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There is no evidence for a far transfer of cognitive training to sport performance

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ABSTRACT

In this short opinion piece I first introduce the concepts of near and far transfer, as described in the psychological literature. I then use a second-order meta-analysis on cognitive training to evidence that near transfer may be common and relatively easy to achieve, yet achieving far transfer is far less straightforward. Nonetheless, many technologies, tools and methods make larger-than-life claims of encouraging far transfer from cognitive or perceptual-cognitive training to sports performance. In this opinion piece I argument, using evidence from research studies on stroboscopic vision, neurofeedback training and the measurement and development of executive functions, that the claims made for the beneficial effects of these training methods on sports performance, esports performance and football expertise are likely exaggerated. I conclude by reiterating that these claims of far transfer are not substantiated in the scientific literature, and much greater scrutiny of these claims by researchers is needed in order to assist practitioners to make better-informed decisions about tools, methods and technologies that may aid sports performance.

INTRODUCTION

Cognitive training – in one form or another – is all the rage in sport. In fact, it appears that, in recent years, the amount of cognitive training tools that claim to transfer to sporting performance (i.e. a so called far transfer) has increased exponentially. Nonetheless, the evidence that supports a transfer of cognitive training to sport performance is underwhelming. Therefore, this short opinion piece is written to provide a scientific rationale for why we should carefully contemplate the usefulness of cognitive training tools in sport that claim to be able to influence sport performance.

A brief introduction to near and far transfer

A transfer of skills is the generalisation of skills that are acquired through training across different domains. A near transfer is a transfer of skills across domains that are related to one another. In contrast, far transfer occurs across domains only weakly, or unelated to one another. In psychological literature, it is well understood that near transfer is very common, while far transfer, though much more interesting to study or achieve, is very rare. This is in

a sense logical, we can expect, for example, that the training of juggling skills makes you a better juggler but may not have any influence on your ability to balance on one foot, given how little one task tasks resemble the other.

However, researchers, consultants, and external service providers rarely make an interesting business or research case facilitating near transfer. As a result, many (and I am not naming any here, I will leave that up to you to decide) make claims their technologies or methods can facilitate far transfer. In other words, using their cognitive training tool or method will make you a better penalty taker, esports player and/or referee, and more. But what really is the scientific basis for these claims? Should we evaluate each and every one of these tools, methods and claims individually, or does evidence already exist that can help organisations make sense of whether the cognitive training tool they are being offered, has any chance of living up to the far transfer promises made by the claimants?

To build my case, I will first introduce a piece of high-level evidence from the psychological literature, before providing some specific examples of cognitive training tools which are often used to facilitate far transfer to sporting performance, while no evidence is available to support this.

There is no evidence for far transfer claims

In this meta-analysis of meta-analyses (a powerful method that combines the evidence reported in many meta-analytical studies in a defined area to see if their claims can truly be substantiated, and as such provides a high level of evidence), the authors[1] first examined what the evidence was for a near transfer of working memory training (a common form of cognitive training) to other related memory tasks across a variety of samples (including both healthy and non-healthy children and adults). Then, in the second part of their review, they examined the evidence for a far transfer from working memory training to other cognitive domains such as fluid reasoning, cognitive control, language etc. I will briefly summarise its findings below to provide a contemporary status quo of the psychological literature on the near and far transfer of cognitive training.

First, to study the near transfer of working memory training to other, related memory domains, four meta-analyses were included using samples of typically developing children,

children with learning disabilities, healthy adults and adults with some level of mild cognitive impairment. The authors concluded that working memory training is generally related to better performance in subsequent memory tasks, especially in typically developing children (while this same effect also exists for both adult groups but is less clear for children with learning difficulties). In conclusion, working memory training transfers to memory performance. Then, to investigate far transfer between memory training and other cognitive assessments, the authors used the same method but altered the outcome variables of interest. Rather than examining the effect of working memory training on memory tasks, they examined its effect on other higher-level cognitive functions such as fluid reasoning, cognitive control, processing speed and language. The researchers found no evidence that far transfer occurred between working memory training and these cognitive tasks.

From this second-order meta-analysis we can conclude that within the psychological literature 1) there is evidence for near transfer from working memory training to memory tasks, but 2) no evidence of the existence of a far transfer to other types of high-level cognitive functioning. Furthermore, the authors also included an analysis of meta-analyses which include far transfer results from other forms of cognitive training such as video-gaming, exergaming, music training and chess training and concluded that these types of 'alternative cognitive training' yielded zero results in terms of their far transfer to other, unrelated cognitive skills. As a result, the researchers concluded that support for a near transfer of cognitive training exists and is likely modulated by the characteristics of the trainee, yet they did *not* find support for a far transfer of various modalities of cognitive training.

WHY DO WE KEEP INVESTING IN TOOLS THAT MAKE OUTRAGEOUS CLAIMS?

A wealth of evidence exists in the psychological literature that should at least make us question the usefulness of cognitive training when the aim is to achieve a far transfer. Yet, hy do so many technology companies and researchers continue to invest in training tools, methods and technologies that claim to facilitate far transfer? Why are we not listening to the evidence in front of us? I believe there are several reasons:

1) We feel a need to use new technologies when they become available. As a consultant, much of my work consists of refuting claims made by technology companies who claim to have the next breakthrough training tool that will accelerate the development of athletes' skill and decision making. Questions about the usefulness of these tools are often posed to me by coaching or management staff, yet they likely originate elsewhere. In fact, these questions often originate from staff members who have seen these tools used on social media or by their competitors (or in the worst set of circumstances *in* social media *by* competitors), and therefore are pressured from higher up or from players to purchase these tools for performance improvement. More often than not these tools are indeed acquired, briefly used, and quickly discarded. As a result, the emergence of and exposure to new technologies, especially in the area of cognitive and decision-making training, likely fuels a FOMO (Fear Of Missing Out for those of us who are not Millennials) -effect which often leads to irrational decision making.
2) There is a certain logic to the claims made. More often than not, an elevator pitch by one of these technology companies will start with: "A player needs to be able to make split-second decisions while on the pitch…" emphasising the role played by the brain in executing the right skill at the right time. Some sports even call it "game intelligence". So logically, a (erroneous) causal relationship forms between improving the function of the brain and performance. One of the most prominent examples is the so called 'brain training games' which claim to improve performance in other aspects of life, or even sport performance.
3) Research is too slow to catch up with new technological advancements. I would like to think I am making an effort developing rigorous studies that test some of the most prominent, yet unsubstantiated claims made in the sports skill learning realm. Yet, it takes me several years to find financial support, design, implement and publish the findings of a study. By that time, the technologies have long been purchased and discarded (or worse, continue to be used without scientific foundation), and my work is lost to the wave of cognitive dissonance of the part of the purchaser.

EXAMPLES OF TOOLS AND METHODS WITH CLAIMS OF FAR TRANSFER IN SPORT

Stroboscopic vision training for sports performance

Many of us have seen the stroboscopic glasses that claim to improve performance for those who wear them. You might have even seen these glasses used by prominent sportspeople during practice, which in the eye of the public may act as a substantiation of their claims to improve performance. In fact, I used these stroboscopic glasses myself when I was a practitioner. The claims made by the producers (and salespeople) of these glasses seem to be logical. When wearing them, the amount of visual information available in the environment is greatly reduced, forcing the athlete wearing the glasses to extract and process relevant information in the environment quicker. As a result, the athlete is then able to perform better when not wearing the glasses, because they can pick up and process more information quicker. A bit like running with ankle weights on, and then suddenly taking them off. This claim follows the same logic.

Indeed, studies that have examined the relationship between wearing stroboscopic glasses and sports performance have concluded that reducing how much visual information is available during a sport task, resulted in impaired motor performance[2,3], which substantiates the claims that stroboscopic vision training adds a level of difficulty to a task over full vision training. There have also been several studies on the effects of training with stroboscopic glasses on subsequent performance in perceptual (near transfer) and sport (far transfer) tasks. The findings of these studies largely align with what we already know about the prevalence of near and far transfers of skill from psychological research. There is plenty of evidence to suggest training with stroboscopic glasses leads to a near transfer to perceptual-cognitive function (motion-sensitivity[4], short-term memory[5], anticipatory timing[6], visual acuity[7], and many more) yet the evidence for a far transfer to sport performance is shaky[8,9], or not supportive of its existence (football dribbling in with full vision available[10], badminton on-field performance[11]). As a result, while using stroboscopic glasses could likely be used to increase the difficulty of practice sessions[3], there is no hard evidence to suggest that training under intermittent visual restriction leads to a far transfer to sport performance.

Neurofeedback headsets in esports

Neurofeedback training is a hot topic in neuroscience. The premise of neurofeedback training is again logical. Experts usually exhibit different brain activity than novices across a range of tasks, including during the learning of motor skills. Therefore, practice that encourages athletes to have more expert-like brain activity, may encourage learners to learn certain skills faster and as a result perform them better. Neurofeedback is specific practice

methods in which learners are given feedback on their brain activity through an electroencephalogram, so they can learn to produce cortical activity patterns that usually belong to experts to speed up the learning or improve the performance of a task[12].

As a result of the logic behind neurofeedback training, many organisations have implemented neurofeedback training to improve motor performance in a variety of domains. One of the most prominent is esports. Esports or electronic sports is a form of competitive gaming. It is a rapidly growing domain of human-computer interaction whereby players manipulate virtual worlds to achieve a specific task goal (e.g. drive a virtual car presented on a screen using a controller). Esports competitions attract thousands of competitors and millions of spectators, and prize pools for those victorious are also significant as a result. As a result, esports companies invest heavily in training tools, instruments and methods that can give them an edge over their rivals. One of the methods that has seen significant investment is neurofeedback training.

Several neurofeedback training instruments such as “brainwave reading EEG headsets/ headbands”, “neurofeedback software” and “brain-training wearables” are commonplace, yet their claims to “improve and optimise performance” cannot be substantiated. Several studies have examined if neurofeedback training can be used to improve sports performance. Most do conclude that neurofeedback training leads to a near transfer by teaching learners to change their cortical activity (e.g. reduce frontal high-alpha power[12]). However, there are several methodological issues that limit our understanding and implementation of neurofeedback training for sports performance (i.e. a far transfer[13]). As a result, neurofeedback “wearables” in esports (regardless of whether these are valid measurement or training instruments in the first place) are unlikely to live up to their claims of transferring learned behaviours during training to competition games.

Developing executive functions for football expertise

Footballers who make split-second decisions, require well-developed cognitive functions. We’ve heard it all before, but this is the main rationale for the implementation of cognitive testing and training for footballers. Of specific interest recently is the role played by executive functions (higher-order cognitive functions such as response inhibition, cognitive flexibility, working memory and attentional control) in sports performance. Again, the argument here

is sensible. A footballer sees a clear and open passing line to a teammate in a position to score, so they line up the pass. However, a sudden movement from an opponent suddenly blocks the passing line. A good player then inhibits the initial passing action and perhaps chooses a different teammate to pass to or exploits the gap left by the moving opposition player to move closer to the goal. So, it seems logical that footballers need good inhibitory control (among other higher-order cognitive functions) to play football at the highest level. As a result of logical reasoning in boardrooms across the globe, there have been massive investments from sporting organisations worldwide into cognitive testing and development as the new frontier of talent identification and development[14]. The premise is here that footballers with better executive functions will perform better on the field, whether players were selected for their executive functions (cognitive assessments) or whether they were developed in-house (cognitive development).

Indeed, some studies have claimed that executive functions are related to football expertise. For example, Vestberg and colleagues[15] claim that executive functions were related to the number of goals and assists a player made in competition two years later. They concluded, erroneously, that the results of this study strongly suggest that results in cognitive function tests predict future success of footballers, which fueled many of the investments made into cognitive assessment and development in football. However, Beavan and colleagues[16-19], in a series of three studies conducted inside an organisation that implements cognitive assessment and training in high-level footballers, found no evidence to support the claim that executive functions are highly related to football expertise. In fact, Beavan et al.[18] showed that the relationship between football and expertise is likely largely mediated by a participant's age and even revealed that professionally contracted players showed poorer executive functions than players in late adolescence[17]. While not discussed here, we can imagine that cognitive training has a near transfer to cognitive performance (i.e. players engaging in cognitive training improve their cognitive performance in related tasks) but no hard evidence of a far transfer to football expertise or performance exists.

CONCLUSION

This short opinion piece is a reaction on the increasing number of technological tools and training methods using cognitive or perceptual-cognitive training that claim to facilitate far skill transfer (i.e. the transfer from cognitive training to domain-specific sports performance).

Psychological research has provided a sound evidence base to suggest that these far transfers are rare, and if a transfer of skills does occur, it is likely to be a near transfer from cognitive training to related cognitive skills. I have used three specific examples of technologies or methods of which the effectiveness on the learning of sport skills hinges on a rare far transfer occurring. I have provided argumentations and examples to contend that these claims of far transfer are hugely exaggerated. It is my intention for this work to reach sport practitioners who regularly deal with the emergence of new technologies and similar methods, so that they can make better informed decisions about their application.

However, this article also aims to serve as a wake-up call for our discipline to come out of our academic bubble. Why is it so easy to make outrageous claims about technologies, tools and methods that contradict findings in recent literature, without scientific scrutiny? Is it perhaps because it is easier to swim with the stream than against it? If we do not act now, we risk letting he or she who shouts the loudest have the most prominent voice. As researchers, we need to investigate these topics using rigorous methods, but we also need to expose the lack of evidence and/or rationales based on apparently logical (and catchy) arguments but unsupported by the available knowledge. As highlighted by the recent article by Simine Vazire[20], we should closely consider if we, as researchers, want to be incredible or credible.

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Contributed to conception and design: JF
Drafted and/or revised the article: JF

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