Title: Investigating the thalamus using fMRI in concussed adolescent hockey players

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Structured Abstract:

Introduction: Concussions result in complex pathophysiological changes in brain networks, which have previously been demonstrated using resting state functional magnetic resonance imaging (rs-fMRI) (Zhu et al., Journal of Neurotrama, 2015). These network abnormalities have also been found to continually persist up to three months post-trauma (Manning et al., Neurology, 2017). Most of these investigations have explored network changes in cortical regions, often overlooking important subcortical structures such as the thalamus. Conveniently, rs-fMRI data can be used to parcellate the thalamus into its functional nucleis (Zhang et al., Journal of Neurophysiology, 2008), and can be used to extract quantifiable metrics that may help to better understand subcortical dynamics in concussed players. We hypothesize that partial correlation scores generated from thalamic parcels and their corresponding cortical components will differ between a baseline control group, and individuals from our concussed adolescent hockey player cohort.

Methods: Resting state fMRI data were acquired from Bantam hockey league players (age 11-14 years) in this preliminary study. Recruitment included an independent, age-matched baseline control group (n=13) and concussed players who were followed, 24 to 72 hours (n=10) and 3 months (n=8) post-concussion. Group-wise resting state networks were identified using FSL software. Based on anatomical-priors of thalamus connections, 9 subject-specific networks were chosen and their timeseries extracted to generate thalamus partial correlation maps. Subject maps were merged using a fixed-effects analysis followed by non-parametric permutation testing ($P<0.05$ corrected for multiple comparisons after threshold-free cluster enhancement) to show regions with dominant thalamocortical connectivity. Partial correlations were extracted using these regions, and one-way ANOVAs correcting for multiple comparisons were performed to investigate changes between groups.

Results: Eight potential group-wise thalamus parcels corresponding to thalamocortical-connections were identified (sensorimotor, auditory, visual, temporal, prefrontal, insular, lateral parietal, and cingulate). Averaged partial correlations using the eight regions were compared between groups with no significant differences found between controls, concussed players within 24 to 72 hours, and concussed players three months post-trauma.

Discussion: We have demonstrated that rs-fMRI can be used to generate group-wise thalamus parcels indicative of thalamocortical-connections shared across controls, 24 to 72 hours and 3 months post-concussion. Furthermore, partial correlation values between the parcels and their corresponding cortical components suggest that the thalamus is not significantly affected by concussion. Further investigations will be needed to examine spatial differences in the thalamic parcels between groups.