Acute concussion during adolescence or adulthood does not lead to measurable impairment in motor function or brain inflammation in a rodent model

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Background: Traumatic Brain Injury (TBI) has become one of the most predominate and pervasive causes of neurological impairment and death in the developed world (Chiu et al., 2016). Concussion, or mild TBI, occurs following a bump or blow to the head, and can occur with or without loss of consciousness (U.S. Department of Health and Human Services Center for Disease Control and Prevention, 2015). Following concussion, numerous cognitive, physical, and emotional symptoms are apparent, both immediately as well as weeks to months later (Mychasiuk, Farran, & Esser, 2014). Adolescents are among the top age groups showing the highest incidence of concussion (Teng & Molina, 2014), with researchers estimating that approximately 20% of adolescents experience a concussion (Veliz et al., 2017). Indeed, the increased risk-taking and sensation-seeking behaviors of adolescents (Spear, 2000) contribute to their greater vulnerability for suffering a concussion. Given that adolescence is a period during which the brain is undergoing dramatic developmental changes, it is important that we understand the consequences of concussion on brain function and health, and its relationship to behavioral impairments. Therefore, the current experiment sought to explore possible age-differences between adolescents and adults in the consequences of concussion on behavior and brain inflammation using a rodent model.

Methods: Concussion-related impairments were examined in separate groups of Sprague Dawley rats at mid-adolescence and adulthood. Concussion was induced using an established closed-head model of injury, which results in a mild TBI (Mychasiuk et al. 2014). In the adolescent group, male rats that received a single concussion were compared to sham (non-injured) male controls. For the adults, both male and female rats were examined. Female sham controls were compared to adult females that received a single mild concussion. Among the adult males, however, sham controls were compared to three different concussion groups: (1) a single concussion with the same parameters used for the adolescent males; (2) a single concussion with the same parameters used for the adult females; or (3) a single concussion with the same parameters as those normally used for adult males. Behavioral impairments, including loss of consciousness and motor impairment, were measured 24 hours after concussion. After behavioral measurement, inflammation was measured in the prefrontal cortex of the brain by assessing inflammatory gene expression using qRT-PCR.

Results: In the present experiment, few significant behavioral impairments were observed. When loss of consciousness following concussion was measured, only adult females exposed to concussion exhibited a significant increase in the time it took to regain consciousness compared to their sham controls. Neither the male adolescent nor male adult rats demonstrated differences in this behavior following concussion. Motor function was assessed one day after concussion using a Rotarod task. In this test, rats walk on an accelerating cylinder for as long as they can before falling onto a soft foam pad. Motor impairment would be evident by shorter times on the rotating cylinder. In this task, no significant deficits in motor function were found after concussion in any of the age groups examined. Finally, when inflammatory gene expression was examined in the prefrontal cortex 24 hours after concussion, no injury-related changes were observed for any of the inflammatory factors measured.

Discussion and Conclusion: The present study aimed to investigate the immediate neuroinflammatory and behavioral sequela of concussion using an established model of mild

TBI. Overall, the few immediate effects of concussion in both adolescents and adults precludes any conclusions that could be drawn regarding age differences in the consequences of concussion. While these data seem to suggest that concussion is without significant deleterious consequences to the brain or behavior, caution is warranted regarding such a conclusion. It is possible that deficits in other cognitive or psychological processes not assessed here may be apparent, and that other brain measurements may reveal alterations in neuroimmune function. Additionally, it is possible that the post-injury time point examined in this study may not be optimal for detecting behavioral or inflammatory effects of concussion. Current experiments are assessing alternative brain inflammatory outcomes at later times following concussion, as well as other behavioral assays that may be more sensitive to concussive-related injury.

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