MEG Findings Correlate to Speech-Language Pathology Deficits in Service Members with Combat Related mTBI and PTSD

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Objective

To evaluate the utility of MEG neurocognitive techniques in characterizing patterns of impaired neural networks in clinical populations of service members (SM) who have sustained combat-related traumatic brain injury (TBI) and comorbid psychological health (PH) conditions.

Background

Service members returning from combat operations with mTBI and PH conditions exhibit a constellation of cognitive and behavioral deficits that include language, memory, attention impairment, irritability, anxiety and depression. The overlap of symptoms from TBI and PTSD provides a challenge in identifying the underlying etiology and means by which the two conditions may coexist and may manifest specific to a given condition.

Magnetic source reconstruction (MSR) analysis was performed to help identify patterns of neural network disturbances that allow for a more precise understanding of the pathophysiology, and in the future help direct individualized therapy.

Design and Methods

Case Study: An initial case study comparison of two active duty SM's diagnosed with mTBI, one with a speech-language deficit and one without a speech-language deficit was performed. Speech-language Pathology and Neuropsychology administrations of the Boston Naming Test (BNT) and Wide Range Memory Test (WRMT) were conducted on the first SM (SM-1), who was diagnosed with a language deficit. The second SM (SM-2) was diagnosed with mTBI/PH without language disturbance. Both SM's were instructed to name an image from a set of line drawings during the BNT and WRMT. The BNT and WRMT were readministered to SM-1 during a delayed test window.

Results

Case Study: SM-1, whose language disturbance initially was attributed to psychiatric cause, showed an impaired BNT score of 9 vs 29 SM-2 with a BNT score of 35, (average score for age group = 55.1). SM-1 also demonstrated a poorer memory performance with a RBMT-3 score of 81 vs 97 (average score = 100). (Table 1) Figure 2 showed that SM-1 had less activity (normalized power +1.5%) in regions of the inferior frontal gyri and with poor wave form progression in Broca's area compared to SM-2 who showed higher activity (normalized power +5.0%) and with better defined peak progression.

Group Study: Group 1 scored in the impaired range for both the Rapid Picture Naming task and RBMT-3 (SM-1 compared to normal scores in Group 2. Significantly lower event related field (ERF) activity was evoked in Group 1 vs Group 2 in the bilateral entorhinal cortices, left pars triangularis, and left superior temporal gyrus using language naming task performed in the MEG (shown as blue regions on the volumetric brain composite in Fig. 3). Comparison of the group average MEG activation curves from these regions, revealed significant group differences between Group 1 (red lines) and Group 2 (blue lines), 14 lower peaks in fig. 3). Group 2 displays defined peaks at approximately 300 ms in the left pars triangularis, and left superior temporal gyrus, as well as an early peak (~100 ms) and 2nd peak (~200 ms) in the bilateral entorhinal cortex compared to Group 1 which showed low amplitude and poor peak time consistency.

Discussion

Patients with comorbid mTBI/PH conditions with language and memory impairments, confirmed by neurocognitive testing, are found to have distinctly different activation patterns of neural networks. Patients with demonstrable language and memory impairment show absence or attenuation of activation curves in the superior temporal gyrus, pars triangularis and entorhinal cortex, observed in unimpaired patients.

Disturbances in language and memory following combat-related traumatic brain injury are many times attributed to anxiety and other psychological factors. Identification of physiological parameters that are correlated with specific deficits may help in the future discriminate psychiatric from neurogenic etiologies. We are embarking on a series of MEG studies to further elucidate the nature of language disturbances following mTBI/PTSD, identifying the contribution of neurologic and psychiatric disorders.

Conclusions

• Magnetoencephalography provides insight into patterns of neural networks demonstrating different brain language disturbances from TBI/PH conditions.

• Differences in patterns identify patient subgroups which may be useful in the future to direct targeted therapy and used as a tool to measure patient response to therapy.

• Lack of early activation of the entorhinal cortex in the memory/language impaired group may be a component underlying their performance deficit.

• Limitations: the case study and group analysis used only a single language-based paradigm. Future studies will require activation of other cognitive functions and evaluation of multiple neural networks.

• This pilot study requires further evaluation and replication.

References


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Table 1. Analysis of the MEG recordings using magnetic source imaging. Electrical activity generates magnetic field that is measured by MEG sensors (A). Signal intensity is merged with T1/MRI image (B). 3D anatomical reconstruction of event related fields (ERF) demonstrate pattern of neural network activation (C).

Table 2. Demographic information, mean RBMT-3 general memory index and the scaled subscores for each RBMT-3 subtest.

Table 3. Brain regions showing group differences (p<0.01) between mTBI patients with high vs low RBMT-3 general memory index (2 upper panels), and their group averaged activation curves (2 lower panels).