms in the auditory cortex -Effects of frequency variation within an audible to ultrasonic range-

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The duration of sound stimulus affects cortical activities as does loudness, whereas stimulus-duration has no effects on auditory brainstem responses. Therefore, it is considered that a temporal-integration mechanism exists in the auditory cortex. The effects of stimulus-frequency, in an audible to ultrasonic range, on auditory temporal-integration at the cortical level were investigated. The effects of stimulus duration on auditory evoked magnetic fields, N1m, evoked by air-conducted audible sounds (AC; 1000, 4000, 8000, 12500-Hz tone bursts) and a bone-conducted ultrasound (BCU; 30000-Hz tone burst), which is perceived even by the profoundly sensorineural deaf, were investigated. For all