A Comparison Between Different Levels of Contact Sports in Executive Function Performance

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Previous research has suggested that individuals who participate in contact sports have decreased performance in measures of executive function in comparison to those who participate in non-contact sports. The purpose of this study was to investigate the difference in executive function performance between athletes of different sport types. This between group design involved an opportunistic sample of male, university students (N= 57, Mean Age =20.77, *SD*= 1.63) who participated in basketball, football or rugby union. It was predicted that those who engaged in basketball would perform with higher accuracy and lower response times in comparison to both the football and rugby conditions. The accuracy and response time of all measures were recorded and analysed for the 3-back task, the cued task-switching paradigm and the go/no-go task. This investigation found that those who participate in football had significantly increased response time in comparison to both the basketball and rugby conditions. These findings were attributed to the hand-eye coordination training received by those in the rugby and basketball conditions. There were no significant differences in accuracy scores between the three sport types. These findings were not attributed to a speed-error trade off, due to the lack of correlations between the accuracy and response time scores. It was concluded that the sport type of the athlete significantly impacts the response time on measures of executive function. This highlights the effect that training can have on measures of executive function such as these.

INTRODUCTION

Executive Functions (EFs) describe higher-order cognitive processes, such as, working memory, cognitive flexibility and inhibition (Baddeley & Della Sala, 1996). EFs have been shown to be effected by engagement in contact sports such as American football (Tsushima, Siu, Yasmashita, Oshiro & Murata, 2018), rugby (Pearce, Rist, Fraser, Cohen, & Maller, 2018) and football (Koerte et al., 2017).

Concussive forces are those which compromise the axonal structure of a neuron, consequently, causing symptoms such as headaches and dizziness (Montinegro et al., 2017). In contrast, sub-concussive force is that which compromises axonal integrity but is asymmetrical (Montinegro et al., 2017). Currently, research focuses predominantly on the influence of concussive forces on executive functions rather than sub-concussive forces.

AIMS

This study aimed to compare working memory control, cognitive flexibility and inhibition performance between sports with different levels of contact; football, rugby union and basketball.

It was predicted that the basketball condition would perform with higher accuracy and lower response times than those in the football and basketball conditions. It was also predicted that those in the football condition would perform with higher accuracy and lower response times than the rugby participants.

METHOD

- 57 male, university students who participated in the basketball, football and rugby union teams.
- Between groups design. One independent variable, sport type, of three levels.
- Response time (RT) and accuracy was measured for the 3-back task (Kirchner, 1958), the cued task-switching paradigm (Rogers & Monsell, 1995) and the go/no-go task (Verbruggen & Logan, 2008).
- A pilot study identified no ceiling or floor effects.

RESULTS

- Restricted means were calculated (Anscombe, 1960).
- Data were transformed accordingly.
- MANOVA data revealed a main effect of sport type on RT, V= .29, $F(6,100)=2.85$, $p< .01$, $\eta^2_p=.15$. Follow-up one-way ANOVA's revealed these significant effects were present for the 3-back task, $F(2,53)=4.16$, $p<.02$, task-switching paradigm, $F(2,53)=4.70$, $p<.01$, and go/no-go task, $F(2,53)=5.78$, $p<.01$. Subsequent independent t-tests showed significant differences between footballers and basketball players $t(37)=-2.57$, $p<.02$, and football, and rugby players, $t(34)=2.35$, $p<.03$ for the 3-back task (See Figure 1), significant differences between footballers and basketball players $t(36)=-3.03$, $p<.01$, and football and rugby players , $t(34)=2.67$, $p<.01$, for the go/no-go task (See Figure 2) and significant difference between football and rugby, , $t(34)=3.17$, $p<.01$, on the task switching paradigm (See Figure 3).
- The one-way ANOVA and two separate Kruskal-Wallis analyses revealed no significant differences between sport type in the accuracy of all three tasks.
- Findings were not attributed to speed-error trade-off (Fitts, 1954).

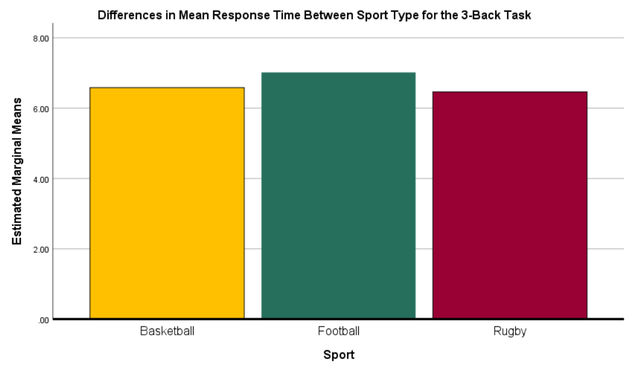

Figure 1: Estimated Marginal Means for the RTs on the 3-back task.

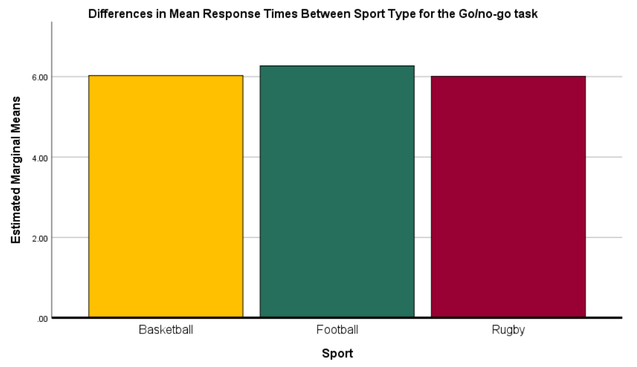

Figure 2: Estimated Marginal Means for the RTs on the go/no-go task.

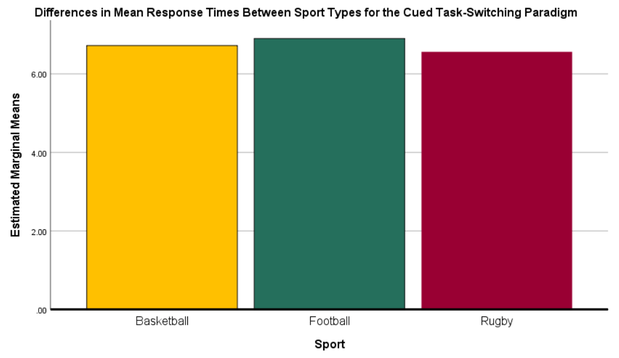

Figure 3: Estimated Marginal Means for the RTs on the cued task-switching paradigm.

DISCUSSION

- Footballers performed the slowest in comparison to the rugby and basketball conditions in the tasks of inhibition and working memory. The football players were also significantly slower than the rugby players in the cognitive flexibility task. These findings do not support the initial hypothesis that basketball players will perform faster than those in the other two sporting conditions. This opposes research which proposes football enhances EF performance (e.g. Alesi et a., 2016; Levitch et al., 2018). These findings support the 'Cumulative heading hypothesis' (Witol & Webbe, 2003) and those who support it (e.g. Master et al., 1999; Koerte et al., 2017).
- These differences in RT were attributed to the hand-eye co-ordination training received by basketball and rugby players as an essential aspect of their sport. In a similar fashion to how individuals who had received intense musical training had better RTs due to the increased hand-eye co-ordination (Landry & Champoux, 2017).
- This supports previous research which found differences between sport type and RTs (Mann et al., 2007).
- No significant differences found between sport type for the accuracy score on all three EF measures which supports previous literature (e.g. Stephens et al., 2010; Mayers et al., 2011). May be explained by sports engagement increasing accuracy at a similar rate (e.g. Vestberg, , Gustafson, Maurex, Ingvar & Petrovic, 2012; Jacobson & Mattaeus, 2014; Alesi et al., 2016).

APPLICATION TO RESEARCH

- Findings highlight the possible positive impacts of participating in sport.
- Highlights how sport-type can influence measures of executive function which should be considered in future designs.

IMPLICATIONS FOR FUTURE RESEARCH

- Assess these differences using a longitudinal design.
- Implement a second control group of non-athletes or a control group compiled of different non-contact sport athletes.
- Investigate the possible positive influence of sports participation on EF performance.

CONCLUSION

- Football players performed the slowest on measures of executive function.
- These differences were attributed to the training styles of the respective sports.
- No significant differences of accuracy were found.
- Highlights the influence sport type itself has on executive function measures.
- Demonstrates how there could be benefits to executive function performance which arise from sports participation.

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