2024-04-08

Imagery training for athletes with low imagery abilities

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Running Head: Imagery Training for Athletes with Low Imagery

Imagery training, specifically visual and kinesthetic imagery training, is a well-established method of increasing performance in sport. However, some athletes may have impoverished imagery abilities (e.g., aphantasia; low visual imagery) which may hinder performance increments that benefit others. We administered the Plymouth Sensory Imagery Questionnaire (Psi-Q) which tests multisensory imagery, to 329 participants from nine different sports across two levels: semi-professional and professional. This formed the baseline test, finding no significant differences between sport or level for imagery ability. The Psi-Q located 27 low imagers (mean total scores <4.2/10), including seven non-visual imagers, three non-auditory, seven non-olfactory, and five non-gustatory imagers, and one across all senses. We split the sample randomly into two groups and immediately delivered the imagery intervention, Functional Imagery Training (FIT) to the first group (over two weeks), followed by delivering the same intervention to the wait group. A wait period was due to the lengthy delivery time of the personalized intervention. Both groups received the intervention for the same duration ending in a Psi-Q retest after the intervention. In both groups, FIT increased overall imagery scores which was maintained six months after intervention completion. This indicates that imagery can be trained and maintained in those with a low ability. Follow up interviews (n=22) explored how imagery was being used beyond the intervention, revealing that the majority now use imagery to plan and manage thinking. Recommendations are given for ways to train imagery in an applied sport setting and future research in broader areas is detailed.

Keywords*: Aphantasia, Imagery, Functional Imagery Training, Applied Imagery for Motivation.*

Lay Summary

We identified 27 individuals with low multi-sensory imagery scores, and used Functional Imagery Training (FIT) to produce enduring improvements in imagery ability, positioning FIT as a valuable tool for enhancing cognitive skills in sports.

IMPLICATIONS FOR PRACTICE

- Those working with athletes should assess imagery ability and build a personalized strategy that supports learning.
- To effectively cater to a diverse range of athletes with varying imagination and planning styles, coaches may find it necessary to adapt their communication styles accordingly.
- Functional Imagery Training (FIT) is an effective method for improving imagery abilities, offering a viable intervention for athletes with impoverished sensory imagery, including aphantasia or low visual imagery.

Imagery Training for Athletes with Low Imagery Abilities

Introduction

To most people it is difficult to think about not having the ability to imagine, but around 2.1-2.7% of the population (Faw, 2009) report no visual imagery, termed aphantasia. The lack of imagery ability in other sensory modalities like auditory (hearing a ball bounce) and emotional imagery (feeling excitement) are unknown. Neurologists specifically studying aphantasia (Zeman et al., 2015; Milton et al., 2021) suggest that several factors could contribute to a lessened imagery ability, from neurological to personality and mood.

Functional magnetic resonance imaging (fMRI) research has revealed diminished activity in the brain's visual processing regions among individuals with aphantasia, especially during attempts to generate visual images. Furthermore, there is evidence of reduced functional connectivity between these visual processing areas and other regions implicated in imagery and memory processes (Pearson, 2019; Zeman et al., 2020). Studies have also proposed potential associations between aphantasia and alterations in the structure and function of the brain's frontoparietal network, which plays a role in attention, working memory, and cognitive control (Oostra et al., 2016).

While further investigations are needed to comprehensively understand the neural foundations of aphantasia, it is acknowledged that visual imagery is interconnected with other sensory modalities (Zvyagintsev et al., 2013). Consequently, imagining a sound, for example, might elicit a corresponding visual representation. This insight suggests that it could be feasible to enhance imagery in an extant modality—for instance, imagining the sound of a ball bouncing —resulting in potential improvements in a deficient modality, such as imagining seeing a ball. The concept aligns with studies in brain plasticity, indicating that imagery can be trained even in individuals with visual impairments, emphasizing the brain's capacity for adaptive changes (Lambert et al., 2004).

Imagery is an important skill in sport because it has been shown to play a critical role in enhancing sports performances for those who can imagine effectively. It has long been known that an athletes' ability to create vivid multisensory mental images of a successful performance can increase confidence, motivation, and focus (Moritz et al., 1996). Moreover, research has shown that mental imagery can improve physical performance in various sports, such as basketball (Guillot et al., 2009), gymnastics (Battaglia et al., 2014), and golf (Smith et al., 2008). However, while the benefits of multisensory imagery have been well documented, the specific methods behind how to train those detected as having aphantasia or other weak imagery sensory modalities are still not fully understood.

Detecting those with low imagery ability is done using self-report measures such as the Vividness of Visual Imagery Questionnaire (VVIQ; Marks, 1973), but fMRI tests of low imagers identified in this way show limited brain activation in the areas responsible for imagery (Zeman et al., 2020), validating the approach. In sport, self-report questionnaires typically ask athletes to rate their ability to generate and control various aspects of mental imagery, such as the vividness, clarity, and control of their images (e.g., the Sport Imagery Ability Questionnaire; Williams & Cumming, 2011). Kinesthetic-based assessments, whilst still a self-report measure, evaluate an athlete's ability to use mental imagery for physical performance, such as measuring their ability to complete a complex motor task while imagining each step in their mind (e.g., the Movement Imagery Questionnaire (MIQ); Isaac et al., 1986).

Furthermore, measures may involve asking athletes to imagine themselves performing a specific skill or task, and then give a single rating of their imagined experience (Rhodes et al., 2018). These measures can help researchers and coaches assess an athlete's imagery ability specific to sport, but none provide multisensory ratings.

The VVIQ and MIQ focus on evaluating specific sensory modalities rather than providing a comprehensive assessment of multisensory imagery abilities. The Plymouth Sensory Imagery Questionnaire (Psi-Q; Andrade et al., 2014), developed to measure general multisensory imagery ability, has been administered to a wide variety of participants, albeit mostly students. It has not yet been used in sport, possibly because it does not measure specific sporting cognitive imagery or motivation which are of interest to consultants working with athletes in pursuit of performance excellence (Gould et al., 2014). In professional soccer, refined questions from the VVIQ which assesses the vividness of a scene were administered to athletes (Rhodes et al., 2020) and a significant improvement in imagery ability was found following to imagery training. This indicates that imagery ability can be trained if the right method is administered, but still there is no specificity of how to train low imagers including those with aphantasia.

Imagery training methods, according to Paivio (1985) fall into two categories: cognitive (thinking of the task) and motivational (emotional regulation). The most cited form of imagery training is PETTLEP (Physical, Environmental, Task, Timing, Learning, Emotion, and Perspective), which engages the athlete into a sequence of imagining each of the seven components as they build the scene which is discussed with the mental skills consultant (Holmes & Collins, 2001). In a similar way, LSRT (Layering Stimulus Response Training; Williams et al., 2013) constructs a multisensory scene by asking the athlete questions to add detail evoking motivation, reporting improvements in kinesthetic imagery ability and skill. While both PETTLEP and LSRT are designed to enhance task performance in the short term, few studies show their long-term effectiveness.

Functional Imagery Training (FIT: Rhodes et al., 2018; Rhodes & May, 2021) is a combination of motivational interviewing (see Miller & Rollnick, 2012) and imagery training. FIT has been shown to outperform PETTLEP on performance tasks such as penalty shooting, with improvements lasting for a significantly longer period (Rhodes et al., 2020). FIT involves four processes of conversation: engaging, focusing, evoking and planning. During the focusing process, goal centered imagery training is deployed, which explores positive (success) and negative (failure) outcomes, ultimately resulting in a tangible plan being put into action through a series of self-prescribed targets. Going further than Paivio's (1985) cognitive and motivational suggestions, FIT tips the balance by exploring intrinsic motivation before periodically integrating cognitive imagery through PETTLEP and LRST methods which involve process goals.

This research aimed to examine multisensory imagery using the Psi-Q across a series of sports, locate poor imagers and determine the prevalence of low scorers in sport, then attempt to train imagery ability in the poor imagery sample. By training imagery, it was hoped that the low imagery sample would begin to use imagery and start to experience the performance benefits that other athletes reap.

Based on the research of Pocock et al. (2019) who integrated multiple imagery approaches, and Rhodes et al. (2018) whose FIT intervention enhanced imagery ability in soccer players, we hypothesized that imagery ability will improve in the low imagery sample due to imagery training, and that changes will be maintained after six months. We hypothesized that all the senses on the Psi-Q will correlate because athletes tend to use multisensory imagery when (for example) anticipating performance (Holmes & Collins, 2001). Finally, we anticipated that after the intervention, the low imagery ability sample would establish a consistent use of imagery and begin to reap the performance benefits akin to those with average baseline abilities.

Method

Participants

Initially, 450 athletes across nine sports (diving, fencing, pentathlon, rowing, rugby, sailing, soccer, swimming, and tennis) were recruited from online advertisements or the lead author approaching sports clubs to ask for participation. The rationale behind opting for a large sample size stemmed from our assumption that athletes will be better than the general population at using imagery due to the nature of sports performance, making it difficult to detect low imagers. We predicted a change in scores based on Cohen's d to be 0.8, and for a power of 0.8 and alpha of 0.05 we needed to recruit a minimum of 26 participants with low imagery. Based on Faw's (2009) estimated incidence of 2.1-2.7%, we would expect to find 10-12 visual aphantasics in this sample, and expected to find a similar number with low imagery on other modalities.

Participants were from Europe (94% mostly from Great Britain) and Oceania (6% from Australia, Fiji, and Tonga).

Materials

Plymouth Sensory Imagery Questionnaire (Psi-Q; Andrade et al., 2014).

The Psi-Q assesses seven imagery modalities (vision, sound, touch, taste, smell, body sensations and feelings) using 5 items for each modality (e.g., *Imagine* *the appearance of a sunset*). Each question is rated from 0, no image at all, to 10, as vivid as real life. The reliability, internal consistency, and external validity all fall within acceptable parameters, and have been well documented by the authors of the Psi-Q (Andrade et al., 2014), and when converted to other languages, such as Spanish (Pérez-Fabello & Campos, 2020), Japanese (Hitsuwari & Nomura, 2023), and German (Jungmann et al., 2022).

Procedure

Ethical approval was granted from the lead author's institutional ethics committee. All participants read information briefs, were asked to give ethical consent, and subsequently completed the Psi-Q. Of the initial sample, 329 participants (*Mean age* = 24.1 years, *SD* = 4.9; 224 males and 105 females) self-categorized as either semi-professional (n = 130) or professional levels (n = 199) and returned the questionnaires with all items answered.

To identify low imagers, we used total Psi-Q scores and considered participants whose imagery mean was less than 4.2, based on the findings from previous research (Andrade et al., 2014; Dance et al., 2021) with the bottom 10% considered as low imagers. To be consistent with the way wider research reports imagery scores (cf., Dance et al., 2021), we consequently reported mean overall scores in the results section by each of the modalities, and mean overall imagery score out of 10. According to Andrade et al., (2014), mean overall imagery score for the general population is 7.04 (SD=2).

All 27 participants scoring below the threshold of 4.2 agreed to be in the study and signed a second informed consent form agreeing to receive the intervention, with the Psi-Q being completed before and after the intervention. Six months post-intervention, the Psi-Q was completed a final time, and a semi-structured interview was conducted which examined the sporting application of imagery use and general feedback on the training process.

Intervention. FIT (Functional Imagery Training) is the combination of motivational interviewing (Miller & Rollnick, 2012) with goal-based imagery (e.g, Pavio, 1985) used at strategic times to amplify motivation. Imagery deployment is dependent on how the practitioner and athlete discuss goals (e.g., personal long-term goals and process goals, Kingston & Hardy, 1997) and purpose (how the goal benefits others), and how they move through the processes of motivational interviewing. The specifics of how FIT is administered follows the Applied Imagery for Motivation model (AIM; Rhodes & May, 2021), which starts with a one-hour motivational interview where the athlete discusses their personal values, beliefs and wider purpose. In the subsequent sessions, imagery is often used by adding layers (Williams et al., 2013; Cumming et al., 2017) to goals or tasks such as a penalty kick (Rhodes et al., 2020) to explore how the future experience is fantasized (Oettingen, 2012). In the case with low imagers, it was not possible to immediately fantasize about future goals, so every participant experienced imagery training in smaller workshop sessions which included the same home practice tasks.

A session plan, including the average time each activity lasted, is provided in Table 1. The session plan was followed as closely as possible, although due to the conversational style of motivational interviewing, tangents sometimes occurred in the session when participants had questions or wanted to explore a related point. Specific imagery training, the second meeting with the participant, was split into four parts: exploration (how does imagery work?), application (how can imagery be used in training?), refinement (how can imagery be used for the participant in competition?), and development (what methods work best for the participant?), all occurring at least

24 hours apart depending on participant and practitioner availability. Tasks were set at the end of each meeting to evoke meta-cognitions and awareness, working towards imagery mastery, and acted as a discussion point for the start of the subsequent session.

Insert Table 1 about here

Title: Applied Imagery for Motivation (AIM) session plan, including activity, mean time and tasks.

In the fifth and final session, the AIM model was revisited. By this point, most participants were able to imagine and fantasize about their future and elaborate on their process goals, evident from their ability to discuss events in a multisensory way. For the minority who continued to struggle with (for example) visual imagery, scenes were created vividly using the other senses, usually sound, kinesthetics and emotional imagery. Because of the diverse sample from professional and semi-professional levels and from different sports, participants were ultimately encouraged to develop their own performance routines using a behavioral cue and activating imagery through the participants highest scoring sense. For example, a tennis player had a physical cue (wiping their hands on their shorts), which activated their highest scoring imagery sense; sound (such as hearing the ball bounce), causing a domino effect as they imagined the point (feeling the movement, controlling breathing, visualizing the opponent's likely return). This routine equipped each athlete to perceive challenges and plan ways to overcome them before they arise using multisensory imagery.

Data Analysis

All data analysis was conducted in R Studio 4.3.0. The data and associated code are freely available on Open Science Framework here: https://osf.io/z5rjv/?view_only=2fd7854ac54e4820bd0e3c3c999b5624. Significance was measured at 0.05, and parametric tests conducted on all tests of difference and for correlations.

Results

Quantitative Analysis

The descriptives and correlations from the original 329 participants for the Psi-Q are presented in Table 2, showing significant positive correlations between all senses. A regression analysis between average score, sporting level, the nine sports, and sex showed no significant differences (F(10,318)=1.56, p=0.12).

Insert Table 2 about here

Title: Psi-Q mean scores (M), standard deviation (SD), and correlations with confidence intervals.

Of the 329 participants, 8% (N=27) were regarded as having a low imagery ability with a mean overall rating below 4.2 (M=2.7, SD=1.1). The overall mean of the remaining 302 was 7.1, SD=1.14. There was a significantly higher proportion of low-imagers in the semi-professionals, (N=16, 12%) than in the professionals, (N=11, 6%), chisq(1)=4.80, p=.028. Six had complete aphantasia (no visual imagery), seven had no imagery for taste or for smell, three no sound imagery, two no bodily sensation imagery, and one no touch or emotional imagery (Figure 1).

Insert Figure 1 about here

Title: Low imagery participants (N=27) multisensory baseline scores, with each modality differentiated by shape

The low imagery sample were then randomly split into Immediate ((N=14, semi-professional=8, professional=6, imagery M=2.7, SD=1.12) and Delayed ((N=13, semi-professional=8, professional=5, imagery M=2.7, SD=1.11) groups, which did not differ in imagery scores t(25)=.13, p=0.9. The Immediate group received the FIT intervention over a two-week span. The Delayed group experienced the same intervention after a month-long waiting period. Figure 2 shows the two groups average Psi-Q scores for each timepoint.

The second baseline measure for the Delayed group M=2.75, SD=1.14) showed no significant change t(12)=1.63, d=.07, p=0.13. For further analysis, we coded the session immediately prior to each group's intervention as pre-intervention, the session after the intervention as post-intervention, and the final session as follow-up.

Insert Figure 2 about here

Title: Overall imagery rating for immediate and delayed groups at each testing point.

An ANOVA comparing time (Pre-intervention, post-intervention, follow-up) and group (Immediate, Delayed) showed no difference between group (*F*<1) or interaction (*F*<1), but a significant effect of time (*F*(1,26)=80.94, *ges*=0.36, *p*<0.001). Paired contrasts for the immediate group were significant between pre-intervention and post-intervention *t*(13)=5.25, *d*=1.6, *p*<0.001, with improvements (M=4.64, SD=1.26) remaining six months after the intervention had finished (M=4.61, SD=1.28, *t*(13)=5.17, *d*=1.56, *p*<0.001). The same occurred for the delayed group with significant improvements from pre-intervention to post-intervention (M=4.30, SD=0.93, *t*(12)= 13.53, *d*=1.49, *p*<0.001) and maintained, at follow-up (M=4.26, SD=0.87, *t*(12)=10.71, *d*=1.49, *p*<0.001). Furthermore, when both intervention groups were combined, all seven sensory modalities reported significant differences from pre- to post-intervention, and a breakdown of all scores can be found in Table 3.

Insert Table 3 about here

Title: Psi-Q Descriptives and Inferentials Split by Sensory Modality and Time.

Finally, we compared the combined imagery intervention groups at the end of the study (M=4.42, SD=1.06) to the baseline scores of the 302 athletes who did not receive the intervention (M=7.06, SD= 1.18) to determine if the imagery ability gap had significantly closed, but there was still a significant difference $t(32)=12.26$, $d=2.35$, $p<0.001$.

Follow-up Interviews

An experienced interviewer conducted all follow up interviews with 22 participants to review the imagery training process. All participants discussed their appreciation for being taught how to train their imagination and said that they would recommend the program to others. Only one participant said that they were not able to imagine, and the training did not improve their imagery ability, but they developed "ways of paying more attention" to process goals which they perceived "increased performance." The remaining 21 participants were actively implementing imagery in previously low sensory modalities to plan after initiating a specific cue. One participant said: "Before the training I'd always plan what I'll be doing next in some way, but it was fleeting; just a quick thought. Imagery training has enabled me to develop a routine, beginning from a simple cue. For me I wipe my hands on my shorts. That starts a sort of immersive video played in my head which goes through my plan in detail, a specific goal, and ends with me feeling in control of what will happen next."

Participants were asked 'when' they practiced imagery and to describe the 'benefits'. 17 participants said that imagery was a "formal practice", and 15 said that it was a way to "manage thoughts/thinking" by refocusing attention onto a process goal. Formal practices were in the form of "morning routines" (n=19) which explored "challenges and obstacles" (n=11), through to a way to refocus attention from "frustration to a manageable goal" (n=3). Furthermore, participants reported using imagery to "improve performance consistency" (n=16), and in their general life such as "before meetings" (n=9), and "at the end of the day to prepare for tomorrow" (n=4) to become more aware of upcoming challenges and develop plans to as they work towards goals.

Discussion

This research examined multisensory imagery using the Psi-Q across nine sports and with athletes competing at semi-professional and professional levels, identifying several with poor imagery ability. Low imagery was only half as likely in professional athletes than in semi-professionals, who were more like the general population (Faw, 2009). This is the first known study to explore imagery differences between sporting levels, showing no significant differences the professional and non-professional levels.

At baseline, the modality imagery scores on the Psi-Q correlated. Clearly, when motivation and performance pressure are present a holistic process of imagery is involved which means that imagery should not only be taught through an isolated task (e.g., imagining serving a tennis ball) but focused on intrinsic motivation, rewards, and process goals (Shenhav et al., 2013). Therefore, athletes appear to use imagery to imagine event episodes (e.g., travelling to the location, the day of the week, being at the specific venue) and then imagine performing process goals (e.g., serving, body position during a tackle) at specific events against opponents. When motivation and mastery are present, imagery is goal-centered and reflects a holistic process.

In the low imagery sample, imagery improved over time for both intervention groups after the use of imagery training, and those changes were maintained six months later. Although it was not the aim of this research, imagery training for the low imagery group did not raise ability scores to those of the original sample, with significant differences remaining. Participants reported having a formalized practice and an improvement in performance consistency because of imagery training.

FIT is a holistic approach that focuses on intrinsic motivation through goal-centered imagery. This method of coaching is based on a well-established behavior change model used in domains such as addiction, and it goes beyond cognitive manipulation techniques like PETTLEP, which have been shown to improve imagery ability and performance in the short term (Collins & Carson, 2017). However, in the long term, a comprehensive approach that combines multiple methods of engagement, including motivational discussions, action observation, and specific imagery training, woven together with practical application, is the most effective approach to coach individuals with low imagery ability (e.g., Rhodes et al., 2020; Wright et al., 2022). The social validation obtained from the interviews supports this approach, as many athletes reported using imagery beyond the intervention and in their personal lives, indicating that the intervention had a lasting impact.

There are several recognized limitations in the design of this study, including variations in athletes' training environments, distinct goals in different sports, the potential influence of leading questions during interviews, and the likelihood of bias arising from the pressure to complete homework tasks. As a research team, we diligently acknowledged these limitations, maintaining a pragmatic approach in our applied research. It is important for future researchers employing the AIM model session plan to be mindful of its limitations, especially when applied to a diverse sample of athletes with varied imagery abilities.

Successfully implementing this approach (like most others) hinges on establishing a personal connection with athletes and focusing on their individual motivations, ambitions, values, and expectations, as emphasized by Miller and Rollnick (2012). While proficient practitioners using FIT can adeptly navigate these conversations, those less experienced, particularly in motivational interviewing, might require additional time to achieve comparable results (Rhodes et al., 2018). Hence, our recommendation is for practitioners intending to use AIM to undergo training in motivational interviewing before implementation. This preparatory step will enhance their comprehension of the approach's nuances and contribute to a more streamlined and effective coaching process.

Psychologists, coaches, mental skills consultants, and practitioners working with athletes should focus on effective communication strategies when discussing thinking strategies. This includes understanding that most athletes can imagine technical and tactical instructions, often using visual and kinesthetic cues. However, some athletes may require hands-on experience to truly comprehend and imagine the next step in their learning process, with research showing a link between vivid imagery only when the individual has experience physically executing the skill (Kraeutner et al., 2016). It is important to recognize this variability and conduct imagery ability testing to establish how athletes imagine information such as gameplans.

Coaching styles may need to be adapted to cater to a diverse range of athletes, with evidence from this study showing that imagery use in low imagery professional athletes is better than semi-professionals. In the general athletic population imagery ability does not predict sporting performance, which supports wider studies when examining children who play sport and their imagery ability (Dey et al., 2016). To advance the understanding of athlete imaginations, we intend to build upon the work of Andrade et al. (2014) by creating a multisensory imagery scale specific to sport and conducting research across various sports, ages, sexes, and ethnicities. Improved imagery training can lead to performance benefits for athletes, especially for those who initially score low on imagery tests. Therefore, testing athletes' imagery ability and adapting coaching styles accordingly is crucial.

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