UNIVERSITY OF BIRMINGHAM
University of Birmingham Research at Birmingham

A PETTLEP Imagery Intervention with Young Athletes

Quinton, Mary; Cumming, Jennifer; Gray, Robert; Geeson, Joseph; Cooper, Andrew; Crowley, Hannah; Williams, Sarah

DOI:
10.1515/jirspa-2014-0003

License:
Other (please specify with Rights Statement)

Document Version
Publisher's PDF, also known as Version of record

Citation for published version (Harvard):
Quinton, M, Cumming, J, Gray, R, Geeson, J, Cooper, A, Crowley, H & Williams, S 2014, 'A PETTLEP Imagery Intervention with Young Athletes', *Journal of Imagery Research in Sport and Physical Activity*, vol. 9, no. 1, pp. 47-59. https://doi.org/10.1515/jirspa-2014-0003

Link to publication on Research at Birmingham portal

Publisher Rights Statement:
Article available online at: http://dx.doi.10.1515/jirspa-2014-0003

Eligibility for repository checked July 2015

General rights
Unless a licence is specified above, all rights (including copyright and moral rights) in this document are retained by the authors and/or the copyright holders. The express permission of the copyright holder must be obtained for any use of this material other than for purposes permitted by law.

•Users may freely distribute the URL that is used to identify this publication.
•Users may download and/or print one copy of the publication from the University of Birmingham research portal for the purpose of private study or non-commercial research.
•User may use extracts from the document in line with the concept of 'fair dealing' under the Copyright, Designs and Patents Act 1988 (?)
•Users may not further distribute the material nor use it for the purposes of commercial gain.

Where a licence is displayed above, please note the terms and conditions of the licence govern your use of this document.

When citing, please reference the published version.

Take down policy
While the University of Birmingham exercises care and attention in making items available there are rare occasions when an item has been uploaded in error or has been deemed to be commercially or otherwise sensitive.

If you believe that this is the case for this document, please contact UBIRA@lists.bham.ac.uk providing details and we will remove access to the work immediately and investigate.

Download date: 13. Oct. 2026

Research Article

Mary L. Quinton*, Jennifer Cumming, Rob Gray, Joseph R. Geeson, Andrew Cooper, Hannah Crowley and Sarah E. Williams

A PETTLEP Imagery Intervention with Young Athletes

Abstract: The PETTLEP model of imagery (Holmes & Collins, 2001) was designed to produce more effective imagery. The PETTLEP acronym represents seven key elements (i.e., Physical, Environment, Task, Timing, Learning, Emotion, and Perspective) which should be considered by researchers and practitioners when delivering an imagery intervention. It is thought that by including these elements the functional equivalence at the neural level between imagery and performance will be increased. A number of interventions have supported the use of PETTLEP imagery in improving performance of motor skills (e.g., Smith, Wright, Allsopp, & Westhead, 2007, 2008). To date, however, these PETTLEP interventions have mainly been applied to adult populations with very few conducted with children. The aim of the present study was to test the effects of a 5-week layered-PETTLEP intervention (i.e., adding PETTLEP elements progressively) on movement imagery ability and performance of a soccer task in children. A secondary aim was to examine the potential for a sport-specific nutritional intervention to serve as an effective control condition. Thirty-six children (34 male, 2 female, M age = 9.72 years, SD = 2.05) from a local futsal club were age matched and then randomly allocated to either a PETTLEP imagery intervention group or a nutrition control group. Pre-testing consisted of the Movement Imagery Questionnaire for Children and a dribbling and passing motor task. Post-test protocol was the same with the addition of a nutritional knowledge test. Despite the imagery intervention producing no significant improvements in imagery ability or motor task performance, there was a significant correlation at post-test for the imagery group between age and external visual ($r = 0.56$, $p < 0.05$) and kinesthetic imagery ability ($r = 0.57$, $p < 0.05$). Furthermore, the nutrition group scored significantly higher than the imagery group on the nutrition test ($p < 0.05$). This study highlights important aspects that need to be considered when delivering PETTLEP imagery interventions to children. This study is also one of the first studies to show that control groups, especially with children, can be used for educational purposes. Similar control groups should be considered in future research, as it means interventions can not only be used in a practical manner to improve sporting performance but also to educate and improve knowledge.

Keywords: PETTLEP, imagery ability, children, behavioral matching, intervention

DOI 10.1515/jirspa-2014-0003

***Corresponding author: Mary L. Quinton,** School of Sport, Exercise and Rehabilitation Sciences, University of Birmingham, Edgbaston, Birmingham B15 2TT, UK, E-mail: mxq977@bham.ac.uk; mlquinton@hotmail.co.uk

Jennifer Cumming: E-mail: j.cumming@bham.ac.uk, **Rob Gray:** E-mail: r.gray.2@bham.ac.uk, **Joseph R. Geeson:** E-mail: joe-rob123@hotmail.co.uk, **Andrew Cooper:** E-mail: dennisisking@hotmail.co.uk, **Hannah Crowley:** E-mail: x-hana-banana-x@hotmail.co.uk, **Sarah E. Williams:** E-mail: s.e.williams@bham.ac.uk, School of Sport, Exercise and Rehabilitation Sciences, University of Birmingham, Edgbaston, Birmingham B15 2TT, UK

As an experience that mimics real experience, imagery involves combining different sensory modalities in the mind and has become an increasingly popular technique during the past few decades (Cumming & Ramsey, 2009; Morris, Spittle, & Watt, 2005). Within sport, deliberate and systematic imagery use has been recognized as a means to facilitating performance improvements through skill and strategy learning, as well as the regulation of thoughts, emotions, and arousal levels (Cumming & Williams, 2012; Martin, Moritz, & Hall, 1999). Interventions to train athletes on how to use imagery have been successfully introduced in a diverse range of sports, including figure skating, flat-race horse racing, gymnastics, hockey, netball, and rugby, resulting in enhanced performance and other outcomes such as self-confidence (e.g., Callow & Waters, 2005; Cooley, Williams, Burns, & Cumming, 2013; Cumming & Ste-Marie, 2001; Evans, Jones, & Mullen, 2004; Smith et al., 2007; Wakefield & Smith, 2009).

Brought to you by | University of Birmingham
Authenticated | mxq977@bham.ac.uk author's copy
Download Date | 6/2/14 10:50 AM

The performance benefits of using imagery have been explained by the partial overlap of brain areas involved with motor planning and execution that are activated during imaged and physical movements (Jeannerod, 1994). However, imagery and action are represented not just in overlapping voxels according to brain imaging methods, but they also largely employ the same mechanisms (Guillot, Di Rienzo, MacIntyre, Moran, & Collet, 2012; Moran, Guillot, MacIntyre, & Collet, 2012). Similarities between these two processes have also been found with peripheral measures of the autonomic nervous system (e.g., cardiac activity) as well as behavioral measures (e.g., movement time; Louis, Collet, Champely, & Guillot, 2012; Williams, Cumming, & Balanos, 2010). Collectively, this evidence has been taken to show that a structural and functional equivalence exists between imagery and physical movement at the neural level (Finke, 1980; Jeannerod, 1997).

Although these processes will never be completely identical, Holmes and Collins (2001) were the first to recognize that the extent to which imagery and motor processes do covary (i.e., their neural functional equivalence) has important implications for how imagery is delivered and performed. They proposed that, "if physical and mental practice are equivalent, then many of the procedures shown to be efficacious in physical practice should also be applied in mental practice as well" (p. 62). Furthermore, the memory trace of a movement representation will be strengthened during imagery similar to how this occurs during motor planning and execution. Initially, Holmes and Collins (2001) believed that for imagery to be effective in mimicking the benefits of motor processes at a central level, "functional equivalence" is an important prerequisite. However, more recently Wakefield, Smith, Moran, and Holmes (2013) have argued that PETTLEP imagery might be able to optimize the efficacy of an imagery intervention through the concept of "behavioral matching". That is matching the imagery and execution of the situation as closely as possible. This suggests that the effectiveness of the PETTLEP model is likely through matching behavioral characteristics between imagery and physical movement (i.e., a phenomenological similarity) rather than on neutrally based functional equivalence between imagery and action (Wakefield et al., 2013).

The PETTLEP model

To monitor the equivalence of imagery to the physical movement targeted for improvement, Holmes and Collins (2001) proposed the PETTLEP model. Drawing from Lang's (1977, 1979) bioinformational theory, the model also emphasizes the importance of including personally meaningful stimulus (i.e., details of the situation) and response (i.e., emotional and physiological responses to the situation) propositions into the imagery. These propositions are inter-related and essential for eliciting the beneficial effects of imagery on performance (Smith, Holmes, Whitemore, & Devonport, 2001). When used together, stimulus and response propositions can also enhance the vividness and ease of imaging (e.g., Callow & Hardy, 2004; Williams, Cooley, & Cumming, 2013).

The PETTLEP model consists of seven elements that form a checklist for preparing imagery scripts and instructions: Physical, Environment, Task, Timing, Learning, Emotion, and Perspective (for a detailed description of each element, see Wakefield & Smith, 2012). Physical refers to the physical nature of the imagery whereas Environment pertains to where the imagery is carried out. Task focuses on the imagery content, the characteristics of the task being imaged and the level of expertise. Timing refers to the temporal nature of the imagery (i.e., real-time vs slow/fast motion). Learning indicates that imagery content should evolve with learning and refinement of behavior. Emotion refers to the athlete's affective and emotional responses to the imaged situation. Finally, Perspective refers to the adopted visual imagery perspective.

Images can be viewed from a first person perspective, also known as internal visual imagery (IVI), or from a third person perspective, also known as external visual imagery (EVI). It is suggested that IVI may be preferred for open skills and those when timing is important, whereas EVI is more advantageous for viewing form and body position (Hardy & Callow, 1999). Wakefield and Smith (2012) also emphasize the importance of taking individual preference into account to ensure the performer is comfortable with the technique and therefore more motivated to image as instructed.

Evidence in favor of a PETTLEP approach to designing imagery interventions has accumulated in recent years. It is apparent that including PETTLEP elements into imagery is effective for improving the performance of motor skills (e.g., Smith et al., 2007, 2008; for a recent review, see Wakefield et al., 2013). Despite behavioral matching being recently proposed as the mechanism that provides the benefits of imagery, the fundamental principle of the model remains the same: "the importance of matching closely the imagined and actual skill-learning environments" (Wakefield & Smith, 2012, p. 2). For

Brought to you by | University of Birmingham
Authenticated | mxq977@bham.ac.uk author's copy
Download Date | 6/2/14 10:50 AM

example, a football player imaging taking a penalty would try to match the timing of the image to that of the physical execution of the task. Despite the matching of physical and imagined environments (and therefore the inclusion of more PETTLEP elements) being highlighted as a central premise to the PETTLEP model, there is a paucity of evidence in this regard (see Guillot, Collet, & Dittmar, 2005 for an exception).

Layering PETTLEP elements and imagery ability

Using more PETTLEP elements in an intervention can result in more effective imagery (Smith et al., 2007). It can also be argued that incorporating more elements provides an intervention with a greater degree of ecological validity; that is, the imagery will more accurately reflect the real life situation with each additional element included. To maximize performance results, it would therefore be optimal to include all PETTLEP elements within the same intervention. However, this recommendation may be impractical in some situations and care is also needed to not overload athletes (Wakefield & Smith, 2012). If all seven elements are included from the start of an intervention, it may be difficult for an individual to focus on the appropriate stimulus and response propositions due to the large amount of information provided. This issue might be particularly relevant to subsamples of athletes who are new to imagery interventions and/or find it difficult to image.

A solution to this problem that is in accordance with the Learning element would be to evolve the complexity of a PETTLEP imagery intervention by introducing fewer and simpler elements at the beginning (e.g., physical, environment, and task) and systematically introducing more complex elements (e.g., emotions and timing) as the intervention progresses. This approach is based on Lang's (1979) bioinformational theory (which PETTLEP draws upon) by gradually incorporating more stimulus and response propositions as the layering of the image progresses. To our knowledge, layering the PETTLEP elements during an imagery intervention is yet to be done. Furthermore, this approach may be effective as imagery, similar to physical skills, can be broken down into more manageable chunks and improved with practice (Hall, 2001; Williams et al., 2013). For example, children are able to learn a skill quicker through breaking it down, or "chaining" (Slocum & Tiger, 2011). A similar approach was undertaken with the present imagery intervention. Imagery is a skill, and like any new skill, it would be beneficial to start simply and make it more complex as learning progresses. The aforementioned suggestion to avoid overloading athletes with too much information when starting an imagery training program seems particularly relevant to young athletes who are still developing their imagery ability. For example in an intervention, the physical, environment, and task elements might be initially introduced to the athlete. These elements may be the easiest to begin with as they do not include imagery content that is too complex. For example, a tennis player would be on the court, dressed in their whites, and asked to image the desired task appropriate to their level of expertise. Once the athlete can generate and maintain quality images, emotions might be added as another layer, and so forth. The imagery experience then becomes more detailed and complex with the inclusion of additional PETTLEP elements until, ideally, all elements are included.

A similar layering technique of stimulus and response propositions has already been shown to be effective for improving imagery ability and golf putting performance in adults with relatively low imagery ability (Williams et al., 2013). However, to our knowledge, it has not yet been directly applied to the elements of the PETTLEP model. Moreover, little is currently known about which techniques might be effective for improving imagery ability, a factor known to influence the benefits received from using imagery (for a recent review, see Cumming & Williams, 2012). Cumming and Williams (2013) describe imagery ability as a multidimensional construct, emphasizing aspects such as the vividness (i.e., clarity or "lifelikeness" of the image), controllability (i.e., the ease to which the image can be manipulated), ease (ability to engage in the imagery process), accuracy, and duration of the image. Imagery ability can also refer to different aspects of the imagery process, such as being able to easily produce a scenario in the mind or generating different types of imagery content (Cumming & Williams, 2012; Williams & Cumming, 2011). However, imagery ability is a complex entity which not only includes the aforementioned constructs based on phenomenology (e.g., vividness and controllability) but it also refers to other constructs based on the neural pathways (e.g., spatial and motor imagery). The PETTLEP elements might lead to better image generation by enabling athletes to more easily create vivid, realistic, and detailed images (Gould & Damarjian, 1996). Although a PETTLEP approach to designing imagery interventions has been recognized as potentially beneficial for improving imagery ability (e.g., Smith et al., 2008), limited work has addressed this issue to date.

Brought to you by | University of Birmingham
Authenticated | mxq977@bham.ac.uk author's copy
Download Date | 6/2/14 10:50 AM

Applying PETTLEP imagery to young athletes

Another gap in the PETTLEP literature concerns the application of the model to youth athletes. PETTLEP interventions have mainly been applied to adult populations, but the few studies conducted with children have so far yielded promising results. For example, Smith et al. (Study 2, 2007) reported significantly greater performance on a turning beam jump for gymnasts aged 7–14 years following PETTLEP imagery compared to those who received stimulus-only imagery. Although not a PETTLEP based intervention per se, Taktek, Zinsser, and St-John (2008) investigated the effects of visual and kinesthetic imagery (KI) with children aged 8–10 years to determine which modality was more effective for improving skill retention and transfer. They found no difference between imagery types but retention of the task for both imagery groups was equivalent to the specific physical practice group (SPPG), and transfer to another task was better than both SPPG and a control group. Moreover, improvements in imagery ability were found when compared to the control participants. Additional support for conducting imagery interventions with young athletes stems from recent research by O, Munroe-Chandler, Hall, and Hall (2014), who showed an individualized imagery intervention to be effective at improving self-efficacy for young squash players (M age = 10.80 years, SD = 1.93). Collectively, these studies indicate that children will likely benefit from effective imagery interventions, both in terms of improving motor skill performance as well as developing their imagery ability. However, additional research with young athletes is required to expand upon the existing small body of literature with this sample.

Study aims

The primary aim of the present study was to test the effects of a layered-PETTLEP intervention (i.e., adding PETTLEP elements progressively) on movement imagery ability and performance of a soccer task in children. We hypothesized that the imagery group would significantly improve their imagery ratings measured by the Movement Imagery Questionnaire – Children (MIQ-C) and improve significantly more at the dribbling and passing task compared to a placebo control group.

PETTLEP studies have typically involved asking the control group to read literature associated with the sport, which is known to elicit spontaneous imagery among participants (Smith et al., 2007, 2008). Furthermore, an inactive control group with children would most likely lead to boredom. To overcome these issues and because the sample involved children whose reading levels might vary considerably, a second intervention focusing on nutritional information was employed as a placebo control.

Having good nutritional knowledge is an important life skill that is especially useful in today's society as a way to increase awareness of the risks associated with unhealthy eating and combat against obesity (Rutkowski & Connelly, 2011; Swinburn & Egger, 2002). It has already been shown that providing nutritional information to children can significantly improve their knowledge regarding the benefits of eating healthily (Koch, Waliczek, & Zajicek, 2006). To our knowledge, no sport-specific nutritional intervention has yet to be conducted with youth athletes. Because the opportunity presented itself to investigate this issue in the present study, a secondary aim was to examine the effects of a sport-specific nutritional intervention taught through games and activities on the nutritional knowledge of children. We hypothesized that children in the nutrition group would score significantly higher on a nutritional knowledge test at post-intervention than those in the imagery group.

Method

Participants

Thirty-six children (34 male, 2 female, M age = 9.72 years, SD = 2.05) from a futsal club participated in the study. Futsal is an indoor, South American version of the traditional English "five a side" football which differs due to using a smaller ball with reduced bounce, therefore increasing the demand on fitness, skill, and tactical awareness (The Football Association, 2009). Participants varied in years of experience (M = 2.72 years, SD = 1.76) and participation in extracurricular hours of sport per week (M = 11.72 hours, SD = 5.32). Ethnicity varied between participants (White 39%, Black 14%, Asian 17%, Mixed 25%, and Other 5%). The majority of children had very little or no previous exposure to imagery.

Instruments

Movement Imagery Questionnaire – Children

The MIQ-C (Carter, Yoxon, Ste-Marie, Cumming, & Rose, 2013) is an adaptation of the Movement Imagery

Brought to you by | University of Birmingham
Authenticated | mxq977@bham.ac.uk author's copy
Download Date | 6/2/14 10:50 AM

Questionnaire – 3 (MIQ-3; Williams et al., 2012) for children to measure visual (internal and external) and KI ability. Instructions are read to participants by a researcher, and pictures are used to help children understand the different types of imagery ability being tested and the rating scale employed. The questionnaire consists of 12 items and four simple movements (i.e., knee raise, arm movement, waist bend, and jump). For each item, participants first physically perform the movement and then image the movement using IVI, EVI, or KI. They then rate the ease or difficulty of imaging each movement on a 7-point Likert scale, with 1 representing "very hard to see/feel" and 7 representing "very easy to see/feel". Due to the age range of the study, participants provided a verbal rating of each item to prevent any problems arising from any reading or writing difficulties. The MIQ-C is still undergoing psychometric testing, but initial evidence appears favorable (Carter et al., 2013). Moreover, the MIQ-3 has already been shown to be a valid and reliable instrument (Williams et al., 2012). In the present study, the MIQ-C demonstrated adequate internal reliability for kinesthetic ($\alpha = 0.85$, 0.85), internal visual ($\alpha = 0.74$, 0.78), and external visual ($\alpha = 0.70$, 0.83) subscales at both pre-test and post-test.

Waterloo Footedness Questionnaire – Revised

An adapted version of the Waterloo Footedness Questionnaire – Revised (WFQ-R; Elias, Bryden, & Bulman-Fleming, 1998) was used to record the children's foot dominance in the present study. Participants were asked to perform three movements (kicking a ball, pretending to stomp a bug, and raising their knee) from the WFQ-R. The researcher observed which leg was used to perform the action and recorded this information. One point was given for each action (+1 for right and –1 for left), with a positive score indicating right foot dominance and a negative score indicating left foot dominance.

Nutrition test

A multiple choice test was devised for the present study to measure nutritional knowledge related to sport. It consisted of 10 questions; one question was based on each nutrition intervention session (e.g., Which is the main nutrient that gives you energy? Which drink is best to drink after exercise?). Choices of answers varied from pictures or words to add variety and make the test more appealing to children. The nutrition test can be obtained from the lead author. One point was awarded for the correct answer, with the highest possible score being 10.

Procedure

Following ethical approval from the institution where the authors are based, an information session was held to inform parents and guardians about the study. They were given an information letter and asked to give consent for their child to participate. As well, parents and guardians provided demographic information about their child concerning their age, years of experience, participation in extracurricular sport activities, and ethnicity. All testing and intervention sessions occurred during a regularly scheduled futsal training session.

Pre-test

Baseline measures of imagery ability and performance of the soccer task were obtained at the pre-test. The soccer task was developed specifically for the present study and involved the skills of dribbling and passing (Figure 1). A number of "filler" tasks were also carried out as part of the club's normal testing procedures but were not analyzed for the present study. The children were put into small groups and rotated through each task.

The dribbling and passing soccer task was designed to be as reflective of game situations as possible by

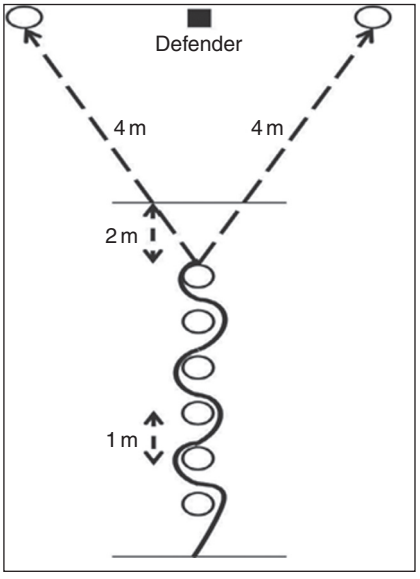

Figure 1 Dribbling and passing task

Brought to you by | University of Birmingham
Authenticated | mxq977@bham.ac.uk author's copy
Download Date | 6/2/14 10:50 AM

testing players' ball control and decision-making skills. To complete the task, the participants were instructed to dribble in and out of the cones with a ball. Once they reached the final cone, the aim was to pass the ball to the cone as indicated by the "defender" (a researcher) before reaching the line marked on the gymnasium floor 2 m in front of the final cone. If the defender turned to the right, the participant aimed to pass the ball to the left cone (and vice versa). The order of the direction in which the defender turned (right vs left) was randomized and counterbalanced across all participants. The task was completed with the right foot only, the left foot only, and by alternating feet. After viewing a video-taped demonstration, participants were given a practice trial on each condition before performing it for real. Participants were told the aim was to complete the task as quickly, but as accurately as possible. Performance was timed with a stopwatch following a "go signal" until the ball left the participant's foot to make the pass. Accuracy was scored as follows: (1) 0 points allocated if player made a pass in the wrong direction and missed the cone, (2) 1 point allocated if player made a pass in the wrong direction which hit the cone, (3) 2 points allocated if player made a pass in the correct direction which missed the cone, and (4) 3 points allocated if player made a pass in the correct direction which hit the cone.

Imagery and nutrition interventions

Following the pre-test, the children were matched by age and randomly allocated to either the imagery or nutrition group ($n = 18$ each). The interventions were delivered twice per week for 5 weeks, for a total of ten sessions.

The imagery sessions were designed as a layered-PETTLEP approach, with more elements introduced as the intervention progressed. In the same format as the MIQ-C, the session content was first physically performed and then imaged. Participants were also given stimulus–response training in the first session to help them be more aware of what they were seeing and feeling in their images (Lang, Kozak, Miller, Levin, & McLean, 1980). The participants helped to generate relevant propositions, which the researchers reinforced in the first and subsequent sessions. Examples of stimulus propositions were details of the gymnasium where the intervention (and testing) took place. Response propositions emphasized kinesthetic (e.g., muscles working) and tactile sensations (e.g., contact of the ball).

In every session, participants were always dressed in their soccer kit and placed their foot on top of the ball during the imagery (Physical). All sessions took place in the same gymnasium where the dribbling passing task was assessed at pre- and post-tests (Environment). The imagery content focused on the skills of dribbling and passing, but the task varied from session to session (Task). Changing the session content was done for two reasons: (a) to keep the children interested and engaged and (b) to evolve the content in complexity throughout the intervention (Learning).

Participants were encouraged to always see and feel the images as clearly as possible, with visual imagery performed in the participants' preferred visual perspective (Perspective). They were also told to close their eyes if they found this helpful for generating the images. The same pictures used to introduce the concepts of visual perspective in the MIQ-C were shown to the participants at the start of each session when these instructions were given. The researchers verbally checked that each participant understood the difference between visual imagery perspectives and instructed them to use their preferred perspective in the session. In later sessions, the Emotion element was introduced and participants were asked to include personally meaningful and facilitative emotions within their imagery (e.g., feeling confident and "untouchable"). The concept of imaging in real-time was also emphasized more to the participants as the intervention progressed (Timing). At the end of each session, the researcher recorded the participants' ease of seeing and feeling the session content. Ratings were made on the same 7-point Likert-type scales used in the MIQ-C, with 1 representing "very hard to see/feel" and 7 representing "very easy to see/feel". We refer to this measure as specific imagery ability (see Cumming & Ste-Marie, 2001 for similar terminology).

The nutrition intervention contained general and sport-specific nutritional advice given throughout the ten sessions. For example, participants were informed about the correct choice of foods and the optimum time to eat them in relation to exercise. The nutrition intervention matched the imagery intervention in terms of being interactive through the use of props (e.g., which sized water bottle is the correct choice to drink after exercise?) and playing games (e.g., can you guess which of these meals has the highest fat content?). The main aim was to improve their knowledge and to develop an important life skill.[1]

1 The full intervention details are available from the lead author.

Brought to you by | University of Birmingham
Authenticated | mxq977@bham.ac.uk author's copy
Download Date | 6/2/14 10:50 AM

Post-test

The post-test took place the week after the intervention was completed. The same measures from pre-test were again administered (i.e., dribbling and passing task, MIQ-C, and filler tasks). The WFQ-R and nutrition test were also given to participants at this time.

Results

Self-report data

Group characteristics

To ensure there were no pre-existing group differences in footedness and the number of intervention sessions completed, two independent samples *t*-tests were performed. A Bonferroni adjustment was made due to multiple comparisons being performed ($p < 0.025$). Results revealed no significant differences between groups (imagery mean: 1.08, $SD = 0.28$; nutrition mean: 1.00, $SD = 0.00$) in footedness, $t\ (22) = 0.92$, $p = 0.369$, or number of intervention sessions completed, $t\ (34) = -1.31$, $p = 0.199$, with all participants experiencing at least three intervention sessions (imagery mean: 8.00, $SD = 2.25$; nutrition mean: 8.94, $SD = 2.07$).

Specific imagery ability

Mean ratings for how easily participants were able to see and feel the intervention images ranged from 4.82 ($SD = 1.67$) to 6.18 ($SD = 0.75$) and from 4.66 ($SD = 1.37$) to 5.64 ($SD = 1.57$), respectively. Consequently, participants were able to image each session's imagery task.

General imagery ability

In general, before any imagery training, all children found visual imagery easier than KI (EVI: $M = 5.70$, $SD = 1.00$; IVI: $M = 5.61$, $SD = 1.00$; KI: $M = 5.09$, $SD = 1.27$). Three paired samples *t*-tests with a Bonferroni correction ($p < 0.017$) revealed that EVI, $t\ (33) = -3.14$, $p = 0.004$, and IVI, $t\ (33) = -3.01$, $p = 0.004$, imagery were significantly easier than KI imagery. However, there was no significant difference between both types of visual imagery, $t\ (33) = -0.64$, $p = 0.524$. Table 1 shows MIQ-C imagery ratings at pre-test and post-test for both intervention groups according to imagery type (IVI, EVI, and KI).

Table 1 Means and standard deviations of MIQ-C imagery ratings at pre-test and post-test for both intervention groups according to imagery type (IVI, EVI and KI)

	Pre-test			Post-test		
	EVI	IVI	KI	EVI	IVI	KI
Imagery	5.91 (1.05)	5.57 (0.90)	5.04 (1.44)	5.79 (0.96)	5.79 (0.83)	5.63 (0.88)
Nutrition	5.88 (0.90)	6.02 (0.91)	5.40 (1.20)	6.21 (1.09)	6.17 (0.87)	5.77 (1.25)

A 2 (group) × 2 (time) mixed design MANOVA investigated whether there were any group differences in imagery ability types from pre- to post-test. Results revealed no significant multivariate effect for time [Wilks' $\lambda = 0.83$, $F(3,\ 22) = 1.52$, $p = 0.236$, $\eta_p^2 = 0.17$, with an observed power of 35%], group [Wilks' $\lambda = 0.89$, $F(3,\ 22) = 0.94$, $p = 0.44$, $\eta_p^2 = 0.11$, with an observed power of 22%], or time*group interaction [Wilks' $\lambda = 0.93$, $F(3,\ 22) = 0.58$, $p = 0.635$, $\eta_p^2 = 0.07$, with an observed power of 15%]. Consequently, no differences in imagery ability were found between the groups at pre- or post-test and imagery ability did not change during the intervention.

Bivariate correlations investigated the relationship between imagery ability of both intervention groups at pre- and post-test and age and years of experience. Participants in the imagery group who were older and more experienced scored higher on the EVI ($r = 0.56$, $p = 0.031$) and KI ($r = 0.57$, $p = 0.036$) subscales at post-test. There was no significant relationship between futsal experience and imagery scores in either group at pre- or post-test. Due to the large variability in the number of intervention sessions completed, bivariate correlations investigated the relationship between the number of intervention sessions completed and imagery ability scores for both groups. Participants in the imagery group who completed more of the intervention scored higher on the EVI subscale ($r = 0.65$, $p = 0.004$) and KI subscale ($r = 0.50$, $p = 0.036$) of the MIQ-C at post-test than those who completed less of the intervention. There were no significant correlations between the number of intervention sessions completed and MIQ-C scores at either the pre- or post-test. Results of these correlations are reported in Table 2.

Nutritional knowledge

A two-tailed independent samples *t*-test showed a significant between group difference in test scores with the

Brought to you by | University of Birmingham
Authenticated | mxq977@bham.ac.uk author's copy
Download Date | 6/2/14 10:50 AM

Table 2 Correlation coefficients between imagery ability and age, futsal experience, and number of intervention sessions completed for both groups at pre- and post-test

		Pre-test			Post-test		
		EVI	IVI	KI	EVI	IVI	KI
Intervention group	**Age**						
Imagery		−0.17	0.07	0.08	0.56*	0.44	0.57*
Nutrition		0.48	0.31	0.45	0.23	0.33	0.28
	Futsal experience						
Imagery		0.35	0.40	0.31	0.50	0.40	0.49
Nutrition		−0.01	−0.25	0.11	0.11	0.34	0.27
	Sessions completed						
Imagery		0.28	0.48	0.23	0.65*	0.39	0.50*
Nutrition		−0.14	−0.03	−0.01	0.48	0.53	0.17

Note: *$p < 0.05$.

nutrition group ($M = 5.92$, $SD = 2.78$) scoring significantly higher than the imagery group ($M = 3.94$, $SD = 2.29$), $t(27) = -2.11$, $p = 0.044$.

Performance data

Speed

Three separate 2 (group) × 2 (time) mixed design ANOVAs investigated whether there were any group differences in motor task speed at pre-test and post-test. Separate analyses were run for right foot, left foot, and alternating feet trials. For the right foot, results showed no significant effect for time, $F(1, 24) = 0.57$, $p = 0.813$, $\eta_p^2 = 0.002$, group, $F(1, 24) = 1.57$, $p = 0.223$, $\eta_p^2 = 0.06$, and no time × group interaction, $F(1, 24) = 0.36$, $p = 0.552$, $\eta_p^2 = 0.02$. The observed powers were 6%, 23%, and 9%, respectively. There were also no significant main effects for time, $F(1, 24) = 0.45$, $p = 0.510$, $\eta_p^2 = 0.02$, group, $F(1, 24) = 0.67$, $p = 0.420$, $\eta_p^2 = 0.03$, and time × group interaction, $F(1, 24) = 0.09$, $p = 0.773$, $\eta_p^2 = 0.004$, for left foot speed. The observed powers were 10%, 12%, and 6%, respectively. Similarly with the alternating feet, there was no significant main effects for time, $F(1, 24) = 0.51$, $p = 0.480$, $\eta_p^2 = 0.02$, group, $F(1, 24) = 0.00$, $p = 0.985$, $\eta_p^2 = 0.00$, and group × time interaction, $F(1, 24) = 0.20$, $p = 0.659$, $\eta_p^2 = 0.008$. The observed powers were 11%, 5%, and 7%, respectively. Consequently, neither group significantly improved their speed from pre-test to post-test in any performance condition. Means and standard deviations of both groups at pre- and post-test can be seen in Table 3.

Accuracy

Three separate 2 (group) × 2 (time) mixed design ANOVAs investigated whether there were any group differences in motor task accuracy at pre-test and post-test. Results for the right foot trial accuracy revealed no significant main effects for time, $F(1, 24) = 0.43$, $p = 0.517$, $\eta_p^2 = 0.02$, group, $F(1, 24) = 0.14$, $p = 0.715$, $\eta_p^2 = 0.01$, and no time × group interaction, $F(1, 24) = 0.43$, $p = 0.517$, $\eta_p^2 = 0.02$, with observed powers of 10%, 7%, and 10%, respectively. There were also no significant main effects for left foot accuracy for time, $F(1, 24) = 0.36$, $p = 0.070$, $\eta_p^2 = 0.13$, group, $F(1, 24) = 0.77$, $p = 0.390$, $\eta_p^2 = 0.03$, and no time × group interaction, $F(1, 24) = 3.61$, $p = 0.07$, $\eta_p^2 = 0.13$, with observed powers of 45%, 13%, and 45%, respectively. For the alternating feet trial there was also no significant main effects for time, $F(1, 24) = 0.01$, $p = 0.941$, $\eta_p^2 = 0.00$, group, $F(1, 24) = 0.13$, $p = 0.727$, $\eta_p^2 = 0.01$, and time × group interaction, $F(1, 24) = 0.24$, $p = 0.630$, $\eta_p^2 = 0.01$, with observed powers of 5%, 6%, and 8%, respectively.

Table 3 Means and standard deviations of performance data of both groups at pre- and post-test

		Pre-test			Post-test		
		Right foot	Left foot	Alternate feet	Right foot	Left foot	Alternate feet
Intervention group	**Speed**						
Imagery		7.89 (1.34)	8.79 (1.50)	8.39 (1.85)	7.99 (1.34)	8.92 (2.23)	8.01 (1.42)
Nutrition		8.62 (1.28)	9.35 (1.75)	8.24 (1.55)	8.38 (1.27)	9.68 (3.13)	8.15 (1.81)
	Accuracy						
Imagery		2.40 (.51)	2.07 (.46)	2.36 (.50)	2.40 (.51)	2.07 (.73)	2.27 (.47)
Nutrition		2.36 (.50)	2.00 (.45)	2.33 (.62)	2.55 (.52)	2.45 (.52)	2.40 (.51)

Note: Speed was measured in milliseconds, accuracy was measured from 0 to 3 with a higher score representing a more accurate pass.

Brought to you by | University of Birmingham
Authenticated | mxq977@bham.ac.uk author's copy
Download Date | 6/2/14 10:50 AM

Consequently, neither group significantly improved their performance accuracy from pre-test to post-test in any performance condition. Means and standard deviations of both groups at pre- and post-test can be seen in Table 3.

Discussion

The aim of the study was to investigate the effects of a 5-week layered-PETTLEP intervention on children's movement imagery ability and performance at a soccer task. A secondary aim was to examine the effects of a sport-specific nutritional intervention taught through games and activities as a suitable control group activity for children not in the imagery intervention group. Results of the study revealed children's initial imagery ratings mimicked findings in adults: visual imagery ability tends to be reported higher than KI ability (Callow & Hardy, 2004; Louis et al., 2012). Interestingly, when investigating children's imagery use, Munroe-Chandler, Hall, Fishburne, O, and Hall (2007) found that only children in the oldest age cohort (13–14 years old) reported using KI. Consequently, although children as young as 3 years old have the ability to image (Joh, Jaswal, & Keen, 2011), they may not think of using KI in sport or simply choose not to use it. This is supported by the MIQ-C ratings in the current study (Table 1). Children younger than 13–14 years can successfully image basic movements using KI, but they found IVI and EVI easier therefore suggesting that when imaging in sport, they may simply choose not to use it.

Following imagery training, EVI and KI ability were significantly correlated with age. Previous research states that younger children have difficulty visualizing movement images due to their inability to make anticipations (Munroe-Chandler et al., 2007). This may explain why younger children scored lower on these MIQ-C subscales and suggests that the older children may have benefitted from the intervention more than the younger children. However, due to the small sample size we are unable to investigate this further.

PETTLEP imagery

Contrary to our hypothesis, results revealed that the intervention did not have any significant effect on imagery ability or performance of the dribbling and passing task. This may have been due to the frequency and overall number of sessions completed by the participants. Wakefield and Smith (2009) found that significant improvements in PETTLEP imagery performed three times a week compared to once and twice a week, suggesting imagery should be performed more frequently to elicit greater results. PETTLEP imagery undertaken by children three times a week has been shown to improve imagery ability (Smith et al., 2007). Consequently, it may be that two sessions a week over 5 weeks were not sufficient enough to bring about improvements. Moreover, children would miss various sessions throughout the intervention for reasons beyond the researchers' control. To be included in the analysis, children had to complete at least three sessions over the intervention period. This may not have been sufficient to bring about any changes in imagery ability, particularly as the children reported a relatively high ease of imaging at the pre-test. The significant positive correlations between the number of intervention sessions completed and post-test EVI and KI MIQ-C ratings suggest that a greater number of sessions was needed to elicit improvements in imagery ability and this may have generalized to improvements in the dribbling and passing task.

Another possible explanation why the intervention may not have yielded any imagery or performance increases is due to the imagery content (i.e., the futsal drills) and characteristics (i.e., VI and KI) being too difficult for the children to perform. Previous imagery interventions usually incorporate the same task (i.e., content) throughout the intervention (Smith et al., 2008; Wakefield & Smith, 2009). To maintain the children's interest and prevent them becoming bored, we decided to change this each week. Additionally, the imagery content gradually evolved in a layering approach to make it more detailed. Images started with fewer PETTLEP elements to ensure the content was more basic and throughout the intervention incorporated more difficult PETTLEP elements, such as emotion to create a more detailed image. This layering approach was done to prevent "overloading" the participants from the start. It is possible that the imagery group was able to create more vivid and clear images at the post-test, but with the same amount of ease to that performed at the start of the intervention, resulting in no change in MIQ-C scores. However, further research is required to support this notion by assessing ease of imaging along with other measures such as vividness and detail of the image. Due to younger children not using KI (Munroe-Chandler et al., 2007), these participants may not have been able to use KI as effectively when performing the intervention images. The literature suggests that using KI in addition to visual imagery can

Brought to you by | University of Birmingham
Authenticated | mxq977@bham.ac.uk author's copy
Download Date | 6/2/14 10:50 AM

produce greater performance benefits than visual imagery alone (Hardy & Callow, 1999). KI imagery can reinforce response propositions to create a more vivid image (Lang, 1979; Holmes & Collins, 2001). Therefore, the imagery may not have been as effective in improving the younger children's performance of the dribbling and passing task.

A third possibility preventing changes in imagery ability could be the participants' experience of imaging the tasks. Research suggests that the frequency of an event and how recently it took place can influence the ability to image it (Lequerica, Rapport, Axelrod, Telmet, & Whitman, 2002; Szpunar, Watson, & McDermott, 2007; Williams, Cumming, & Edwards, 2011). In the current intervention, most of the imagery tasks had not been performed by participants prior to the intervention. Consequently, the imagery may have been neither as accurate nor as effective as it would have been had the tasks been more familiar. When developing movement imagery interventions, it is important to consider the previous experience participants have of performing the task to ensure the imagery is accurate and sufficient enough to be effective.

Finally, it is also important to note that although the dribbling and passing task was devised to be as ecologically valid as possible, testing occurred in a training environment, rather than a competitive one, meaning it did not elicit the emotion and anxiety intensity that would akin to what is experienced in competition. As a result, the children's emotions within the imagery might not have accurately reflected the pre-test and post-test environment. Ramsey, Cumming, Edwards, Williams, and Brunning (2010) stated that PETTLEP interventions may be more suitable for improvements in competition rather than practice due to these different interpretations of anxiety direction. Also, while the system devised to assess the accuracy of the dribbling and passing task was considered to be the most practical option for the nature of this field study, it may not have been sensitive enough to detect any improvements.

This study provided an opportunity to test the relatively novel MIQ-C in an applied setting. The Cronbach alpha's for all subscales at pre- and post-test were above 0.70, demonstrating good internal reliability. The MIQ-C is based on the MIQ-3 (Williams et al., 2012) but is more child friendly by including pictures to explain the rating scale and provide examples of the different imagery perspectives. The Movement Imagery Questionnaire – Revised (MIQ-R; Hall & Martin, 1997) and the Vividness of Movement Imagery Questionnaire (Isaac, Marks, & Russel, 1986) have previously been used in imagery interventions with children (Smith et al., 2007; Taktek et al., 2008), but it can be questioned whether these instructions are too complex for children to comprehend. Although the MIQ-C may be more appropriate, the 12-items proved to be quite time consuming and slightly impractical when children were tested in larger groups. A shorter 8-item version as seen in the MIQ-R may keep children more focused when completing an imagery ability questionnaire.

Nutritional knowledge

Relating to the secondary aim of the study, results of the nutrition test suggest that a 5-week nutritional training intervention significantly improved nutritional knowledge compared to the imagery group. This supported our second hypothesis. Typically, imagery intervention control groups are usually instructed to read sport associated literature, which can often lead to spontaneous imagery. A nutrition intervention was chosen for this study for a number of reasons. Firstly, it was important to implement a strategy that would engage the children's interest. Secondly, it provided general information on healthy eating and making the correct diet choices. Thirdly, the intervention content also focused on sport-specific nutrition and gave children an insight into ways to improve performance through implementing the correct nutritional strategies. Therefore, the intervention not only provided the children with beneficial advice of sports nutrition but also improved their knowledge of healthy eating. To date, no previous studies have implemented the use of sports nutritional knowledge as a control group. This is the first study to suggest that children's sport-specific knowledge can be improved in a relatively short period of time. Unfortunately, the nutrition intervention was devised as the weeks progressed meaning we were unable to obtain a pre-test measure of nutritional knowledge. However, we believe that it is unlikely that pre-existing knowledge may have contributed toward the results, especially for sport nutrition-related questions, as during the intervention it was evident that very few children had been educated on this particular topic. The finding suggests that future research could teach control group children about important sport-related information such as sports nutrition or rules or tactics.

Limitations and future research

A limitation of this study was the generalized approach of the intervention delivery. The PETTLEP model is based on

Brought to you by | University of Birmingham
Authenticated | mxq977@bham.ac.uk author's copy
Download Date | 6/2/14 10:50 AM

behavioral matching which emphasizes the need for imagery to be specific and meaningful to the individual. Due to practicalities, the imagery intervention was delivered to children in groups of about six to eight participants at a time, often varying in age and level of experience. A generalized approach was adopted to relate to all participants but this may have meant the intervention was not specific enough for participants (e.g., younger children found the concept of KI harder to grasp, which may have required further explanation). Therefore, age should be considered when developing future PETTLEP interventions for children. As of yet there are no studies that have investigated whether the delivery of an imagery intervention should be adjusted for children and how this approach should be undertaken. Based on our findings that age correlated with post-test MIQ-C scores, research should specifically investigate the influence age might have on PETTLEP interventions. It is important that future research establishes the effects of individual differences among child athletes to facilitate effective imagery interventions for groups or teams of children.

A second limitation was the relatively short nature of the intervention. Due to practical constraints, only a 5-week intervention was feasible. However previous PETTLEP studies (e.g., Smith et al., 2007, 2008) have reported performance benefits from 6-week interventions, suggesting that other factors together with the intervention duration may have prevented a significant improvement in imagery ability and performance.

It is also important that research examines how many PETTLEP imagery sessions are required before an intervention becomes effective. This effectiveness can include improving imagery ability as well as achieving other outcomes such as improvements in performance. Imagery research remains unclear about the appropriate amount of imagery to elicit greater effects (Cooley et al., 2013). However, establishing how many sessions are needed to elicit benefits with children and how soon these benefits can occur will help in the design of future interventions.

To observe improvements in imagery ability, measures beyond ease of imaging should be employed. These could include measures tapping different imagery ability dimensions such as vividness or accuracy, and measures beyond self-report such as chronometric assessment which is also thought to reflect imagery ability (Collet, Guillot, Lebon, MacIntyre, & Moran, 2011). Finally, outcomes beyond improvements to performance should be examined. There have been relatively few imagery interventions that have set out to investigate the effects of PETTLEP imagery on outcomes such as regulating arousal and anxiety or modifying cognitions (Ramsey et al., 2010) despite the fact that there has been a call for the PETTLEP model to be tested in this area of the literature (Smith et al., 2007).

Conclusions

The results of this study suggest that in order for a PETTLEP imagery intervention to be most effective, there are important considerations to take into account such as the imagery type used, performance environment, frequency of imaging and the performer's age and level of experience. The main reasons why this imagery intervention did not produce significant results are most likely the length of intervention, the training environment not eliciting the appropriate anxiety intensity and the generalized intervention delivery not being specific to all individuals. Although the findings were not significant, this study contributes to the imagery literature by highlighting important things that need to be considered when delivering PETTLEP imagery interventions to children. This includes the potential of delivering imagery in separate cohorts according to age. The effects of PETTLEP imagery on alternate factors that contribute to performance, such as self-confidence and anxiety interpretation should also be investigated. This study is one of the first to show that control groups, especially with children, can be used in an educational way. This should be considered in future research as it means interventions can not only be used in a practical manner to improve sporting performance but also to educate and improve knowledge.

References

Callow, N., & Hardy, L. (2004). The relationship between the use of kinaesthetic imagery and different visual imagery perspectives. *Journal of Sports Sciences*, *22*(2), 167–177. doi:10.1080/02640410310001641449

Callow, N., & Waters, A. (2005). The effect of kinesthetic imagery on the sport confidence of flat-race horse jockeys. *Psychology of Sport and Exercise*, *6*(4), 443–459. doi:10.1016/j.psychsport.2004.08.001

Carter, M. J., Yoxon, E., Ste-Marie, D. M., Cumming, J., & Rose, M. (2013). The validation of a movement imagery questionnaire for children (MIQ-C). *Journal of Sport & Exercise Psychology*, *35*, S16–59.

Collet, C., Guillot, A., Lebon, F., MacIntyre, T., & Moran, A. (2011). Measuring motor imagery using psychometric, behavioral, and psychological tools. *Exercise and Sport Sciences Reviews*, *39*, 85–92. doi:10.1097/JES.0b013e31820ac5e0

Brought to you by | University of Birmingham
Authenticated | mxq977@bham.ac.uk author's copy
Download Date | 6/2/14 10:50 AM

Cooley, S. J., Williams, S. E., Burns, V. E., & Cumming, J. (2013). Methodological variations in guided imagery interventions using movement imagery scripts in sport: A systematic review. *Journal of Imagery Research in Sport and Physical Activity*, *8*(1), 1–22. doi:10.1515/jirspa-2012-0005

Cumming, J., & Ramsey, R. (2009). Sport imagery interventions. In S. Mellalieu & S. Hanton (Eds.), *Advances in applied sport psychology: A review* (pp. 5–36). London: Routledge.

Cumming, J. L., & Ste-Marie, D. M. (2001). The cognitive and motivational effects of imagery training: A matter of perspective. *The Sport Psychologist*, *15*, 276–288.

Cumming, J., & Williams, S. E. (2012). The role of imagery in performance. In S. Murphy (Ed.), *Handbook of sport and performance psychology* (pp. 213–232). New York, NY: Oxford University Press.

Cumming, J., & Williams, S. E. (2013). Introducing the revised applied model of deliberate imagery use for sport, dance, exercise, and rehabilitation. *Movement & Sport Sciences*, *82*(4), 69–81. doi:10.1051/sm/2013098

Elias, L. J., Bryden, M. P., & Bulman-Fleming, M. B. (1998). Footedness is a better predictor than is handedness of emotional lateralization. *Neuropsychologia*, *36*(1), 37–43. doi:10.1016/0028–39329700107-3

Evans, L., Jones, L., & Mullen, R. (2004). An imagery intervention during the competitive season with an elite rugby union player. *The Sport Psychologist*, *18*, 252–271.

Finke, R. A. (1980). Levels of equivalence in imagery and perception. *Psychological Review*, *87*(2), 113–132. doi:10.1037/0033-295X.87.2.113

Gould, D., & Damarjian, N. (1996). Imagery training for peak performance. In J. L. Van Raalte & B. W. Brewer (Eds.), *Exploring sport and exercise psychology* (pp. 25–50). Washington, DC: American Psychological Association.

Guillot, A., Collet, C., & Dittmar, A. (2005). Influence of environmental context on motor imagery quality: An automatic nervous system study. *Biology of Sport*, *22*, 215–226.

Guillot, A., Di Rienzo, F., MacIntyre, T., Moran, A., & Collet, C. (2012). Imagining is not doing but involves specific motor commands: A review of experimental data related to motor inhibition. *Frontiers in Human Neuroscience*, *6*, 1–22. doi:10.3389/fnhum.2012.00247

Hall, C. R. (2001). Imagery in sport and exercise. In R. Singer, H. Hausenblas, & C. Janelle (Eds.), *Handbook of sport psychology* (pp. 529–549). New York, NY: Wiley.

Hall, C. R., & Martin, K. A. (1997). Measuring movement imagery abilities: A revision of the Movement Imagery Questionnaire. *Journal of Mental Imagery*, *21*, 143–154.

Hardy, L., & Callow, N. (1999). Efficacy of external and internal visual imagery perspectives for the enhancement of performance on tasks in which form is important. *Journal of Sport & Exercise Psychology*, *21*, 95–112.

Holmes, P. S., & Collins, D. J. (2001). The PETTLEP approach to motor imagery: A functional equivalence model for sports psychologists. *Journal of Applied Sport Psychology*, *13*(1), 60–83. doi:10.1080/10413200109339004

Isaac, A., Marks, D., & Russel, E. (1986). An instrument for assessing imagery of movements: The Vividness of Movement Imagery Questionnaire (VMIQ). *Journal of Mental Imagery*, *10*, 23–30.

Jeannerod, M. (1994). The representing brain: Neural correlates of motor intention and imagery. *Behavioral and Brain Sciences*, *17*(2), 187–202.

Jeannerod, M. (1997). *The cognitive neuroscience of action*. Oxford, UK: Blackwell.

Joh, A. S., Jaswal, V. K., & Keen, R. (2011). Imagining a way out of the gravity bias: Preschoolers can visualize the solution to a spatial problem. *Child Development*, *82*(3), 744–750. doi:10.1111/j.1467-8624.2011.01584.x

Koch, S., Waliczek, T. M., & Zajicek, J. M. (2006). The effect of a summer garden program on the nutritional knowledge, attitudes, and behaviours of children. *HortTechnology*, *16*(4), 620–625.

Lang, P. J. (1977). Imagery in therapy: An information processing analysis of fear. *Behavior Therapy*, *8*(5), 862–886. doi:10.1016/S0005-7894(77)80157-3

Lang, P. J. (1979). A bio-informational theory of emotional imagery. *Psychophysiology*, *16*, 495–512. doi:10.1111/1469-8986.197901511.

Lang, P. J., Kozak, M. J., Miller, G. A., Levin, D. N., & McLean, A. (1980). Emotional imagery: Conceptual structure and pattern of somato-visceral response. *Psychophysiology*, *17*, 179–192. doi:10.1111/14698986198000133

Lequerica, A., Rapport, L., Axelrod, B. N., Telmet, K., & Whitman, R. D. (2002). Subjective and objective assessment methods of mental imagery control: Construct validation of self-report measures. *Journal of Clinical and Experimental Neuropsychology*, *24*, 1103–1116. doi:10.1076/jcen.24.8.1103.8370

Louis, M., Collet, C., Champely, S., & Guillot, A. (2012). Differences in motor imagery time when predicting task duration in alpine skiers and equestrian riders. *Research Quarterly for Exercise and Sport*, *83*(1), 86–93. doi:10.1080/02701367.2012.10599828

Martin, K. A., Moritz, S. E., & Hall, C. R. (1999). Imagery use in sport: A literature review and applied model. *The Sport Psychologist*, *13*, 245–268.

Moran, A., Guillot, A., MacIntyre, T., & Collet, C. (2012). Re-imagining motor imagery: Building bridges between cognitive neuroscience and sport psychology. *British Journal of Psychology*, *103*, 224–247. doi:10.1111/j.2044-8295.2011.02068.x

Morris, T., Spittle, M., & Watt, A. P. (2005). *Imagery in sport*. Champaign, IL: Human Kinetics.

Munroe-Chandler, K. J., Hall, C. R., Fishburne, G. J., O, J., & Hall, N. V. (2007). The content of imagery use in youth sport. *International Journal of Sport and Exercise Psychology*, *5*(2), 158–174. doi:10.1080/1612197X.2007.9671817

O, J., Munroe-Chandler, K. J., Hall, C. R., & Hall, N. D. (2014). Using motivational general-mastery imagery to improve the self-efficacy of youth squash players. *Journal of Applied Sport Psychology*, *26*(1), 66–81. doi:10.1080/10413200.2013.778914

Ramsey, R., Cumming, J., Edwards, M. G., Williams, S., & Brunning, C. (2010). Examining the emotion aspect of PETTLEP-based imagery with penalty taking in soccer. *Journal of Sport Behaviour*, *33*(3), 295–314.

Rutkowski, E. M., & Connelly, C. D. (2011). Obesity risk knowledge and physical activity in families of adolescents. *Journal of Pediatric Nursing*, *26*, 51–57. doi:10.1016/j.pedn.2009.12.069

Slocum, S. K., & Tiger, J. H. (2011). An assessment of the efficiency of and child preference for forward and backward chaining.

Brought to you by | University of Birmingham
Authenticated | mxq977@bham.ac.uk author's copy
Download Date | 6/2/14 10:50 AM

Journal of Applied Behavior Analysis, *44*(4), 793–805. doi:10.1901/jaba.2011.44-793

Smith, D., Holmes, P. S., Whitemore, L., & Devonport, T. (2001). The effect of theoretically based imagery scripts on field hockey performance. *Journal of Sport Behavior*, *24*(4), 408–419.

Smith, D., Wright, C., Allsopp, A., & Westhead, H. (2007). It's all in the mind: PETTLEP-based imagery and sports performance. *Journal of Applied Sport Psychology*, *19*, 80–92. doi:10.1080/10413200600944132

Smith, D., Wright, C. J., & Cantwell, C. (2008). Beating the bunker: The effect of PETTLEP imagery on golf bunker shot performance. *Research Quarterly for Exercise and Sport*, *79*(3), 385–391. doi:10.1080/02701367.2008.10599502

Swinburn, B., & Egger, G. (2002). Preventive strategies against weight gain and obesity. *Obesity Reviews*, *3*, 289–301. doi:10.1046/j.1467-789X.2002.00082.x

Szpunar, K. K., Watson, J. M., & McDermott, K. B. (2007). Neural substrates of envisioning the future. *Proceedings of the National Academy of Sciences of the United States of America*, *104*(2), 642–647. doi:10.1073/pnas.0610082104

Taktek, K., Zinsser, N., & St-John, B. (2008). Visual versus kinesthetic mental imagery: Efficacy for the retention and transfer of a closed motor skill in young children. *Canadian Journal of Experimental Psychology*, *62*(3), 174–187. doi:10.1037/1196-1961.62.3.174

The Football Association. (2009, January 4). What Is Futsal? thefa.com. Retrieved February 2, 2012, from http://www.thefa.com/News/my-football/small-sided-football/futsal/2009/jan/futsal-explained

Wakefield, C. J., & Smith, D. (2009). Impact of differing frequencies of PETTLEP imagery on netball shooting performance. *Journal of Imagery Research in Sport and Physical Activity*, *4*(1), 1–11. doi:10.2202/1932-0191.1043

Wakefield, C., & Smith, D. (2012). Perfecting practice: Applying the PETTLEP model of motor imagery. *Journal of Sport Psychology in Action*, *3*(1), 1–11. doi:10.1080/21520704.2011.639853

Wakefield, C., Smith, D., Moran, A. P., & Holmes, P. (2013). Functional equivalence or behavioural matching? A critical reflection on 15 years of research using the PETTLEP model of motor imagery. *International Review of Sport and Exercise Psychology*, *6*(1), 105–121. doi:10.1080/1750984X.2012.724437

Williams, S. E., Cooley, S. J., & Cumming, J. (2013). Layered stimulus response training improves motor imagery ability and movement execution. *Journal of Sport & Exercise Psychology*, *35*, 60–71.

Williams, S. E., & Cumming, J. (2011). Measuring athlete imagery ability: The Sport Imagery Ability Questionnaire. *Journal of Sport & Exercise Psychology*, *33*, 416–440.

Williams, S. E., Cumming, J., & Balanos, G. M. (2010). The use of imagery to manipulate challenge and threat appraisal states in athletes. *Journal of Sport & Exercise Psychology*, *32*, 339–358.

Williams, S. E., Cumming, J., & Edwards, M. G. (2011). The functional equivalence between movement imagery, observation, and execution influences imagery ability. *Research Quarterly for Exercise and Sport*, *82*, 555–564. doi:10.5641/027013611X13275191444224

Williams, S. E., Cumming, J., Ntoumanis, N., Nordin-Bates, S., Ramsey, R., & Hall, C. (2012). Further validation and development of the Movement Imagery Questionnaire. *Journal of Sport & Exercise Psychology*, *34*, 621–646.

Brought to you by | University of Birmingham
Authenticated | mxq977@bham.ac.uk author's copy
Download Date | 6/2/14 10:50 AM