Frontoparietal Priority Maps as Biomarkers for mTBI

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PUBLIC ABSTRACT

Mild traumatic brain injury (mTBI) can result from either blast exposure during deployment or a direct impact to the head. Approximately 10%-20% of returning service members have experienced mTBI, and roughly two-thirds of people who have experienced mTBI complain of disturbances to their visual systems. The disturbances can take many forms -- difficulty focusing, difficulty looking directly at a target, or difficulty directing attention toward an important object, for example. We do not yet know exactly what happens as a result of mTBI that causes these visual disturbances.

This research will consider the possibility that diffuse or low-level damage to the brain -- damage that is generally very hard to detect -- impairs performance of the brain networks that usually control eye movements and attention direction. In order to test this hypothesis, we will invite 100 veterans with mTBI to participate in our study. After screening volunteer participants based on their ability to direct their attention toward a target and perceive subtle differences in patterns of moving dots, we will invite 48 of these veterans -- half with vision disruptions and half without -- to participate in a magnetic resonance imaging (MRI) scanning session. The MRI scanning session will measure (1) the strength of responses in brain regions responsible for attention and eye movement, and (2) the health of the white matter that communicates information from these regions to the rest of the brain. By comparing behavioral data and imaging data for the two groups, we will discover whether visual attention problems can be attributed to weak performance in (or weak connections to) these high-level brain regions that contain maps of visual priority.

The result of this study will be an understanding of how much high-level (cognitive) brain damage contributes to vision problems. On the face of it, many of these vision problems seem low-level: eye movements are automatic, controlled by nerves in the brainstem. However, the fact that something is automatic does not always mean that it relies only on low-level nerve function. Vision is, however, a surprisingly complicated behavior. Even though we generally do it without thinking, figuring out where something is and how far away it is, and moving your eyes there, is actually a behavior that requires coordinated computations in networks throughout the brain. High-level attention networks and scene-processing networks need to communicate effectively with low-level eye-control networks. The goal of this research is to understand how much deficits in high-level networks are contributing to difficulties with eye movement and attention control. Visual disturbances can be especially frustrating for people because they impact daily navigation skills like driving and reading and because there is no clinical measurement that can explain what is wrong. Our results will help (1) develop measurements that do a good job of predicting how much trouble a person is having with his or her visual skills, and (2) guide clinical interventions (e.g., cognitive training instead of oculomotor strengthening) to address vision deficits related to mTBI. The proposed research will take 2 years to complete. If our hypothesis is true, we will be ready to then begin testing whether systematic practice of cognitive tasks like shifting attention and shifting gaze can help re-train the networks we hypothesize are impaired by mTBI. Development and validation of these training tasks...
would take another 1-2 years, but the long-term goal of this research is to define new therapies that are available in the clinic 3 or 4 years from now that will help people overcome vision challenges that result from mTBI.