inter-stimulus intervals more than one second. In 5Hz periodical median nerve stimuli common BSS patterns of the primary somatosensory cortex, power electric noise, eye blinks, and alpha waves were observed in seven subjects. Although the absolute summation of off diagonal elements of correlation matrices is minimized in the algorithm of the decorrelation method, the correlation between BSS components still remains. For a trivial example there are two BSS components necessary to express power electric noise, which are not independent. That is, the decorrelation method is not perfectly the independent component analysis but the blind source separation. Taking advantage of little cross-correlation between BSS components we could find typical BSS components related to periodical median nerve stimuli. In each individual case their BSS patterns were found as one of two types with ipsilateral dipole pattern near SI:1) activity of ipsilateral primary somatosensory cortex,2) phase locked activity of alpha or beta wave. Another typical patterns near contralateral SI were the BSS components necessary to spatial expansion of the waveform of SEF.The other typical patterns of dipole related to periodical median nerve stimuli were observed near the second contralateral somatosensory or the auditory cortex.

1-4-6: Waveform analysis of neuromagnetic response by mixed AEF and SEF using DSVD

*Bong-Soo Kim[1,2], Yoshinori Uchikawa[2], ManYoel Lim[1,3,] ChunKee Chung[1,3]

[1]MEG Center, Department of Neurosurgery, Seoul National University Hospital [2]School of Science and Engineering, Tokyo Denki University [3]College of Natural Sciences, Seoul National University

Introduction
The aim of this study is to investigate neuromagnetic response elicited by mixed auditory and somatosensory stimulations using dynamic singular value decomposition (DSVD), having time window and shift time [1]. We performed measurement of AEF, SEF, and mixed AEF and SEF, respectively. The DSVD method was applied to each magnetic data for investigating multiple source activities overlapping in time.
Methods
We performed measurements of the SEF by median nerve stimulation and the AEF by tone burst to right ear, respectively (5 males, age: 20-36 years, Neuromag122TM). In the mixed AEF and SEF, stimulation to the median nerve was delivered 80 and 200ms later than to the right ear, respectively. The DSVD method was applied to each spatio-temporal magnetic data. Finally, time-frequency analysis was applied to each magnetic data to discuss the frequency component.
Results and Discussion
It showed that the time course of the first singular value corresponded to the latencies (SEF: around 20, 80 and 120ms, AEF: around 100ms) of magnetic waveforms, respectively. Furthermore, to discuss hemispheric characteristics, the DSVD was also applied to the contra and ipsilateral data, respectively. The correlation coefficient between the contralateral and all magnetic data showed a higher value (more than 0.7) than that of the ipsilateral. Dominant power spectrum of the AEF showed wide distribution from 50 to 220 ms and the peak frequency is 6Hz. However, dominant power spectrum of the SEF showed narrow distribution from 50 to 120 ms and the peak frequency is 11Hz. We conclude that the DSVD is useful for analyzing spatio-temporal neuromagnetic activity of the human cortex.
Reference
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1-4-7: Somatosensory evoked magnetic fields following stimulation of the tongue in humans

*Kiwako Sakamoto[1,2], Hiroki Nakata[1,3], Ryusuke Kakigi[1,2]

[1]Department of Integrative Physiology, National Institute for Physiological Sciences [2]Department of Physiological Sciences, School of Life Sciences,The Graduate University for Advanced Studies [3]School of Health Sciences, Nagoya University

Objective: To clarify thecharacteristics relating to the temporal dynamics of the tongue primary somatosensory cortex (SI).Methods: We fabricated individual intraoral devices, and recorded somatosensory evoked magnetic fields (SEFs) from ten normal subjects. The tongue was stimulated with a concentrated bipolar electrode in four areas: the right and left antero-lateral margins, and the right and left postero-lateral margins.Results: The primary component was recorded about 19 ms post-stimulation. Six components, termed 1M, 2M, 3M, 4M, 5M, and 6M, respectively, were found within 130 ms of the stimulation. These activities were detected in hemispheres both contaralateral and ipsilateral to the stimulation, and were estimated to be located around the tongue SI. In addition, the latency of the contralateral hemisphere was significantly shorter than that of the ipsilateral hemisphere for all components, independent of the area stimulated.Conclusions: Tactile stimulation of the tongue elicited activity in the tongue SI in both hemispheres. Significance: This is the first study to investigate the brain responses evoked by stimulating different areas of the tongue, using magnetoencephalography.

1-4-8: Developmental changes of cortical oscillatory activity patterns following finger stimulation in healthy children

*Yingying Wang[1], Jing Xiang[1], Rupesh Kotecha[1], Elana Harris[1], Xiaolin Huo[1], Yang Liu[1], Elijah Kirtman[1], Nat Hemasilpin[2], Hisako Fujiwara[1], Douglas Rose[1]

[1]Department of Neurolgoy, Cincinnati Children's Hospital Medical Center, Cincinnati, Ohio [2]Department of Clinical Engineering, Cincinnati Children's Hospital Medical Center, Cincinnati, Ohio

To investigate the developmental changes of cortical oscillatory activity patterns following finger stimulation in healthy children, we recorded neuromagnetic activity during electrical stimulation of the right index finger in 60 healthy right-handed children (30 females and 30 males, aged 6-17 years, mean 11.3) using 275-channel whole head magnetoencephalography (MEG) system. Electrical stimulation was applied to the right index finger with two Digital Rings. 100 trials were recorded. Focal increases of spectral power were localized in the primary somatosensory cortex using wavelet based beamformer. Oscillatory activity was analyzed from the raw MEG waveform for the primary somatosensory cortex using Morlet wavelet transform. This analysis was carried out from 5 Hz up to 1000 Hz. We compared three age groups (6-9, 10-13 and 14-17 years old). Our results demonstrated that high-frequency oscillations changed as a function of age with regard to spectral power, duration, and source volume. In addition, the interpeak latency of high-frequency oscillations in children increased with age. These results suggest that high-frequency oscillations are a signature of the functional development of the brain in children.

1-4-9: Laser-evoked magnetic fields following noxious stimulation of the thigh

*Hiroki Nakata[1,2,3], Yohei Tamura[4], Kiwako Sakamoto[1,5], Masahiro Hirai[1,3], Koji Inui[1], Minoru Hoshiyama[1,2], Ryusuke Kakigi[1,5]

[1]Department of Integrative Physiology, National Institute for Physiological Sciences, Okazaki, Japan [2]School of Health Sciences, Nagoya University, Nagoya, Japan [3]Japan Society for the Promotion of Science, Tokyo, Japan [4]Department of Neurology, Jikei University School of Medicine, Tokyo, Japan [5]Department of Physiological Sciences, School of Life Sciences, The Graduate University for Advanced Studies, Hayama, Kanagawa, Japan

Primary somatosensory cortex (SI) and posterior parietal cortex (PPC) are activated by noxious stimulation. In neurophysiological studies using magnetoencephalography (MEG), however, it has been difficult to separate the activity in SI from that in PPC following stimulation of the upper limb, since the hand area of SI is very close to PPC. Therefore, we investigated human pain processing using MEG following the application of a thulium-YAG laser to the left thigh to separate the activation of SI and PPC, and to clarify the time course of the activities involved. The results indicated that cortical activities were recorded around SI, contralateral secondary somatosensory cortex (cSII), ipsilateral secondary somatosensory cortex (iSII), and PPC, with early components peaking at about 100 ms and late components at about 150-185 ms. The precise location of PPC was indicated to be the inferior parietal lobule (IPL), corresponding to Brodmann area 40. The mean peak latencies of SI, cSII, iSII and IPL for late components were 152, 170, 181, and 183 ms, respectively. This is the first study to clarify the temporal dynamics of SI, SII, and PPC in human pain processing using MEG.

1-4-10: Adaptive beamformer analysis of visceral pain processing

*Thomas P White[1], David Humes[2], Matt Brookes[1], Debbie Bush[2], Luca Marciani[2], Sue Francis[1], John Simpson[2], Claire Stevenson[1], Penny Gowland[1], Peter Morris[1], Robin Spiller[2]

[1]SPMMRC, University of Nottingham, Nottingham, UK [2]WDDC, University Hospital, Nottingham, UK

Introduction: fMRI results suggest that noxious visceral distension elicits activity in a widespread network of brain structures including bilateral insula, ACC, S2 and less robustly S1 [1,2]. Using MEG to investigate visceral pain processing is a promising application to this field. Here we explore the use of MEG, in conjunction with beamformer analysis, to monitor cortical activity during painful rectal distension. Method: 11 healthy female volunteers (age 31 ± 12 years) took part in a 24-minute task comprising dynamic assessment of noxious rectal-balloon barostat distension. MEG data were recorded using a 275 channel CTF whole-head MEG scanner. Source localisation was performed using SAM. Data were analysed in δ (0.1-4 Hz), θ (4-8 Hz), α (8-13 Hz), β (13-25 Hz), and γ (25-45) bands, with windows selected to contrast noxious and baseline periods. Pseudo-T-statistical images showing the spatial distribution of power change between these windows were overlaid onto individual MRI images. Results: Significant α-band event-related synchronisation (ERS) was found in anterior insula in 8 subjects. θ ERS was also found in ACC (7 subjects), δ and θ ERS in S2 (5 subjects alike), and notably θ ERS in S1 (5 subjects). Discussion: We report an extensive network of brain regions mediating rectal pain perception in healthy subjects, similar to that previously detected with fMRI. Beamformer techniques were considered useful with such a temporally ill-defined stimulus. MEG also provides the advantage of permitting assessment of the precise timing of responses in disparate brain regions. This technique thus provides

suitable basis for the quantitative comparison of cerebral processing in healthy individuals and people with GI tract pathophysiology. References: [1] Price et al., Pain 127, 63-72. [2] Ladabaum et al., Neuroimage 34, 724-732.

1-4-11: Skin-stretch stimulator

*Veikko Jousmaki[1], Nobuyuki Nishitani[2,3]

[1]Brain Research Unit, Low Temperature Laboratory, Helsinki University of Technology, Finland [2]Cognitive Sciences Section, Department of Sensory & Communicative Disorders, Research Institute, National Rehabilitation Center for Persons with Disabilities, Tokorozawa, Japan [3]Department of Brain Pathophysiology, Human Brain Research Center, Kyoto University Graduate School of Medicine, Kyoto, Japan

We have developed a novel nonmagnetic hand-held device to produce skin stretch, known to activate slowly adapting type 2 (SA2) mechanoreceptors, i.e., Ruffini endings.
Our skin stretch stimulator is manually operated and the force applied on the skin is measured by means of strain gages. We measured somatosensory evoked fields (SEFs) in 9 subjects to light skin stretch stimuli, presented on the dorsal skin of the hand at interstimulus intervals between 5 to 8 s.
Skin stretch elicited clear and reproducible SEFs peaking at about 60 ms after the stimulus onset agreeing with the activation of the hand region of the primary somatosensory cortex. Additional cortical activity in the contralateral hemisphere was detected in 9 subjects and in the ipsilateral hemisphere in 5 subject.The device seems feasible for MEG experiments to address functional anatomy of the human somatosensory system using natural, ecologically relevant skin stretch stimuli. Such a selective stimulus offers new possibilities for experimental designs and to study the human mechanoreceptor system.
References
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Poster: 1-5 Basic MEG: Cognitive function

1-5-1: Attention effect on neural spatio-temporal activity to emotional faces presented in central and peripheral visual fields

*Dimitri J Bayle[1,2], Margot J Taylor[2]

[1]Brain dynamics and cognition, INSERM U821, Lyon, France, [2]Diagnostic imaging, research institute, Hospital for Sick Children, Toronto, Canada

Facial expression recognition is important for non-verbal communication. fMRI studies have largely highlighted the neural correlates of this process, while electrophysiological research has demonstrated that it can occur before 130 ms. However, it remains difficult to link these data to specific spatio-temporal dynamics following emotional face presentation. It also remains unclear how this perception can be altered or enhanced by attention. Combining high temporal and spatial resolution, MEG was used to investigate the spatio-temporal processing of emotional faces and determine the effect of attention. We used photographs of faces that expressed 3 different emotions: neutral, fear or happy. Stimuli were presented randomly in central or peripheral (left or right) visual fields. Pictures were shown in 3 different blocks to 15 adults, who were asked to respond to a target. The target was a red dot in the first block and a specific facial expression in the two other blocks. MEG activity was recorded with a 151 sensor CTF/VSM system. Event-related-beamformer source analyses were performed at the individual latencies of the main magnetic peaks, for centrally presented stimuli.When attention was directed to the faces, fearful faces activated the orbito-frontal cortex more than neutral faces around 100ms after stimulus presentation, and the right fusiform gyrus around 150ms. If attention was not directed to the faces, the same effect was observed in the fronto-dorsal area around 100ms and in the left temporal cortex at 150ms. Further sources analyses are being completed to study the effect of peripheral presentation of emotional faces. Our first results showed that emotional processing starts in the first 100ms, implicating anterior regions. It also demonstrates than attention can modify the early brain responses to emotion.