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Comparing PETTLEP Imagery against Observation Imagery on Vividness and Ease of Movement Imagery

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Abstract

The present study compared the effects of: a) PETTLEP imagery (e.g., imaging in the environment); b) prior-observation (i.e., observing prior to imaging); and c) traditional imagery (e.g., imaging sat in a quiet room) on the ease and vividness of external visual imagery (EVI), internal visual imagery (IVI), and kinesthetic imagery (KI) of movements. Fifty two participants (28 female, 24 male, *M*age = 19.60 years, *SD* = 1.59) imaged the movements described in the Vividness of Movement Imagery Questionnaire (VMIQ-2) under the three conditions in a counterbalanced order. Vividness and ease of imaging ratings were recorded for each movement. A repeated measure MANOVA revealed that ease and vividness ratings for EVI, IVI, and KI were higher during the PETTLEP imagery condition compared to the traditional imagery condition, and vividness of EVI was higher during the observation imagery condition compared to traditional imagery. Findings indicate that incorporating PETTLEP elements into the imagery instructions leads to easier and more vivid movement EVI, IVI, and KI imagery.

Keywords: Imagery ability, external visual imagery, internal visual imagery, kinesthetic imagery, PETTLEP, observation.

Comparing PETTLEP Imagery against Observation Imagery on Vividness and Ease of Movement Imagery

Imagery is a process that reflects a real experience in that different senses (e.g., visual, smell, taste, sounds) are experienced in the mind without actually experiencing the real thing (White & Hardy, 1998). This mental technique is widely used in sport, exercise, dance, and rehabilitation settings to serve a number of outcomes such as enhancing motivation and self-efficacy, improving skills and strategies, regulating arousal and anxiety, and facilitating recovery (Cumming & Williams, 2013; Guillot & Collet, 2008). The effectiveness of imagery interventions to achieve these outcomes is influenced by an individual's imagery ability (Gregg, Hall, & Butler, 2010; Robin et al., 2007). For example, Robin et al. (2007) found that following an imagery intervention, better imagers experienced a greater improvement in accuracy tennis service return compared to poorer imagers. As the ability to image plays an important role in the extent to which imagery use is effective in achieving its desired outcomes, an important issue for sport psychology is how to improve imagery's effectiveness (for recent reviews, see Cumming & Williams, 2012, 2013).

Imagery ability can be defined as "an individual's capability of forming vivid, controllable images and retaining them for sufficient time to effect the desired imagery rehearsal" (Morris, Spittle, & Watt, 2005; p. 60). When trying to assess imagery ability, it is important to consider its multidimensional nature (Morris, 2010), with ease and vividness being the two most commonly assessed dimensions in the sport domain (Gregg & Hall, 2006; Hall & Martin, 1997; Kosslyn, 1994). Ease of imaging is an individual's capacity to create and control vivid images (Cumming & Williams, 2012; Hall & Martin, 1997) whereas vividness relates to an image's clarity and sharpness or sensory richness (Baddeley & Andrade, 2000; Morris et al., 2005). Williams and Cumming (2011) explained that these dimensions are conceptually distinct and it is possible for athletes to vary in how easily they can generate a vivid image. However, ease and vividness ratings are difficult to empirically distinguish and often highly correlated (Anuar, Cumming, & Williams, 2015; Williams & Cumming, 2011). Nevertheless, higher levels of both ease and vividness appear to directly impact the results of imagery interventions (Callow, Roberts, & Fawkes, 2006; Williams, Cooley, & Cumming, 2013). Consequently, it is important to establish which techniques can improve both dimensions of imagery ability as this may contribute to improved effectiveness of imagery interventions.

One such technique is the PETTLEP model (Holmes & Collins, 2001; Wakefield, Smith, Moran, & Holmes, 2013), which proposes that more effective imagery will be experienced if seven different elements (i.e., physical, environment, task, timing, learning, emotions, and perspective) are incorporated into an image (Holmes & Collins, 2001). Incorporation of these elements includes a combination of adjusting both the mental image experienced (e.g., imaging in real time and experiencing relevant emotions) as well as the conditions in which the person is imaging (e.g., imaging while adopting a stance reflective of the movement being imaged in a similar environment to where the movement would be performed). Increasing the phenomenological similarities between the movement and how/what is imaged has been termed behavioral matching by Wakefield, Smith, Moran, and Holmes (2013), and is the proposed mechanism underlying the benefits of PETTLEP imagery. Indeed, numerous studies have demonstrated that PETTLEP imagery can be more effective than traditional imagery in achieving improvements to skill performance, and increasing self-efficacy and motivation (Smith, Wright, Allsopp, & Westhead, 2007; Wakefield & Smith, 2009; Wright, Hogard, Ellis, Smith, & Kelly, 2008). In addition, incorporating more PETTLEP elements into an image can further its efficacy (Smith et al., 2007; Wakefield & Smith, 2009).

It has also been suggested that the effectiveness of PETTLEP imagery is partly due to increases in ease and/or vividness of the imagery experience (Cumming & Williams, 2012). Gould and Damarjian (1996) proposed that an individual may experience a more vivid image if he/she holds a relevant piece of sporting equipment and makes movements reflective of the task (i.e., physical PETTLEP element). In support, Callow et al. (2006) found that skiers imaging while incorporating the physical and environment elements reported more vivid imagery than participants imaging in a more traditional format.

More recently, Anuar et al. (2015) investigated the effects of PETTLEP imagery on the ease and vividness of 12 movements from the Vividness of Movement Imagery Questionnaire-2 (VMIQ-2; Roberts, Callow, Hardy, Markland, & Bringer, 2008) such as riding a bike or swinging from a rope. Three different types of imagery were investigated: a) external visual imagery (EVI; i.e., third person); b) internal visual imagery (IVI; first person); and c) kinesthetic imagery (KI; i.e., bodily sensations reflective of the movement). Compared to more traditional imagery, involving imaging in an environment without any senses of actual sport (e.g., in everyday clothing, not in the place of the performance), (Smith, Holmes, Whitemore, Collins, & Devonport, 2001), PETTLEP imagery led to significantly easier image generation and more vivid images when performing IVI and KI but no differences were found for EVI imagery. Participants also reported that the physical and environment were the most helpful of the PETTLEP elements for creating more clear and vivid imagery that was easier to generate. This finding supports a proposal that it is these particular elements which add value over and above the other more “traditional” elements for creating effective imagery (Wakefield et al., 2013). Interestingly, PETTLEP imagery did not show the advantage of also increasing ease and vividness of EVI imagery. It may be that the benefits of PETTLEP imagery in this regard are dependent on the visual modality adopted.

However, further research is needed to replicate and extend these findings before any conclusions are made.

Athletes report using both EVI and IVI perspectives and this can depend on the intended function and outcome of the imagery intervention (Callow & Hardy, 2004; Callow & Roberts, 2010). Hardy and Callow (1999) suggested that EVI is more effective for tasks that rely heavily on form for their successful execution such as gymnastic routines whereas IVI is better at facilitating the integration of temporal components of the motor action (the rhythm of the motor execution). As athletes frequently use EVI and IVI, and often switch between the two perspectives (Callow & Hardy, 2004; Callow & Roberts, 2010), it is important to establish techniques for improving both perspectives and compare these techniques to determine whether their effectiveness is dependent on the imagery perspective adopted.

Movement observation is another technique which has been found to increase imagery ability (Williams, Cumming, & Edwards, 2011; Wright, McCormick, Birks, Loporto, & Holmes, 2015). Both movement imagery and observation have some shared neural overlap (Gatti et al., 2013; Munzert, Zentgraf, Stark, & Vaitl, 2008). That is, observing a movement elicits similar brain activity to what we experience when imaging that same movement (Clark, Tremblay & Ste-Marie, 2004; Gallese & Goldman, 1998). This co-activation experienced during movement imagery and observation may help to prime imagery and thus increase ease and vividness of image generation (Williams et al., 2011; Wright et al., 2015). Lang (1979) also proposed that observation facilitates imagery by providing individuals with clear and vivid instructions of what they are imaging. Support for movement observation as a technique for increasing imagery ability also comes from anecdotal evidence in which dancers and gymnasts report observing others to gain images and improve their imagery ability (Hars & Calmels, 2007; Nordin & Cumming, 2005).

More recently, studies have systematically examined the effects of observation on visual and kinesthetic imagery ability (e.g., Williams et al., 2011; Wright et al., 2015). Williams et al. (2011) tested the effectiveness of observation on EVI, IVI, and KI. Participants first observed the movement to be imaged before subsequently imaging the same movement. Results indicated that movement observation elicited greater ease of imaging compared with no prior observation. However, for visual imagery, observation was only effective when the observation perspective (i.e., first person or third person) was congruent with the imagery perspective being adopted. These findings suggest that observing a movement from a third person perspective could be an alternative technique to PETTLEP imagery to improve EVI. To our knowledge, studies have yet to examine the effect of observation imagery on vividness of EVI, IVI and KI or compare it directly to PETTLEP imagery.

In sum, incorporating the PETTLEP elements and prior observation appear to be techniques for increasing vividness and ease of imaging movements. However, research is far from conclusive regarding which imagery dimensions, modalities, and visual perspectives are improved by which technique. Therefore, the aim of the present study is to compare the effects of PETTLEP imagery and observation imagery on ease and vividness of EVI, IVI and KI of movements. These techniques were compared to a traditional imagery group. Based on the findings of Anuar et al. (2015), it was hypothesized that PETTLEP imagery would yield greater ease and vividness scores for IVI and KI compared to the traditional imagery. Based on the findings of Williams et al. (2011), it was also hypothesized that observation imagery would create greater ease and vividness scores for EVI compared traditional imagery. These findings will help contribute to an emerging set of guidelines as to how to improve the quality of an athletes' imagery experience.

Method

Participants

Fifty two athletes (28 female, 24 male, *M*age = 19.60 years, *SD* = 1.59) participated in this study from a mixture of team (*n* = 23), individual (*n* = 28), or combined team and individual (n = 1) sports. In total athletes represented 22 different sports with the majority of participants representing athletics (*n* = 11), football (*n* = 8), and netball (*n* = 4), as well as golf (*n* = 3) and trampolining (*n* = 3). Participant's competitive level of their sport ranged from recreational to international/professional (8 recreational, 25 club, 16 regional, 3 international/professional). Most participants had not received any imagery training (*n* = 47). Five participants had received information about imagery in a university lecture, online, or at a skill based academy.

Procedures

Following ethical approval of the study, participants were recruited via different routes (e.g., poster, email, word of mouth) and given an information letter explaining the nature of the study. Potential participants were informed that their participation was voluntary and they could withdraw if they decided to do so at any point. Those who agreed to participate signed a consent form at the beginning of their first visit. Next, they provided their demographic and sport information. Participants were then given White and Hardy's (1998) definition of imagery and told about the different perspectives and modalities in the present study (i.e., EVI, IVI, and KI). Participants then completed the VMIQ-2 under three different conditions in a random order each 24-48 hours apart. The conditions were: 1) PETTLEP imagery; 2) traditional imagery; and 3) observation imagery. A within-subject design was employed to examine how participant's imagery ability changed as a result of the condition they were exposed to. This also prevented any group differences that may have occurred if using a between-subject design, owing to the expected range of individual differences in imagery ability.

In the PETTLEP imagery condition, participants were instructed to incorporate all of the elements except perspective as this varied according to the VMIQ-2 instructions (Anuar et al., 2015). To incorporate the other elements, participants were asked to adopt the physical position related to each of movement described in the VMIQ-2 with props/visual aids provided as appropriate. Participants also imaged in the environment reflective of where the movement would be performed, imaged in real time performing the movement at an appropriate standard for them, and incorporated any relevant emotions (for more details see Anuar et al., 2015).

The traditional imagery condition involved participants completing the VMIQ-2 while seated in a quiet room; that is, not the environment where the movements would typically be performed. They also had no props and were not told to incorporate any of the other PETTLEP elements (e.g., image in real time).

During the observation imagery condition, participants also completed the VMIQ-2 while seated in a quiet room. Before imaging each movement, an external observation video clip of a model performing the VMIQ-2 movement was played once. After viewing the clip, participants then imaged the same movement with no props or additional visual aids before they rated the ease and vividness of the movement.

Once the VMIQ-2 was completed, participants completed the evaluation form of each condition and, in their final visit, they also filled in the post-experiment evaluation form. Finally, participants were debriefed on the nature of the study and thanked for their participation. Each session took no longer than one hour.

Measures

Demographic information. Participants provided details including their age, gender, and sport played as well as their previous imagery experience.

Vividness of movement imagery questionnaire-2 (VMIQ-2). The VMIQ-2 (Roberts et al., 2008) is a 36-item questionnaire that measures an individual's ability to image 12 movements (e.g., walking, running, throwing a stone) in visual and kinesthetic modalities. Participants read the movement items from the questionnaires and then image the movement as clearly and vividly as possibly with their eyes closed. The 12 movements are first imaged from an EVI perspective before being imaged from an IVI perspective, and finally from a KI modality. Ratings are made on a 5 point Likert-type scale ranging from 1 *(perfectly clear and as vivid as normal/feel of movement)* to 5 *(no image at all, you only know that you are thinking of the skill)*. The VMIQ-2 has demonstrated good validity and is regarded as an acceptable measure of assessing the vividness of movement images (Roberts et al., 2008). Similar to Anuar et al. (2015), the questionnaire was modified in two ways. First, the scale was reversed to make it more intuitive to participants. Therefore, a higher score represented more clear and vivid imagery. Second, ease of imaging was assessed by adding an additional 5 point Likert-type rating scale for each item *(1 = very hard to see/feel, to 5 = very easy to see/feel)*. Unlike previous studies, pictures were also added to each anchor to illustrate and help the participants to understand the different vividness anchors. In the present study the modified VMIQ-2 demonstrated good internal reliability with all Cronbach alpha coefficients being .82 or above for vividness and ease during all three conditions.

Imagery comprehension check. In every visit, participants were given an evaluation form to complete to verify they understood the imagery instructions and explanations of the different modalities and visual perspectives. Responses were made on a 7 point Likert-type scale ranging from 1 (*did not understand at all*) to 7 (c*ompletely understood*).

Imagery evaluation form. After the PETTLEP visit, participants completed the same items used by Anuar et al. (2015) to measure perceived helpfulness of the PETTLEP elements for creating clearer and more vivid imagery that was easier to generate. This form comprised of the following five items and was completed after each condition: 1) “Imaging while adopting the physical positions and having the props reflective of the movements you imaged”, 2) “Performing the imagery in the environment reflective of where the movements would be physically performed”, 3) ”Imaging the movements at a standard reflective of your movement capabilities”, 4) “Imaging the movement in real time”; and 5) ”Incorporating the relevant feelings and emotions into the imagery”. In Part 1, participants rated how helpful the items were for creating clearer and more vivid images, and in Part 2 participants rated how helpful they were in making the imagery easier to perform. All ratings were made on a 7 point Likert-type scale ranging from 1 *(not at all helpful)* to 7 *(very helpful).*

After completing the observation imagery session, participants were asked two additional questions in relation to the observation clips they observed. The first question asked participants how reflective the clips were of their own movement capabilities and imagery performed, and the second asked participants how similar they perceived themselves to be to the model. Both ratings were made on 7 point Likert-type scale ranging from 1 (*not at all similar*) to 7 (*very similar*).

Post-experimental evaluation. At the end of the study, all participants were ask to complete an experimental evaluation form that asked them which condition they thought was more beneficial at enhancing their vividness and ease of imaging.

Video Clips

The model was a 28-year old female. The video clips were filmed using an iPhone 4s camera and lasted between three and 11 seconds depending on the movements. The video clips were filmed from an external/third person perspective. Action recognition research has demonstrated that viewing a movement from 180 degrees can produce greater ipsilateral hemisphere activation compared to activation produced when executing the movement (Shmuelof & Zohary, 2008). However, it has been suggested that the switch of viewing perspective occurs at 135 degrees (Waller & Hodgson, 2006; see also Burgess, 2006). Consequently, in a similar approach to Williams et al. (2011), a viewing angle of 140^{o} was used and the camera was positioned 96 cm above the ground, the height of the model's navel. The distance of the model from the camera varied due to the nature of the different movements but the distance for each clip ensured that the model was visible while performing the entire movement. All movements were filmed in the same location from which participants imaged the movements when they completed the VMIQ-2 during the PETTLEP imagery condition. The videos were played to participants on a laptop and projector. The same video clip for a particular movement was played prior to each image from the different VMIQ-2 modalities (i.e., EVI, IVI, and KI).

Data Analyses

Data were first inspected for any missing values. Based on Tabachnick and Fidell (2012), empty cells were replaced with means of the particular variable. The data was also screened for normality as well as univariate and multivariate outliers. Internal reliability, mean and standard deviations were calculated for each subscale of the VMIQ-2 questionnaires for each condition.

In the preliminary analyses, a repeated measures ANOVA was run to check whether participants understood the imagery instructions during each condition. Bivariate correlations were calculated between vividness and ease scores for EVI, IVI, and KI to establish the relationship between these dimensions for each VMIQ-2 subscale. The result of these correlations determined whether the subsequent main analyses required repeated measures MANOVAs.

For the main analyses, when repeated measures MANOVAs were run, the Pillai's trace value was reported as it is the most robust for the multivariate significance test (Olson, 1976). Mauchly's test of Sphericity was used to examine the equality of the within subject variance. When this was significant (i.e., the assumption of sphericity was violated), the Greenhouse-Geisser correction was applied to reduce the degrees of freedom (Greenhouse & Geisser, 1959). Pairwise comparisons were made using Bonferroni adjustment analyses. A chi square test was also conducted to investigate participants' preferred condition to help them to create vivid imagery that was easy to generate. Two repeated measure MANOVAs were also run with Bonferroni adjusted post hoc analyses for the post-experiment evaluation form of PETTLEP condition to determine which elements were perceived to be most helpful.

Results

Preliminary Analyses

Data screening. Overall only one missing value was found in the data and it was replaced with the mean value of the variable. This option is applicable only when the amount of missing values is extremely low and has minimal influence upon the variance of a variable (Tabachnick & Fidell, 2012). Skewness and kurtosis values met normality assumption based on suggestion (Tabachnick & Fidell, 2012), and no univariate or multivariate outliers were detected in the data.

To examine whether participants understood the instructions and different modalities and visual perspectives equally in all conditions, a repeated measure ANOVA was conducted on the imagery comprehension check items. Results indicated that participants similarly understood the instructions and differences between the modalities and visual perspectives in the PETTLEP condition (M = 6.54, SD = .73), the observation imagery condition (M = 6.37, SD = .79), and the traditional imagery condition (M = 6.50, SD = .70), and this did not significantly differ across conditions (p = .29).

Imagery evaluation form. Mean scores for how reflective the observation clips were of participants own imagery (*M* = 4.48, *SD* = 1.28) and how similar to the model participants perceived themselves to be (*M* = 4.44, S*D* = 1.49) indicated that participants found the observation clips "somewhat" similar to the imagery they performed and the model was "somewhat" similar to them.

Post-experimental evaluation. When trying to create vivid imagery that was easy to generate, 31 participants preferred the PETTLEP imagery condition compared with 10 people who preferred the observation imagery condition, and 1 person preferred the traditional imagery condition. Ten people indicated they had no preference for a particular a condition. A chi-square test indicated these differences were significant, χ^2 (3, *n* = 52) = 37.39, *p* <. 001**.**

Relationship between ease and vividness. Bivariate correlations indicating the relationship between ease and vividness of each of the VMIQ-2 subscales in all imagery conditions (i.e.; PETTLEP imagery, observation imagery, and traditional imagery) are presented in Table 1. Results indicate a strong positive association between ease and vividness for each subscale. Consequently, repeated measures MANOVAs were run on subsequent main analyses of the different VMIQ-2 subscales.

Main Analyses

External visual imagery. A repeated measures MANOVA revealed that there was a significant multivariate effect due to imagery condition, Pillai's trace = .97, $F(2, 48) = 4.98$, $p = .007$, $\eta_p^2 = .02$, observed power = 100%. At the univariate level, results showed a significant difference in vividness, $F(2, 102) = 8.51$, $p < .001$, $\eta_p^2 = .14$, observed power = 96%, and ease, $F(2, 102) = 5.23$, $p = .007$, $\eta_p^2 = .09$, observed power = 82%. Post hoc analysis indicated that participants created significantly more vivid imagery during the PETTLEP imagery (*M* = 3.69, *SD* = 0.72) and observation imagery (*M* = 3.61, *SD* = 0.72) conditions compared to the traditional imagery condition (*M* = 3.37, *SD* = 0.66). For ease of imaging, participants found it significantly easier to image during the PETTLEP imagery condition (*M* = 3.77, *SD* = 0.73) compared with the traditional imagery condition (3.49, *SD* = .78). However, there was no significant difference in ease between the observation imagery condition (*M* = 3.66, *SD* = 0.66) and both the PETTLEP and traditional imagery condition.

Internal visual imagery. Results of the repeated measures MANOVA revealed a significant multivariate effect, Pillai's trace = .98, *F*(2, 50) = 1207.65, $p < .001$, $\eta_p^2 = .98$, observed power = 100% on ease. The univariate level revealed a significant difference for vividness, *F*(2, 102) = 19.603, p < .001, $\eta_p^2 = .28$, observed power = 100%; and ease, *F*(2, 102) = 15.26, $p < .001$, η_p^2= .23, observed power = 100%. Post hoc analyses revealed that participants reported better vividness and ease during the PETTLEP imagery (vividness: *M* = 4.01, *SD* = .68; ease: *M* = 4.07, *SD* = .62) compared with observation imagery (vividness: *M* = 3.66, *SD* = .63; ease: *M* = 3.73, *SD* = .67) and traditional imagery (vividness: *M* = 3.62, *SD* = .63; ease: *M* = 3.71, *SD* = .61). There were no differences in ease and vividness between observation imagery and traditional imagery.

Kinesthetic imagery. A repeated measures MANOVA revealed a significant difference at the multivariate level, Pillai's trace = .99, *F*(2, 50) = 9.26, $p <.001$, $\eta_p^2 = .99$, observed power = 100%. Findings at the univariate level demonstrated significant differences for vividness, *F*(1, 102) = 16.25, $p < .001$, η_p^2= .242, observed power = 100%; and ease, *F*(1, 102) = 9.26, p < .001, η_p^2= .15, observed power = 97%. Similar to the post hoc analyses for internal visual imagery, participants reported higher vividness and ease in PETTLEP imagery (vividness: *M* = 4.02, *SD* = .54; ease: *M* = 4.00, *SD* = .62) compared with the observation imagery (vividness: *M* = 3.69, *SD* = .47; ease: *M* = 3.78, *SD* = .50), and traditional imagery (vividness: *M* = 3.63, *SD* = .59; ease: *M* = 3.68, *SD* = .63). There were no differences in ease and vividness between observation imagery and traditional imagery.

Table 2 provides the information of the differences of ease and vividness between all conditions of EVI, IVI and KI.

Post-experiment (PETTLEP) evaluation form. Two repeated measures ANOVAs were conducted to investigate whether participants found certain PETTLEP elements more helpful in creating clearer and more vivid imagery that was easier to generate.

The analysis for clear and vivid imagery showed a significant difference between the elements $F(4, 204) = 17.21$, $p < .001$, $\eta_p^2 = .25$, observed power = 100%. Post hoc analyses revealed that no significant difference between participants adopting the physical characteristics (*M* = 6.28, *SD* = 1.13) and environment (*M* = 5.75, *SD* = 1.72) of the task, but physical and environment were significantly more helpful than any of the other elements.

However, the results for ease of imaging also showed a significant difference between the PETTLEP elements, $F(4, 204) = 19.72$, $p < .001$, $\eta_p^2 = .28$, observed power = 100%. Following the same pattern, post hoc analyses revealed that participants found adopting the physical characteristics of the task (*M* = 6.39, *SD* = 0.11) significantly more helpful than any of the other elements. Means and standard deviations of how helpful all elements were for vividness and ease are reported in Table 3.

Discussion

The aim of the present study was to compare the effects of PETTLEP imagery and observation imagery on EVI, IVI and KI ease and vividness of different movements. It was hypothesized that ease and vividness ratings would be higher during PETTLEP imagery for IVI and KI compare to traditional imagery. Conversely, it was hypothesized that for EVI, ease and vividness ratings would be higher during the observation imagery condition compared with the traditional imagery.

Results of the experiment partially supported our first hypothesis. The higher ease and vividness ratings of IVI and KI during PETTLEP imagery compared to more traditional imagery is in accordance with Anuar et al. (2015). This supports the suggestion that PETTLEP imagery improves the ease and vividness of the image (Callow et al., 2006; Gould & Damarjian, 1996), and in turn, creates more effective images. Contrary to our hypothesis, however, we found that PETTLEP imagery also significantly increased ease and vividness of EVI compared to more traditional imagery. This result was somewhat unexpected as it opposes recent findings by Anuar et al. (2015) who found no differences in EVI ease and vividness ratings between PETTLEP and traditional imagery conditions. While it had been suggested that PETTLEP imagery might not be able to enhance EVI, findings of the present study suggest that Anuar et al.'s null result may have been due to this previous study being underpowered. That is, the study was more the likelihood of type 2 error (false negative) and had an insufficient sample size to detect a significant result (Cohen, 1992). In contrast, the present study confirms that PETTLEP imagery not only improves ease and vividness of IVI and KI, but also EVI with moderate to large effect sizes (Cohen, 1988). Consequently, PETTLEP imagery appears to help "boost" athletes' ease of imaging and the vividness of imagery, which may in turn explain why these interventions are more effective than traditional imagery (Cumming & Williams, 2012, 2013; Gregg, Hall, & Nederhof, 2005).

Participants' ratings of how helpful they perceived the different PETTLEP elements to be replicated the findings by Anuar et al. (2015). That is, although all elements were perceived as being helpful (i.e., ratings above the mid-point of the scale), the physical element was rated as the significantly most helpful element of the PETTLEP model followed by the environment element. These findings support a recommendation to combine multiple PETTLEP elements to create more effective images (Holmes & Collins, 2001), and the notion that there are additive benefits of incorporating multiple PETTLEP elements (Smith et al., 2007). Results also add to the growing body of evidence that suggest physical and environment elements could play a more important role in enhancing the movement imagery's effectiveness; in this case, through improving ease and vividness of the imagery (e.g., Smith et al., 2007; Callow et al., 2006). The post-experiment PETTLEP evaluation result also suggests individuals are aware of the extent to which different PETTLEP elements may be more or less effective at improving ease and vividness of their imagery (Anuar et al., 2015).

Interestingly, the physical and environment elements are the two PETTLEP elements incorporated by adjusting the external conditions in which the individual is imaging. Incorporating the other elements involves adjusting the internal experience (e.g., imaging in real time and experiencing relevant emotions), and relies on the individual having the capacity to generate and manipulate an image to incorporate and adhere to these details. If individuals are unable to sufficiently perform these mental tasks the corresponding elements will be unlikely to facilitate the imagery process (i.e., task, emotions). Consequently, the straightforward nature of incorporating the physical and environment into an image and these elements being less reliant on an individual's imagery ability may partly explain why individuals find these particular elements most beneficial. Due to the pronounced effects obtained from physical and environment (e.g., Callow et al., 2006; Smith et al., 2007), we urge athletes and coaches to incorporate these elements into their imagery wherever possible.

In partial support of our hypothesis, observation imagery was more effective for priming EVI vividness compared to traditional imagery. However, these differences did not emerge for ease of imaging. Findings for vividness support literature proposing that observation can prime imagery and help enhance imagery ability (Holmes & Calmels, 2008; Lang, 1979; Williams et al., 2011). That is, observing a model perform in the same perspective that is imaged, helps to create a clearer, richer and more lifelike image. Because the observation clips were filmed from a third person perspective, this finding therefore also supports the notion that observation may only prime visual imagery ability when the observation clips are congruent with the imagery perspective (Williams et al., 2011). Unexpectedly, observation imagery did not prime ease of imaging EVI as there were no differences between this imagery condition and traditional imagery. In further contrast to the findings of Williams et al. (2011), observation also did not prime ease or vividness of KI. While the finding for KI has been replicated in other research (Wright et al., 2015), overall the results do not support observation imagery to be as effective at enhancing ease and vividness of imaging as was anticipated.

These equivocal findings could be due to the observation clips not sufficiently matching the content of participants' imagery. Unlike Williams et al. (2011), movements imaged in the present study involved more complex actions that could be performed in different ways (e.g., variations in posture and skill level) by the participants. While participants were able to "somewhat" relate to the observation clips and model used, there are likely characteristics of the clips that would naturally be different to the imagery performed by some participants (e.g., kicking the ball with a different part of the foot, riding a different style of bike). These differences between the observation and imagery may have been sufficient to limit the effects of observation on EVI ease and vividness. A number of factors are known to impact the effects of observational learning including model similarity, viewing angle, speed, and content (for review see Ste-Marie, Law, Rymal, Hall, & McCullagh, 2012). Future research may wish to further investigate the effects of these factors on the effectiveness of observation priming imagery. For example, to our knowledge, no study has compared the use of self-modeling with other modeling as a technique to prime ease and/or vividness for simple and complex actions.

A second explanation could be that some increases in imagery ability previously attributed to observation imagery may have been a result of including PETTLEP elements within the imagery (see Williams et al., 2011). To the best of our knowledge this is the first study to directly compare the effects of observation and PETTLEP imagery conditions on EVI, IVI, and KI ease and vividness. By comparison, previous research has on occasion combined the two techniques. For example, Williams et al. (2011) asked participants to image the movement previously observed in the same environment where the video clip was performed and while adopting the physical position of the movement (i.e., incorporating the environment and physical PETTLEP elements). Consequently, increases in ease of imaging may have been partly due to incorporating these PETTLEP elements. This explanation is even more convincing when the perceived helpfulness of the physical and environmental elements found in the present study (also see Anuar et al., 2015) is also considered, and that PETTLEP imagery was found to be more effective than observation imagery for enhancing KI and IVI ease and vividness, and EVI ease. Future research should compare the conditions used within the present study with a combined PETTLEP and observation imagery condition to further understand the interaction effects that these techniques can have on ease and vividness of movement imagery.

When comparing observation imagery and PETTLEP imagery as techniques to enhance ease and vividness of EVI, IVI, and KI, the present study suggests that PETTLEP imagery may be superior for imaging movements due to its capacity to inflate ease and vividness scores of both visual perspectives and KI. However, it is important to note that certain factors may have meant PETTLEP imagery leant itself better to improving ease and vividness. Other studies have demonstrated that observation can be effective for complex movements that individuals are less proficient at performing (e.g., Wright et al., 2015). Indeed it has been proposed that observation may aid individuals' imagery by providing them with a representation of what to image (Lang, 1979; Nordin & Cumming, 2005). Consequently, observation imagery's effectiveness at enhancing imagery ability may be due to multiple factors including skill level, complexity of the movements, and characteristics of the observation clips (Williams et al., 2011; Wright et al., 2015). It also unknown what effects PETTLEP and observation imagery might have on other types of images commonly experienced by athletes (e.g., strategy, goal, affect, and mastery; Williams et al., 2011).

Despite comparing observation and PETTLEP imagery in the present study, it is important to note that imagery and observation are not mutually exclusive and likely to complement each other (Holmes & Calmels, 2008). Combining both techniques may improve the imagery experience through different processes. For example, incorporation of physical aspects of the image may lead PETTLEP imagery to facilitate kinesthetic imagery, whereas observation provides a visual representation of the movement to be constructed internally (Williams et al., 2011; Wright et al., 2015). We therefore suggest that researchers and applied practitioners combine both techniques when implementing movement imagery interventions for individuals, particularly for those who are new to using imagery or find it harder to generate vivid images.

A limitation of the present study was that the use of self-report measures to assess movement imagery ease and vividness, and the manipulation checks created for the present study have not been previously assessed for validity and reliability. Although self-report measures of imagery ability such as the VMIQ-2 are valid and reliable, it has been suggested that imagery ability should be assessed using a combination of measures (Collet, Guillot, Lebon, MacIntyre, & Moran, 2011; Williams, Guillot, Di Rienzo, & Cumming, 2015). As such, we encourage future research to re-examine the effects of observation and PETTLEP imagery on imagery ability using a range of assessments such as psychophysiological responses, mental chronometry, and qualitative interviews. Furthermore, future research should investigate the test-retest reliability of manipulation checks used in imagery studies.

In conclusion, the present study examined the effects of PETTLEP imagery and observation imagery compared with traditional imagery on ease and vividness of EVI, IVI, and KI. Findings demonstrated that PETTLEP imagery was effective in increasing ease and vividness ratings of EVI, IVI, and KI compared with traditional imagery. While observation imagery did not elicit any differences in ease of imaging EVI, the condition resulted in higher vividness scores compared with the traditional imagery. Consequently, findings suggest that while observation may be a technique for improving EVI vividness, PETTLEP imagery appeared, in the present study, to be a more effective technique due to its capacity to improve ease and vividness of all three imagery types (i.e., EVI, IVI, and KI). Although we separately examined the effects of observation imagery and PETTLEP imagery on imagery ability, we propose that both appear beneficial to the imagery process and suggest that researchers and applied practitioners combine observation with PETTLEP imagery to help maximize the effect of the imagery on the desired outcome.

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Table 1

Correlations between Vividness and Ease in all conditions

PETTLEP imagery condition	EVI Ease	IVI Ease	KI Ease
EVI Vividness	*r* : .90**	*r* : .68**	*r* : .63**
IVI Vividness	*r* : .63**	*r* : .91**	*r* : .59**
KI Vividness	*r* : .48**	*r* : .61**	*r* : .80**
Traditional imagery condition	EVI Ease	IVI Ease	KI Ease
EVI Vividness	*r* : .71**	*r* : .66**	*r* : .65**
IVI Vividness	*r* : .56**	*r* : .87**	*r* : .66**
KI Vividness	*r* : .42**	*r* : .68**	*r* : .88**
Observation condition	EVI Ease	IVI Ease	KI Ease
EVI Vividness	*r* : .90**	*r* : .61**	*r* : .37**
IVI Vividness	*r* : .65**	*r* : .89**	*r* : .57**
KI Vividness	*r* : .58**	*r* : .62**	*r* : .76**

Note. ** p < .001 (2-tailed).

Table 2

Internal reliability, mean and standard deviation of EVI, IVI and KI for vividness and ease of all conditions

	PETTLEP imagery						Observation						Traditional imagery					
	Vividness			*Ease*			*Vividness*			*Ease*			*Vividness*			*Ease*		
	α	*M*	*SD*	*α*	*M*	*SD*	*α*	*M*	*SD*	*α*	*M*	*SD*	*α*	*M*	*SD*	*α*	*M*	*SD*
EVI	.89	3.69^{ab}	.72	.89	3.77^{ab}	.73	.92	3.61^{b}	.72	.92	3.66	.78	.92	3.38	.66	.93	3.49	.66
IVI	.91	4.01^{ab}	.68	.88	4.07^{ab}	.62	.90	3.66	.63	.90	3.73	.67	.91	3.62	.63	.91	3.71	.61
KI	.87	4.02^{ab}	.54	.89	4.00^{ab}	.62	.83	3.69	.47	.82	3.78	.50	.95	3.66	.63	.95	3.73	.67

Note. a = significantly higher than observation and traditional imagery b = significant higher than traditional imagery; $p = < .05$

Table 3

Means and standard deviations of how helpful all elements for vividness and ease

	Vividness		Ease	
	M	*SD*	*M*	*SD*
“Imaging while adopting the physical positions and having the props”	6.17*	1.13	6.39*	.77
“Performing the imagery in the environment reflective of where the movements would be physically performed”	5.71*	1.30	5.79	1.36
“Imaging the movements at a standard reflective of your movement capabilities”	5.25	1.05	5.29	.94
“Imaging the movements in real time”	5.46	1.09	5.33	1.17
“Incorporating the relevant feelings and emotions into the imagery”	5.62	1.16	4.77	1.20

Note. *$p < .05$ = significantly more helpful than the other elements.

Words count: 8059 words