high performance single-trial classification of object categories using Magnetoencephalography (MEG). While several studies have shown neural correlates of object categories using MEG (M100 or 170; Liu, Harris and Kanwisher, 2002), no reports have demonstrated their single-trial classification. Here, we aimed to classify evoked magnetic field (EMF) from three visual stimulus categories (faces, houses, and cars). We analyzed spatial patterns of EMF, 0-500 ms after the visual stimulus onset, using support vector machine (SVM). By creating separate SVMs at each time point, we were able to identify the critical timings (time of interest, TOI) where high performance classification (larger than 70 %) among visual categories was achieved Leave-one-out cross-validation revealed that TOIs are found around 170 ms after the stimulus onset. We further, extended our method by combining high performance TOIs using a Bayesian method, and achieved even higher performance. So far we introduced the success of high performance classification with spatial map pattern of magnetic field. At the conference venue, furthermore, we will present our decoding approach described above, along with our recent attempts to use estimated equivalent current sources solved via Adaptive Beamformer (K.Sekihara et al), which can effectively estimate non-biased sources compared to other spatial filters.Acknowledgement: This research was supported by a Grant-in-Aid for Scientific Research from the Japan Society for the Promotion of Science, Nissan Science Foundation, SCOPE (SOUMU), and NICT. Primary authors M.S. and Y.Y. contributed equally to this work.

Poster: 1-4 Basic MEG: Pain and somatosensory function

1-4-1: Tracking information flow in the human somatosensory system by means of Partial Directed Coherence

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The brain's performance in analysing complex information relies on the interactions of specialised brain areas. Although the functional significance of these interactions for even very basic information processing is evident, we are just beginning to understand the mechanisms of interareal communication. Neurophysiological studies have provided convincing evidence that neural synchronisation, i.e. temporally precise interactions between neurons, represents an important code for interareal communication. Consequently, coherence and phase synchronisation analysis have recently become standard techniques to quantify long-range communication in the human brain. However, coherence and phase synchronisation do not provide information about directionality of information flow. Partial Directed Coherence (PDC) has recently been introduced for the study of Granger causality and directionality of neural signals. Here, we employed source localisation based on spatial filters with PDC analysis of source activity to track information flow in the somatosensory system of 10 healthy subjects. During the experiment magnetoencephalographic signals were recorded (Neuromag-122 system) in a speeded reaction task following median nerve stimulation. Source localisation was performed to identify contralateral primary (S1c) and bilateral secondary somatosensory cortices (S2c, S2i) and ipsilateral primary motor cortex (M1i). PDC analysis on the activity of these regions of interest revealed a significant transient asymmetry of information flow across subjects (S1c->S2c,S2c->S2i,S2i->M1i). Our results indicate that a combined approach of source localisation and PDC analysis is capable of identifying transient asymmetries in the information flow between cortical areas.

1-4-2: Selective attention to fingers induces signal strength changes of early SEF components

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Attention to tactile stimuli was found to produce increases or decreases of early components of somatosensory evoked fields (SEF) in dependence on taskrequirements. We tried to assess somatosensory information processing using paradigm in which we kept stimulation site, stimulation type, and stimulus intensity constant. We investigated different types of tasks (distraction vs.one-back tasks) in the same subjects to demonstrate that the taskrequirements define the amplitude of early SEF components. Twelve normaladult human subjects had to perform three different attention-requiring taskwhile tactile stimulation to the two distal phalanges of the index and ringfinger of the right hand were presented together with visual stimuli but with asynchronous stimulus-onset. Subjects had to detect different targets in distraction and two different one-back tasks. Unexpectedly, SEF mean globalfield power revealed greatest values for the distraction task and slightchanges between the two other tasks. We concluded that task requirements andattention are able to change primary somatosensory processing as early as50ms after stimulus onset.
**Abstract / Poster: 1-4 Basic MEG: Pain and somatosensory function (1)**

**1-4-3: Assessment of localisation accuracy in the primary somatosensory cortex based on combined EEG MEG and realistic head modelling**

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**Introduction**

A number of modelling studies and little experimental data advocate that the combination of MEG and EEG signals should provide the most accurate spatiotemporal localization1,2,3. In this study we provide a separate measure for quantitative empirical assessment aimed at evaluating the benefits of combined EEG and MEG data for early somatosensory evoked activity.

**Methods**

Whole head 64 channel EEG and 275 MEG channel combined data was recorded from healthy subjects following a medial nerve stimulation paradigm. Dipole and Vector Beamformer analysis were employed following the use of confidence ellipsoids and realistic headmodels.

**Results**

Taking into consideration the complementary nature of EEG and MEG, together with the consequent increase in signal to noise ratio from the combined modalities; a significant reduction in the dimensions of confidence ellipsoids are reported (P<0.05). The generators were clearly distinguishable as being focal within Brodmann areas 1, 2 and 3.

**Conclusion**

We found that the localization accuracy increased following the combination of the two modalities with realistic headmodels. The combination of MEG and EEG data may hence provide a new means for high spatiotemporal resolution studies of the human brain.

**References**


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**1-4-4: Source Polarity of Ipsilateral Somatosensory Responses to Median Nerve Stimulation**

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Feedforward and feedback input projections between hierarchically organized cortical areas characteristically differ in their pattern across cortical layers. We examined the hypothesis that the polarity of a macroscopic current dipole (i.e., inwards vs. outwards with respect to the white matter) as measured by electro- and magnetoencephalography (EEG, MEG) distinguishes between expected feedback and feedforward type connections. We compared MEG results with predictions from published primate data for contra- and ipsilateral somatosensory evoked responses. Evoked magnetic fields were recorded in response to median nerve stimuli, presented in a random sequence to the left and the right wrist. A long inter-stimulus interval (4-6 s) was used in order to enhance the ipsilateral response. An equivalent current dipole for the primary somatosensory cortex in each hemisphere was determined by using a single dipole model for the contralateral N20m response. By incorporating these dipoles into a spatiotemporal multidipole model, a weak ipsilateral response was seen at around 50 ms, with an inward polarity, which was opposite to the outward polarity of the contralateral N20m response. The polarities of the contralateral and ipsilateral sources were consistent with the hypothesized polarities for feedforward and feedback type of inputs, respectively.

**1-4-5: Classification of activities related to 5Hz periodical median nerve stimuli by using the temporal decorrelation method of BSS**

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Classification of brain activities related to periodical median nerve stimuli is reported by using the decorrelation method of blind source separation. Since the decorrelation method of BSS is characterized by temporal structure, median nerve stimuli were 5Hz periodical and MEG was recorded by 64 channels of axial gradiometer. Somatosensory activity was commonly observed by a dipole pattern at the primary somatosensory cortex in the contralateral hemisphere, though somatosensory activities are known as unilateral SI, bilateral SIIs, and PPCs in random stimuli with
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

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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


1-4-7: Somatosensory evoked magnetic fields following stimulation of the tongue in humans

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Objective: To clarify the characteristics 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 contralateral 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.