2-7-7: MEG event-related desynchronization and synchronization deficits during basic somatosensory processing in individuals with ADHD

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Recent neuroimaging studies in Attention-Deficit/Hyperactivity Disorder (ADHD) have shown that basic processing regions, such as the somatosensory cortex, show abnormalities and suggest that the function of these regions may be compromised. We used event-related magnetoencephalography (MEG) to examine patterns of cortical rhythms in the primary (SI) and secondary (SII) somatosensory cortices in response to median nerve stimulation, in 9 adults with ADHD and 10 healthy controls. Stimuli were non-painful electrical pulses presented in two counterbalanced conditions: random and predictable stimulus presentation. Neural activities were analyzed with respect to brain location, latency, and frequency to determine spatiotemporal profiles of event-related activity time-locked to stimulus presentation. Initial spatial analyses were performed using synthetic aperture magnetometry: SAM. We then computed the single trial output of the spatial filters ("virtual sensors") for peak locations of source activity in the SAM images. Time-frequency response plots were constructed from the virtual sensor data using a wavelet-based technique which demonstrates both phase-locked and non-phase-locked changes in power. Major findings included a marked reduction in the duration of beta rebound in the ADHD group compared to controls in both SI and SII. Additionally, the ADHD group showed a substantial decrease in SII alpha and beta power during event-related desynchrony (ERD) and event-related synchrony (ERS) during the random condition which was ameliorated when the stimulus was predictable. Our findings support the notion that cortical oscillations are altered during somatosensory processing in those with ADHD. This is the first study to profile somatosensory ERS and ERD in ADHD and also the first to show a reduced duration of beta rebound in a clinical population.

2-7-8: Beta ERD during a memory task decreased in prefrontal cortex in patients with Alzheimer's disease and mild cognitive impairment

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Alzheimer's disease (AD) is the most common dementia disorder. To date, structural and functional imaging in AD has concentrated almost exclusively on group-level differences between patients with AD and healthy controls. There are relatively few magnetoencephalography (MEG) studies using a memory task on AD and mild cognitive impairment (MCI). In the present study, we compared the event-related desynchronization (ERD) during a memory task in early AD, MCI patients and controls. Thirteen patients with probable early AD were selected according to NINCDS-ADRDA criteria (age; 75.6 ±5.0, Mini-Mental State; 22.1 ±2.6). Thirteen patients with MCI were selected according to Petersen's diagnostic criteria (age; 73.9 ±5.0, Mini-Mental State; 26.8 ±2.0). We also selected fourteen normal control subjects (age; 71.2 ±6.8, Mini-Mental State; 28.6 ±1.5). MEG activities were recorded with a 64-channel whole head magnetometer in a magnetically shielded room. The ERD in beta band (15-30 Hz) during a memory task was calculated by using beamforming method implemented in Brain Electrical Source Analysis (BESA). Group comparison of 3D data was performed by using BrainVoyager QX. The ERD was decreased significantly in right middle and inferior frontal gyri in MCI patients compared to controls. The ERD decreased significantly in left superior and middle frontal gyri in AD patients compared to MCI patients. The ERD decreased significantly in right frontal lobe and left superior frontal gyrus in AD patients compared to controls. Prefrontal cortex has been known to play an important role in working memory processes. Our results indicate the hypofunction of working memory in AD and MCI. We suggest that MEG can provide a powerful and non-invasive tool to detect early pathological changes in AD and MCI.

2-7-9: Aging and dementia: Different Strategies for Auditory Word Recognition

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MEG brain activation patterns and performance were examined in 18 elderly controls (>64 years) and 11 elderly diagnosed with mild cognitive impairment (MCI) or Alzheimer's disease (AD) during an auditory incidental verbal leaning task. Participants heard a list of 100 words, representing common nouns, twice. After 20 minutes a word recognition task was performed. MEG responses to old (100) and new words (243) were analyzed using a multidipole, spatiotemporal modeling approach (CSST: Ranken et al., 2004--see Abstract by Aine et al. at this meeting). A cluster
Hepatic encephalopathy (HE) is a complication occurring within patients suffering from cirrhosis of the liver. It is known that occipital alpha oscillation and sleep spindle share quite similar characteristics. The generating mechanism of sleep spindle has been extensively investigated and now it is clarified that its rhythm is generated by thalamic reticular nuclei and thalamo-cortical reverberating circuit. Although the generating mechanism of occipital alpha oscillation is still unclear, it has been suggested that thalamo-cortical reverberating circuit is involved in its generating mechanism. We reported that quadratic phase coupling (QPC) was observed when sleep spindle was dominant in EEG and this seemed to be related with thalamo-cortical reverberating circuit. The degree of QPC among the frequency components of a signal can be quantified by bispectral analysis. We investigated whether QPC could be observed in MEG by bispectral analysis when alpha oscillation was emerged. After obtaining the IRB approval, we enrolled fifteen adult healthy volunteers. Occipital 8 channels of a helmet-shaped 64-channel whole-head magnetometer (NeuroSQUID Model 100, CTF Systems Inc., 625 samples/sec) were recorded in eye-closed (5 minutes) and eye-opened (5 minutes) periods. Then MEG data were analyzed by original software BSA for bispectral analysis. Among fifteen cases, nine cases showed alpha oscillation during eye-closed periods. In those cases, significant QPC was observed during eye-closed periods, while it disappeared after eye opening. Considering the relation between sleep spindle and QPC, we suggest that the rhythm of occipital alpha oscillation might be generated by thalamo-cortical reverberation circuit like sleep spindle.

2-7-11: Resting State Synchronization in Hepatic Encephalopathy

Hepatic encephalopathy (HE) is a complication occurring within patients suffering from cirrhosis of the liver. It is characterized by a variety of cognitive and motor deficits. Higher HE-grades lead to a gradual reduction in the critical flicker frequency (CFF), a reliable measure for HE. Synchronization Likelihood (SL) is a method based on state-space representation that can be used to quantify the functional integration of brain regions. We hypothesized that worsening of HE goes along with global alterations in the oscillatory processing in the human brain as expressed by SL. We recorded in 50 subjects, healthy controls and cirrhotic patients with no HE (HE 0), minimal HE (mHE) and manifest HE grade 1 and 2 (each group n=10), spontaneous activity for 3 min during a resting state eyes-closed condition using MEG. Individual CFF was assessed and mean SL of all sensor combinations was calculated for six different frequency domains: 1-3 Hz, 4-7 Hz, 8-12 Hz, 12-20 Hz, 20-30 Hz and 30-45 Hz. Moreover, we calculated correlation between CFF and SL. We could show that compared to healthy controls SL is increased exclusively in the 4-7 Hz range (theta) in HE 1 and HE 2 patients. Moreover, CFF and SL in the theta range showed an inverse correlation. Our results reveal that worsening of HE is paralleled by global alterations in neural synchronization. An increase of synchronization in the theta range may imply a change to a coarser brain activity with ongoing deterioration and a gradually losing of differentiated brain function.
2-7-12: MEG beamforming reveals different resting-state oscillatory networks in controls, Parkinson’s & Parkinson’s demented patients

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Introduction
Sensor-level analysis of resting-state MEG data1 has suggested that Parkinson’s disease (PD) is characterized by a slowing of oscillatory resting-state brain activity, with further slowing, and reduced reactivity to eye-opening, in demented PD patients (PDD). Here, we set out to localise these differences.

Methods
MEG data was recorded with both an eyes-open (EO) and eyes-closed (EC) condition1. Beamformer images of neuronal activity were reconstructed separately for the δ, θ, α, β, and γ frequency band, contrasting the EO with EC condition2. Significant group-averaged3 power changes are reported (P<0.05).

Results
Relative power decreases were found in a resting-state network that included middle occipital gyrus, cuneus, precuneus, inferior parietal lobule, postcentral gyrus and middle temporal gyrus in both controls (θ, α, β, some γ); but PD also revealed power increases in frontal lobe (θ) and temporal gyrus (α, γ). PDD only showed δ-power decreases in cuneus and precuneus, and power increases in temporal gyrus (β, γ) and culmen (β).

Conclusion
The normal resting-state network is activated in PD, although with a shift towards lower frequencies, whereas in PDD reactivity is much reduced and only a small sub-set of this network is active. The differential activation patterns in PD and PDD suggest that additional mechanisms are involved in the development of dementia in PD.

References

2-7-13: Diagnostic improvement of Alzheimer's disease by using multi-parameter evaluation of spontaneous MEG data

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OBJECTIVE: Alzheimer's disease (AD) diagnosis is mostly based on clinical features, and difficult to find this disease in early stages. MEG is expected to be an early diagnosis tool for it. Many studies have used single-parameter evaluation. In this study, we try to improve the diagnostic performance by using multi-parameter evaluation. METHODS: We measured spontaneous brain activity during eye-closed/opened conditions. It was recorded for 2 min in each condition by using a 160-channel whole head MEG system. The MEG data of 26 patients with early AD and 26 age-matched controls were collected. Off-line band pass filter was applied to the data, and a standard deviation was calculated as the intensity of the spontaneous brain activity in theta, alpha and beta band. RESULTS: The intensity ratio of alpha band activity in eye-closed condition to that in eye-opened condition was one of the evaluation parameters, and the values of AD's subjects were significantly smaller than those of normal control (NC) subjects. We also expressed the magnetic field pattern numerically as evaluation parameters. Furthermore, some parameters were extracted from the spectral profile of MEG signal. In each parameter, there was significant difference between AD and NC. Using ROC (Receiver Operating Characteristic) curve, we investigated the discrimination ability of each single parameter and combination of parameters, and found multi-parameter evaluation had higher performance. CONCLUSION: We extracted some characteristic parameters from spontaneous MEG data, and found significant differences between AD and NC. Combination of these parameters improved the discrimination ability, and seemed to be more effective for practical AD diagnosis.