Neurocognitive Resilience in Collegiate Rugby Athletes: A Study of Sex Differences in Eye-Tracking and Reaction Time

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Introduction

- Concussions and repeated head impacts are a major concern in contact sports, with evidence suggesting males and females may respond differently at the brain level.[1]
- Neuroimaging research has found that female athletes show greater changes in white matter structure, particularly in regions such as the superior longitudinal fasciculus, following repeated head impacts, despite potential hormonal and anatomical protective factors.[2, 3, 4]
- This study aims to compare reaction time, completion times and eye-tracking performance between male and female collegiate rugby players.
- We hypothesize that female players will average faster reaction time performance than males.

Methods

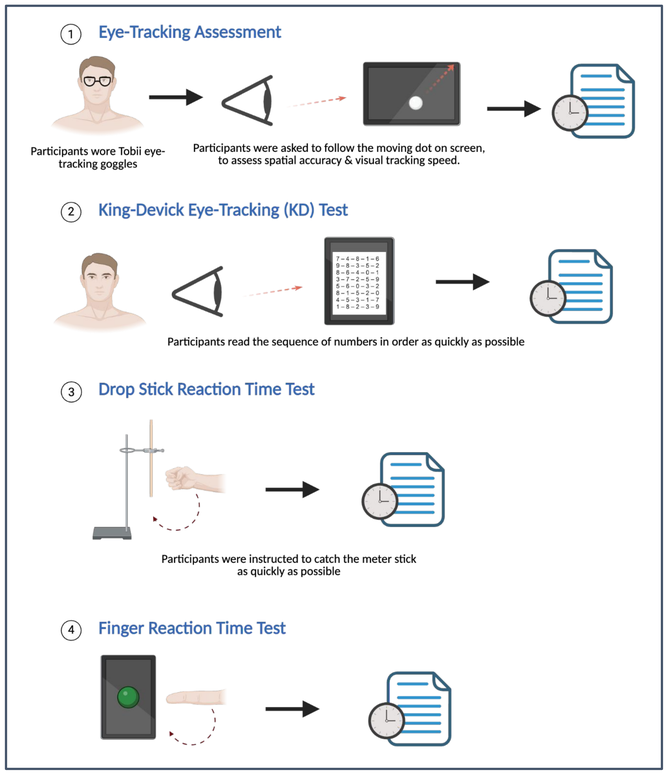

Figure 1. Data Collection. Four different tests were performed to assess a broad range of cognitive and motor functions. These included an eye tracking assessment, the King-Devick Eye-Tracking Test, a drop stick reaction time test, and a finger reaction test. While some tests primarily measure reaction time, others such as the K-D test focused more on oculomotor tracking and verbal processing fluency. Timing data were collected in both seconds and milliseconds and analyzed using box and whisker plots and T tests to determine statistical significance.

Participant Demographics

- Data collections took place in the Motion Analysis Research Laboratory, at Binghamton University.
- There were 17 male participants, and 14 female participants, whose data we have analyzed. With a small sample size, statistical power and generalizability of our results was reduced.

Variable	Males (Mean ± SD)	Females (Mean ± SD)
Age (years)	19.88 ± 1.15	19.36 ± 1.39
Height (inches)	71.06 ± 2.35	65.29 ± 2.99
weight (pounds)	194.56 ± 38.33	166.5 ± 30.88
Years Playing Sport	2.03 ± 1.36	1.89 ± 1.01
Previous Concussions	1 ± 1.12	1.50 ± 1.34

Figure 2. Rugby Player Participants' Demographics. Reaction time, eye-tracking data, and demographics were collected from 31 collegiate athletes. There was a lack of participant diversity, which may limit the applicability of findings to broader populations.

Results

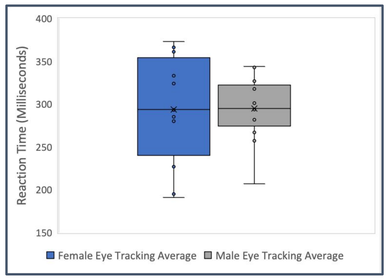

Figure 3. Average eye-tracking reaction times found in male versus female rugby players. The reaction times of male versus female participants were obtained using Tobii eye tracking goggles. No differences were found in average reaction time between males and females (P = 0.95).

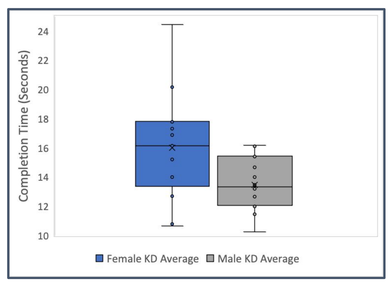

Figure 4. Average King-Devick completion times found in male versus female rugby players. The completion times of participants were obtained through the King-Devick Test. Females had a slower average completion time compared to male participants (P = 0.05).

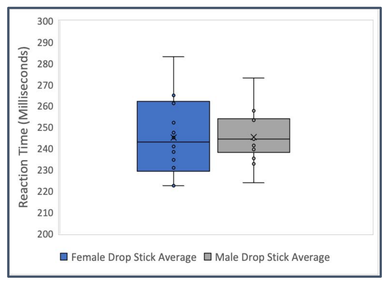

Figure 5. Average drop stick reaction time test values found in male versus female rugby players. A drop stick test was performed by participants to observe the difference in simple reaction times. No differences were found for drop stick reaction times between males and females (P = 0.97).

Results Continued

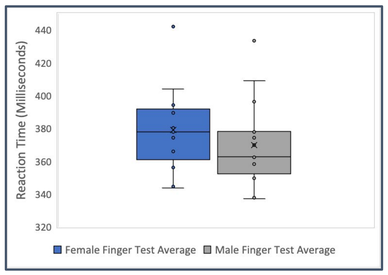

Figure 6. Average finger reaction test reaction times found in male versus female rugby players. A finger reaction time test was performed to observe differences between female and male athletes. No differences were found for the finger reaction test between males and females (P= 0.48).

Discussion

- Findings from the four administered tests are not consistent with our hypothesis. We fail to reject the null hypothesis in three of the four tests, as the p-values were greater than 0.05, indicating there is no statistically significant difference.
- The King-Devick test evaluates a combination of visual processing, reading, and verbal output, and is not a direct measure of reaction time. Our results show a statistically significant difference ($P \leq 0.05$), where we reject the null hypothesis. While males perform better on this measure ($P = 0.05$), this result should not be interpreted within the context of these multi-component demands.
- An explanation for this outcome may be that males prioritized speed and moved through the tasks quickly, even at the risk of making mistakes, while females may have taken a more methodical and accuracy-focused approach, potentially slowing their overall times.
- Seven participants had eye-tracking data that were not useful due to calibration errors. This limited our ability to analyze this metric across all participants.

Future Work

- We plan to repeat these tests with a larger and more diverse sample size in order to increase reliability of results and allow for broader generalizations to different populations. Our next step, is investigating prior concussion history of the participants, as well as years of high-impact sport activity.
- We plan to use MRI scans to examine potential structural or functional brain differences between male and female participants that could explain differences in reaction time.

Acknowledgments

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