



The BASES Expert Statement on the relationship between executive functions and sport and exercise

Produced on behalf of the British Association of Sport and Exercise Sciences by Drs Greg Wood, Lisa-Marie Schutz, Liis Uiga, Jack Brimmell and Philip Furley.

Introduction

Executive functions (EFs) comprise of three core cognitive processes, that include working memory, inhibitory control, and cognitive flexibility. Collectively, they are suggested to underpin higher-order EFs such as reasoning, problem solving, and planning (Diamond, 2013). Consequently, EFs have been proposed to be important for successful performance in almost every domain of human life, including sport and exercise.

Do sport and exercise improve executive functions?

Recommendations for using physical activity and sport to improve EFs and academic performance is appealing and has found some experimental research support (see Furley *et al.*, 2023, for an overview). However, until recently, there has been a lack of critique in the evaluation of the primary evidence on which such recommendations are based. Singh *et al.* (2019) revisited the primary evidence by combining a systematic review with recommendations

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Despite the increasing interest in EFs in sport and exercise (cf. Furley *et al.*, 2023), this field of research has provided highly ambiguous findings on two fundamental questions: Do sport and exercise improve EFs? What is the relationship between EFs and sport expertise? Worryingly, however, the inconclusive evidence is often disregarded, and claims have been made about the direct link between physical exercise, participation in sport and improved EFs. These claims do not only threaten the credibility of scientific evidence but have also led to changes to educational policy (e.g., the introduction of physical activity breaks and classroom-based physical activity in schools) and talent identification/development. As an example, these claims serve as a foundation for a multibillion dollar ‘brain-training’ industry where professional coaches and athletes are sold the promise that assessment of EFs may help to identify future sporting talent or that training EFs can have benefits for on-field performances.

In this expert statement, and in line with BASES values on the importance of professional integrity, we offer a reasoned critique of this research and highlight significant methodological issues which we feel undermine the integrity of these above claims based on the current available evidence.

from an expert panel on the effects of physical activity interventions on cognitive and academic performance. The expert panel concluded that ‘there is currently inconclusive evidence for beneficial effects of physical activity interventions on cognitive and academic performance [...] and more “high-quality” research is warranted’ (p. 640). Further critique was provided by Diamond and Ling (2020), who, after conducting the largest systematic review of its kind (179 studies), concluded that only 7% of the exercise studies and 0% of the resistance training studies provide evidence that these interventions improve EFs. Finally, a recent umbrella review of randomised controlled trials on the effects of physical exercise on cognition found only small exercise-related benefits that became substantially smaller after accounting for key moderators (e.g., baseline group differences) and almost negligible after correcting for publication bias (Ciria *et al.*, 2023). Therefore, based on current evidence, the effects of sport and exercise for improving executive functions are at best unclear and at worst negligible.

What is the relationship between EFs and sport expertise?

High-level athletic performance relies on a variety of cognitive processes, such as attention (see Brimmell *et al.*, 2022, for a review



Above: Can assessing EFs aid talent identification and development?

of attention and EFs), decision-making, and anticipation. As these cognitive processes are closely linked with EFs, it has been suggested that the most successful sport performers should also test high on measures of EFs. Undoubtedly, such a proposition has intuitive appeal and has gained support from some experimental studies. As an example, Kalen *et al.* (2021) conducted a meta-analysis on the expertise and EFs relationship. They reported small-to-medium effects indicating that expert athletes perform better compared to non-expert or novice groups on measures of EFs. However, there are clear issues with the research included in the meta-analysis that undermine the conclusions made. Generally, these studies often report low sample sizes, do not correct for multiple statistical tests, and only find significant differences on a few EF tests (see Furley *et al.*, 2023 for an overview). There is also a lack of consideration regarding the potential effects of publication bias in the EFs and sports expertise literature (cf. Ciria *et al.*, 2023). Consequently, the reported small-to-medium effects in the meta-analytic evidence may represent a much smaller effect or no effect at all, as the literature may be distorted due to publication bias and low-quality primary research which is meaningfully averaged in meta-analysis (Furley *et al.*, 2023). Thus, based on the current available literature we consider the evidence for the relationship between EFs and sport expertise to be weak.

Conclusions and recommendations.

- Exercise and sport participation offer numerous positive benefits that can contribute to mental health and cognitive functioning. However, the current scientific evidence does not support a simple causal effect of either exercise or sport for enhancing EFs and, therefore, should not be advertised as such. While we acknowledge the inherent advantages of exercise and sport in enhancing aspects of executive functioning and academic performance, the existing evidence suggests that these benefits are more likely to stem from the effects of physical activity on aerobic fitness, overall brain health, sleep quality, healthy dietary habits, and enhancing mood, rather than direct effects on EFs.
- High-quality research is essential to fully examine the relationship between sport, exercise, and EFs. Future research should therefore prioritise a mechanistic approach by considering potential moderating variables (e.g., age, sex, genetic differences, the type of exercise/sport, and the intensity of such activity) and delving into the underlying causes (e.g., changes in brain function). Elevating the research quality through a mechanistic approach will yield invaluable insights into the intricate interplay among sport, exercise, and EFs.

- The current evidence for the link between EFs and sporting expertise is limited. However, enhancing primary research by increasing statistical power, better control of confounding variables, and adopting longitudinal research designs can provide a better understanding of this relationship. Moreover, improving the (ecological) validity and reliability of EF tasks will likely help illuminate the role of EFs in sporting expertise.
- From a more practical perspective, based on current evidence we do not recommend screening for EFs within talent identification or talent development programs in sport. For similar reasons, we advise athletes, coaches, and sport teams against investing training time and other resources on commercially available EFs training, as there is no well-established empirical evidence to date suggesting it is likely to improve sports performance. ■



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