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
stimuli, N1m magnitude increased and N1m latencies decreased with an increase of the stimulus-duration and leveled when the stimulus-duration reached 40 ms. N1m for BCU was smaller and later than that for AC; however, no difference was observed in the saturation time. The results indicate that stimulus-frequency does not affect the auditory temporal-integration at the cortical level. It was also suggested that BCU and AC are processed in a similar manner at the cortical level. However, some differences exist in the inner-ear mechanisms.

1-2-22: Timbre perception of phase modulation reflected by P50 features: A preliminary study
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Timbre may be classified into frequency, amplitude, time and phase according to its physical aspects. In this study, we focused on timbre processing in auditory perception, especially on phase modulation, reflected in P50 components. The hypothesis was that the features of P50 components are related to the timbre perception of phase modulation.

Stimuli were pairs of mixed frequencies with length 50ms, composed of 4 harmonic (110, 220, 440, 880 Hz) or non-harmonic (110, 247, 523, 1174 Hz) tones. For deviant conditions, the phases of 2 higher frequencies in each tone were modulated by 0.8 $\pi$. The interpair interval was 500ms. Magnetic signals were recorded using 306 channel whole head MEG system (Elekta NeuroMag VectorView). P50 was identified as the most RMS peak in the 40-80ms time window. P50 suppression was calculated as the ratio of the second to the first P50 amplitude.

Normal P50 suppression was observed as (harmonic: 0.56, non-harmonic: 0.86) that in standard (identical pairs) condition. It may be attributed to gating out effect. In deviant condition (phase modulated in second tone), P50 suppression was not observed (1.02, 10.6, respectively). The detection of phase modulation may belong to the early stage of auditory perception, which is also the stage for timbre feature extraction [1]. There was a slight difference between harmonics and non-harmonics (0.56 vs. 0.86). P50 suppression in non-harmonics was less than that in harmonics [2]. Additional experiments in order to ensure statistical significance may support our hypothesis that P50 reflects the timbre processing, at least the phase modulation and/or complexity of components.


1-2-23: Stochastic resonance observed in phase synchrony and power of auditory steady state responses
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We measured auditory steady state responses (ASSRs) in magnetoencephalogram to the sinusoidal amplitude modulated tone superimposed with ongoing white noise of various intensities. The power and phase coherence of the ASSR were investigated and stochastic resonance was indicated by increased synchrony to the stimulus and by increase in power of the ASSR when there was certain amount of noise compared with those measured without the noise. We also measured the hearing threshold for the noise alone and found that the optimum noise intensity for stochastic resonance was slightly larger than the threshold for most of the subjects. As the power and coherence curves plotted against the noise to signal ratio varied considerably among subjects, we used the maximum values of power and phase coherence as test statistics for testing the group data.

1-2-24: The time course of amplitude changes for N1m and P2m: Effects of age and stimulus type
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N1 and P2 auditory responses have been used to examine training-related changes in brain function and the observed changes are often described in terms of brain plasticity. To learn more about these effects, we examined the role of repeated stimulus presentation on these components as a function of age and stimulus type. Forty-three adults (age range 19-74) participated in this experiment. Responses to two speech tokens and one noise sound were obtained during two baseline recordings, obtained on separate days, prior to training. Amplitude changes for N1 and P2, within and across test sessions, in response to different stimulus types were examined. N1 decreased with repeated stimulation in as short as 2 min. and continued throughout the duration of MEG recording. N1 changes reversed and no significant N1 changes were observed between sessions on different days. In contrast, P2 amplitude did not significantly change in amplitude within each session however P2 increased between session. Larger P2 amplitude in the second session was
observed after up to 20 days for all stimulus types, and this effect was age dependent. Increases in P2 amplitude, continuing for at least several weeks, were most evident for the younger group and less so for the older group, suggesting that the physiological system of young adults is more responsive to repeated stimulus presentations during MEG and behavioral testing. Implications of these findings are: 1) rapid physiological changes might be early indices of rapid perceptual learning 2) these physiological effects are reduced in older adults 3) traditional views of N1-P2 test-retest reliability, which are typically recorded from isolated sensor or electrode sites, are dependent on the location and methods used to quantify amplitude.

1-2-25: Attention enhances MEG recorded gamma-band auditory steady-state response
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Gamma-band oscillations (>30Hz) have been associated with perceptual binding of stimulus features into an object. Selective attention is strongly connected to binding when focusing on target features while ignoring irrelevant information. We investigated the effect of attention on 40-Hz auditory steady-state responses (ASSR) as a model of gamma-band oscillations. Human magnetoencephalography was recorded while young adults listened to monaural sequences of 500-Hz tones with 40-Hz amplitude modulation (AM). In attended condition subjects responded with right-hand button press to 10% of the stimuli with 30-Hz modulation. In non-attended condition, only the 40-Hz AM tones were presented for 5 min while the subjects watched a series of photographs (one per 3 s) and counted four categories of visual objects. Eight blocks of each attended and non-attended conditions were recorded using left and right monaural stimulation respectively. The ASSR assessed by sources in bilateral auditory cortices were significantly larger in attended condition compared to non-attended condition, while the effect was more expressed in the contra-lateral hemisphere and to left ear stimulation. As even stronger effect of attention the sustained response were strongly enhanced. However, attentional enhancement of transient gamma-band response were small (40-80 Hz) or even not detectable (24-28 Hz). The results confirm that steady-state gamma-band oscillation is functionally dissociated from transient components. Modulation of sustained rather than transient responses was interpreted as indicating involvement of top-down attentional control. Volumetric mapping of phase coherence in a dichotic listening task revealed that especially lateral anterior parts of auditory cortices are modulated by attention with higher synchrony contralateral to the attended ear.

1-2-26: A novel type of auditory responses: Temporal dynamics of 40-Hz steady-state responses induced by changes in sound localization
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Magnetoencephalographic responses to 40-Hz amplitude modulated (AM) tones of 4 s duration were recorded in young, middle aged and older healthy participants. Interaural phase difference (IPD) in the sound carrier was changed during stimulus presentation from 0 to 180 degrees, resulting in perceptual change between focal and spacious sound. The stimulus AM elicited 40-Hz auditory steady-state responses (ASSR). Equivalent current dipoles were localized in primary auditory cortices. Cortical activity showed a decrement in ASSR amplitude 100 ms after stimulus IPD change and modification of ASSR phase, which was maximally 90 degrees, corresponding to 6 ms delay, at 150 ms latency. Time courses of ASSR phase deviation were used as a novel auditory response. The amount of ASSR phase change decreased with increasing stimulus frequency and revealed upper limits for physiological IPD detection. IPD thresholds were found at 1500 Hz in the young, at 1250 Hz in middle-aged and at 1000 Hz in the older group. Comparison of 40-Hz ASSR between age groups showed no effects of aging on the size of the 40 ASSR and the size of the ASSR change response. Additionally ASSR change responses were recorded at higher rate of stimulus changes every 400 ms. Response detection at this rate was superior to response detection based on the auditory evoked P1-N1-P2 response. Responses to changes from focal to spacious sound were larger than in reverse direction. The ASSR were interpreted in relation to oscillatory gamma activity representing auditory object representation. Observed temporal dynamics are in line with a series of studies which demonstrated the general mechanism of stimulus induced modifications of driven gamma band oscillations. A common result was that the time course of phase changes is the most sensitive indicator for the event related change.