

Dissociation between univariate and functional connectivity fMRI differences during working memory performance in retired football players



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Background

- In studies on retired athletes, a history of sport-related concussions has been linked with an increased likelihood of memory complaints, depressive symptoms, dementia, and early-onset Alzheimer's Disease (AD) as compared to age-matched individuals with no history of concussions.
- Aside from concussions, football players have been shown to receive many sub-concussive episodes that are not captured by their concussion history and may instead be reflected by their overall level of football exposure.
- APOE-ε4 genotype has been implicated in increased risk for development of AD, and also development of disordered patterns of cognitive aging in retired football players.
- The current study was designed to compare the long-term effects of concussion history, football exposure, and genotype on fronto-parietal connectivity during working memory performance to examine what factors might underlie disrupted patterns of connectivity during the task.

Methods

Participants

- Sixty-three former college football and professional National Football League players between age 52 and 65, who had received anywhere from 0-27 concussions in their careers
 - NFL and college players were matched on age, position played (i.e., offensive lineman, quarterback, wide receiver, etc.), and concussion history

Measures

- Head Impact Exposure Estimate (HIEE): estimate of cumulative hours of contact exposure from High School through professional career
 - Estimate weighted by position, exposure type (contact practice, game, etc.), and frequency/magnitude of hits
- Connectivity network strength: graph theory metric of functional connectivity measuring strength of all connections among all regions in the network of interest

Procedure

- N-back task
 - 0, 1, and 2 back memory task
 - Block design
 - 6 blocks
 - Each block contained only 1 type of task (i.e., only 0-back), and there were 2 consecutive blocks per task type
 - Task order was randomized

Results

Behavioral Results

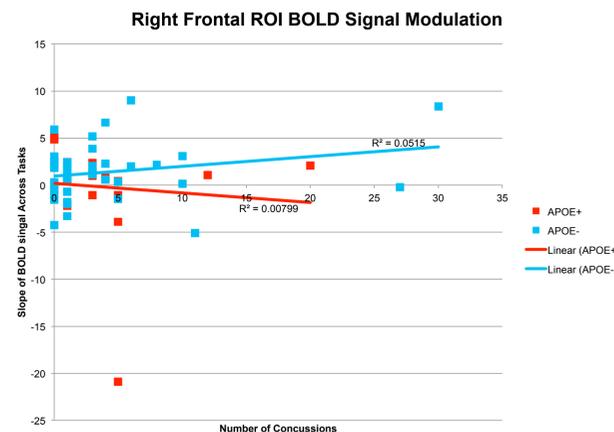
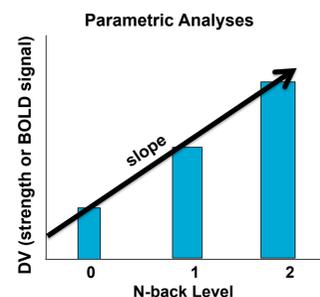
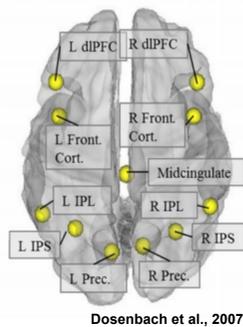
- The four groups did not differ in terms of mean accuracy performing each task, or mean response reaction times

Univariate Imaging Parametric Results

- Parametric analysis of BOLD signal across n-back levels
 - Differences in modulation of BOLD signal in Right Frontal ROI based on interaction between concussion history and genotype

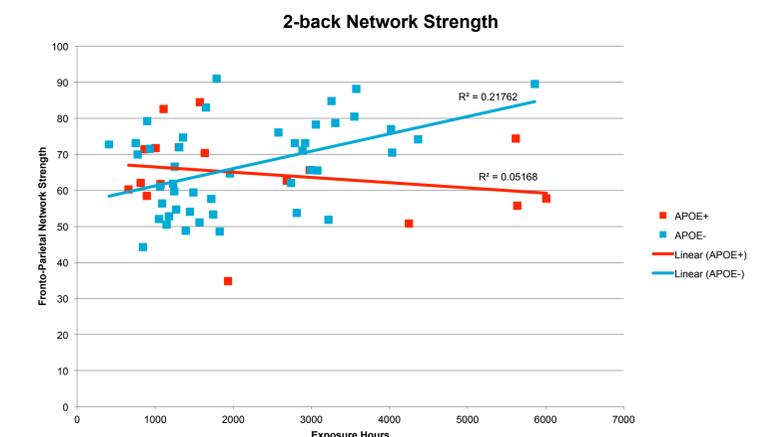
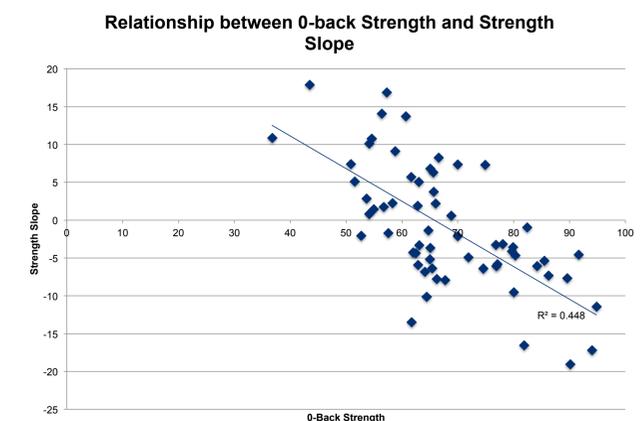
Functional Connectivity Parametric Results

- Parametric analysis of strength across n-back levels
 - No differences in modulation of network strength as per increases in working memory load based on concussion history, HIEE, or genotype
 - Negative correlation between slope of strength across levels and strength at 0-back level



Functional Connectivity Task-level Results

- Within-task analysis of strength
 - No differences based on concussion history, HIEE, or genotype at 0-back or 1-back, but interaction between HIEE and genotype in predicting strength at 2-back



Discussion

- Univariate and functional connectivity analyses reveal substantively differing results concerning efficiency of neural recruitment during working memory task performance, and the degree to which this efficiency can be predicted based on concussion history, HIEE, and genotype.
- While univariate parametric analyses revealed that activity within the Right Frontal ROI showed differing degrees of parametric modulation of activity based on concussion history and genotype, there was no predictive validity of the variables of interest in predicting parametric modulation of network strength across n-back levels.
- The only measure of network connectivity strength that was significantly predicted by the variables of interest was network strength during 2-back task performance, and only HIEE and genotype significantly predicted this metric.
- Thus, although concussion history and genotype predicted the degree of parametric modulation of BOLD activity, HIEE and genotype predicted network strength at the 2-back level.