

MEG Measured Default Mode Network is Altered by History of Concussion in High School Football

Monday 3:40-3:50 PM | SSE19-05 | Room: N230

PURPOSE

The purpose of this study is to determine if history of previous concussion modulates connectivity changes in the magnetoencephalography (MEG) measured default mode network (DMN).

METHOD AND MATERIALS

Twenty players from a high school football team (mean age=16.9; right handed) were included in this study. Eight minutes of eyes-open, resting-state MEG data were acquired for each subject using a 275 channel CTF whole-head system, pre- and post-season. Structural anatomic MRI was acquired for co-registration with MEG. Using Brainstorm, MEG data were pre-processed and filtered to 1-100Hz. Eye blinks, and muscle artifacts were removed using independent component analysis. MEG data were projected into standard source space using the whitened and depth-weighted linear L2-minimum norm estimates algorithm (wMNE). A mean time series was extracted from eight regions of interest (ROIs) representing the DMN: inferior parietal L&R, medial orbitofrontal L&R, posterior cingulate L&R, superior frontal L&R. The correlation between all ROIs was computed. Each correlation was converted to z-scores, the average DMN correlation was computed, and the difference between pre- and post-season correlation was computed. The subjects were divided into two groups: those with a history of concussion (N=5) and those without a history of concussion (N=15). A two sample t-test was performed to estimate the difference in mean DMN correlation between the two groups.

RESULTS

Subjects with a history of concussion had significantly lower DMN correlations from pre-season to post-season ($p = 0.001$). The subjects with previous concussions had a negative change in correlation whereas subjects without a history of concussion had, on average, a positive change. No significant differences were found in age, BMI, or head impact exposure between the two groups. One data point was excluded based on outlier analysis.

CONCLUSION

Changes in the MEG measured DMN, over a season of football, may be dependent on the subject's history of concussion. fMRI literature has also demonstrated changes in the DMN are dependent on the history of concussion. Our previous work has shown that concussion history can modulate DMN connectivity changes associated with head impact exposure.

CLINICAL RELEVANCE/APPLICATION

MEG has shown promise as a sensitive modality for concussion diagnosis. Prior concussion history should be considered when performing analyses of MEG data involving repeated head impacts.

Intra-Default Mode Network Connectivity Changes from a Single Season of Youth Football Distinguish Levels of Head Impact Exposure

Monday 3:30-3:40 PM | SSE19-04 | Room: N230

PURPOSE

This purpose of this study is to determine whether intra-default mode network (DMN) connectivity changes occur from youth (ages 9-13) contact sports using a machine learning-based approach.

METHOD AND MATERIALS

In this IRB-approved study of youth football athletes, each player was instrumented with the HIT system to record head impact acceleration. The seasonal risk of concussion was calculated by converting each impact into a risk of concussion and summing to a value, the player's risk of concussion-weighted cumulative exposure (RWE). Players were dichotomized into highest and lowest 10% exposure groups (13/group). Players experiencing a concussion or with a history of concussion were excluded. 13 non-contact sport controls were used as a third group. A pre and post-season 6 minute rs-fMRI was performed in all players and controls at 3-month scan interval. The fMRI data was preprocessed for motion correction, spatial smoothing and normalization. Resting-state network (RSN) sub-components, including DMN sub-components, were extracted using a higher order (60 component) group independent-components analysis (ICA). 8 DMN sub-components were identified and back-reconstructed to form individual subject's DMN sub-components pre- and post-season. Connectivity was computed using Pearson's correlation between sub-component mean time courses. The post minus pre-season connectivity changes formed our features. Five machine learning classification algorithms were evaluated to predict whether a player was a non-contact, low, or high impact exposure player.

RESULTS

Ten-fold cross validation results demonstrated for a Linear SVM classifier accuracy (82%) discriminating high impact and control groups, moderate accuracy (70%) between control and low exposure players, and roughly chance classification accuracy (60%) between high and low impact. The results suggest an increasing functional change with increasing head impact exposure.

CONCLUSION

Our work suggests that RSN sub-components can be extracted from rs-fMRI using ICA, analyzed with deep learning, and that the connectivities of the DMN sub-components are altered by repeated sub-concussive head impact exposure.

CLINICAL RELEVANCE/APPLICATION

This work demonstrates that playing a season of contact sports at the youth level, when brains are undergoing maturation, can produce neuroimaging brain changes, particularly for the DMN.