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Oscillatory modulations during human verbal interaction – A simultaneous EEG/MEG study

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Introduction: Social interactions in daily life play an important role in establishing human social relationships. Using hyper-scanning techniques, many studies have revealed that neural synchronization takes place during social interaction [1]. One EEG study attempted to address inter-brain synchronization when two subjects engaged in verbal communication, and oscillatory modulations in the theta and alpha bands during human-machine interactions were reported [2]. In this work, we investigated reciprocal live verbal interactions between humans, and collected EEG and MEG data simultaneously to seek oscillatory changes in these interactions.

Materials, Methods and Results: Two multimodal EEG/MEG systems (19-ch EEG and 152-ch MEG) located 100 miles apart were introduced to conduct hyper-scanning with two humans (Figure 1(A)). Reciprocal live verbal interaction was performed using condenser microphones and magnetic-compatible earphones. Ten naïve subjects (five pairs, aged 23.9±3.3 years) participated in the experiment and they were strangers to each other. Subjects were instructed to interact verbally with their partners by counting from 1 until the end period. This consisted of five runs in which each run contained six trials for each task period. After 5 seconds of instruction, a task period began with the presentation of a blank, black screen for 30 seconds. Thereafter, three different tasks (interaction, speaking, and listening) were conducted. In the interaction task, one participant began by saying one number, after which the partner said the consecutive number. In the speaking task, each participant spoke numbers beginning with '1' until the given time limit. In the listening task, the participant simply listened to the partner's voice while s/he counted from 1 to time limit. As a result, we found the oscillatory changes between interaction and speaking conditions (Figure 1(B)); MEG gamma increase and EEG alpha decrease were observed in the left temporal lobe, which was statistically significant (with FDR correction).

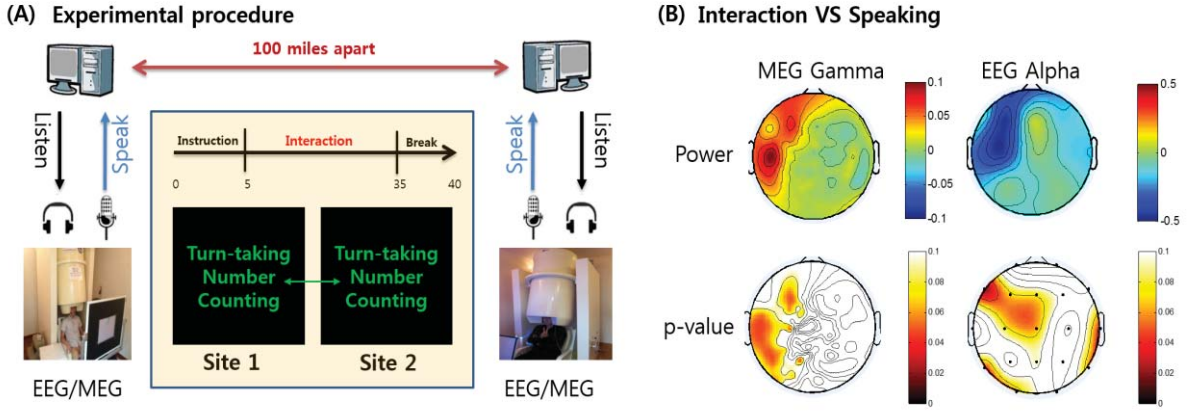

Figure 1. *(A) Simultaneous EEG/MEG experimental procedure of live verbal interaction. (B) MEG gamma and EEG alpha differences between interaction and speaking conditions. Power differences under each condition (top) and significant p-value distributions (FDR corrected) over all subjects (bottom).*

Discussion: We found the significant differences (MEG gamma increase and EEG alpha decrease) in the left temporal lobe; this is closely related to speech perception and production [3]. Therefore, these results may give us to understand neural mechanism in verbal interaction between humans and oscillatory modulations, which may be useful in developing interactive brain-to-brain or brain-to-machine communication techniques.

Significance: Simultaneous MEG/EEG recording for human verbal interaction was conducted at two distant sites.
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