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

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1 **Abstract**

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

15

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

18

19

1 can generate a vivid image. However, ease and vividness ratings are difficult to empirically
2 distinguish and often highly correlated (Anuar, Cumming, & Williams, 2015; Williams &
3 Cumming, 2011). Nevertheless, higher levels of both ease and vividness appear to directly
4 impact the results of imagery interventions (Callow, Roberts, & Fawkes, 2006; Williams,
5 Cooley, & Cumming, 2013). Consequently, it is important to establish which techniques can
6 improve both dimensions of imagery ability as this may contribute to improved effectiveness
7 of imagery interventions.

8 One such technique is the PETTLEP model (Holmes & Collins, 2001; Wakefield,
9 Smith, Moran, & Holmes, 2013), which proposes that more effective imagery will be
10 experienced if seven different elements (i.e., physical, environment, task, timing, learning,
11 emotions, and perspective) are incorporated into an image (Holmes & Collins, 2001).
12 Incorporation of these elements includes a combination of adjusting both the mental image
13 experienced (e.g., imaging in real time and experiencing relevant emotions) as well as the
14 conditions in which the person is imaging (e.g., imaging while adopting a stance reflective of
15 the movement being imaged in a similar environment to where the movement would be
16 performed). Increasing the phenomenological similarities between the movement and
17 how/what is imaged has been termed behavioral matching by Wakefield, Smith, Moran, and
18 Holmes (2013), and is the proposed mechanism underlying the benefits of PETTLEP
19 imagery. Indeed, numerous studies have demonstrated that PETTLEP imagery can be more
20 effective than traditional imagery in achieving improvements to skill performance, and
21 increasing self-efficacy and motivation (Smith, Wright, Allsopp, & Westhead, 2007;
22 Wakefield & Smith, 2009; Wright, Hogard, Ellis, Smith, & Kelly, 2008). In addition,
23 incorporating more PETTLEP elements into an image can further its efficacy (Smith et al.,
24 2007; Wakefield & Smith, 2009).

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

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

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

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

13 Movement observation is another technique which has been found to increase
14 imagery ability (Williams, Cumming, & Edwards, 2011; Wright, McCormick, Birks,
15 Loporto, & Holmes, 2015). Both movement imagery and observation have some shared
16 neural overlap (Gatti et al., 2013; Munzert, Zentgraf, Stark, & Vaitl, 2008). That is,
17 observing a movement elicits similar brain activity to what we experience when imaging that
18 same movement (Clark, Tremblay & Ste-Marie, 2004; Gallese & Goldman, 1998). This co-
19 activation experienced during movement imagery and observation may help to prime imagery
20 and thus increase ease and vividness of image generation (Williams et al., 2011; Wright et al.,
21 2015). Lang (1979) also proposed that observation facilitates imagery by providing
22 individuals with clear and vivid instructions of what they are imaging. Support for
23 movement observation as a technique for increasing imagery ability also comes from
24 anecdotal evidence in which dancers and gymnasts report observing others to gain images
25 and improve their imagery ability (Hars & Calmels, 2007; Nordin & Cumming, 2005).

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

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

25

1 **Method**

2 **Participants**

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

12 **Procedures**

13 Following ethical approval of the study, participants were recruited via different
14 routes (e.g., poster, email, word of mouth) and given an information letter explaining the
15 nature of the study. Potential participants were informed that their participation was
16 voluntary and they could withdraw if they decided to do so at any point. Those who agreed
17 to participate signed a consent form at the beginning of their first visit. Next, they provided
18 their demographic and sport information. Participants were then given White and Hardy's
19 (1998) definition of imagery and told about the different perspectives and modalities in the
20 present study (i.e., EVI, IVI, and KI). Participants then completed the VMIQ-2 under three
21 different conditions in a random order each 24-48 hours apart. The conditions were: 1)
22 PETTLEP imagery; 2) traditional imagery; and 3) observation imagery. A within-subject
23 design was employed to examine how participant's imagery ability changed as a result of the
24 condition they were exposed to. This also prevented any group differences that may have

1 occurred if using a between-subject design, owing to the expected range of individual
2 differences in imagery ability.

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

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

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

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

24

25

1 **Measures**

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

4 **Vividness of movement imagery questionnaire-2 (VMIQ-2).** The VMIQ-2
5 (Roberts et al., 2008) is a 36-item questionnaire that measures an individual's ability to image
6 12 movements (e.g., walking, running, throwing a stone) in visual and kinesthetic modalities.
7 Participants read the movement items from the questionnaires and then image the movement
8 as clearly and vividly as possibly with their eyes closed. The 12 movements are first imaged
9 from an EVI perspective before being imaged from an IVI perspective, and finally from a KI
10 modality. Ratings are made on a 5 point Likert-type scale ranging from 1 (*perfectly clear*
11 *and as vivid as normal/feel of movement*) to 5 (*no image at all, you only know that you are*
12 *thinking of the skill*). The VMIQ-2 has demonstrated good validity and is regarded as an
13 acceptable measure of assessing the vividness of movement images (Roberts et al., 2008).
14 Similar to Anuar et al. (2015), the questionnaire was modified in two ways. First, the scale
15 was reversed to make it more intuitive to participants. Therefore, a higher score represented
16 more clear and vivid imagery. Second, ease of imaging was assessed by adding an additional
17 5 point Likert-type rating scale for each item (*1 = very hard to see/feel, to 5 = very easy to*
18 *see/feel*). Unlike previous studies, pictures were also added to each anchor to illustrate and
19 help the participants to understand the different vividness anchors. In the present study the
20 modified VMIQ-2 demonstrated good internal reliability with all Cronbach alpha coefficients
21 being .82 or above for vividness and ease during all three conditions.

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

1 **Imagery evaluation form.** After the PETTLEP visit, participants completed the
2 same items used by Anuar et al. (2015) to measure perceived helpfulness of the PETTLEP
3 elements for creating clearer and more vivid imagery that was easier to generate. This form
4 comprised of the following five items and was completed after each condition: 1) “Imaging
5 while adopting the physical positions and having the props reflective of the movements you
6 imaged”, 2) “Performing the imagery in the environment reflective of where the movements
7 would be physically performed”, 3) ”Imaging the movements at a standard reflective of your
8 movement capabilities”, 4) “Imaging the movement in real time”; and 5) ”Incorporating the
9 relevant feelings and emotions into the imagery”. In Part 1, participants rated how helpful
10 the items were for creating clearer and more vivid images, and in Part 2 participants rated
11 how helpful they were in making the imagery easier to perform. All ratings were made on a
12 7 point Likert-type scale ranging from 1 (*not at all helpful*) to 7 (*very helpful*).

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

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

22 **Video Clips**

23 The model was a 28-year old female. The video clips were filmed using an iPhone 4s
24 camera and lasted between three and 11 seconds depending on the movements. The video
25 clips were filmed from an external/third person perspective. Action recognition research has

1 demonstrated that viewing a movement from 180 degrees can produce greater ipsilateral
2 hemisphere activation compared to activation produced when executing the movement
3 (Shmuelof & Zohary, 2008). However, it has been suggested that the switch of viewing
4 perspective occurs at 135 degrees (Waller & Hodgson, 2006; see also Burgess, 2006).
5 Consequently, in a similar approach to Williams et al. (2011), a viewing angle of 140° was
6 used and the camera was positioned 96 cm above the ground, the height of the model's navel.
7 The distance of the model from the camera varied due to the nature of the different
8 movements but the distance for each clip ensured that the model was visible while
9 performing the entire movement. All movements were filmed in the same location from
10 which participants imaged the movements when they completed the VMIQ-2 during the
11 PETTLEP imagery condition. The videos were played to participants on a laptop and
12 projector. The same video clip for a particular movement was played prior to each image
13 from the different VMIQ-2 modalities (i.e., EVI, IVI, and KI).

14 **Data Analyses**

15 Data were first inspected for any missing values. Based on Tabachnick and Fidell
16 (2012), empty cells were replaced with means of the particular variable. The data was also
17 screened for normality as well as univariate and multivariate outliers. Internal reliability,
18 mean and standard deviations were calculated for each subscale of the VMIQ-2
19 questionnaires for each condition.

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

1 **Imagery evaluation form.** Mean scores for how reflective the observation clips were
2 of participants own imagery ($M = 4.48, SD = 1.28$) and how similar to the model participants
3 perceived themselves to be ($M = 4.44, SD = 1.49$) indicated that participants found the
4 observation clips “somewhat” similar to the imagery they performed and the model was
5 “somewhat” similar to them.

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

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

17 **Main Analyses**

18 **External visual imagery.** A repeated measures MANOVA revealed that there was a
19 significant multivariate effect due to imagery condition, Pillai’s trace = .97, $F(2, 48) = 4.98, p$
20 $= .007, \eta_p^2 = .02$, observed power = 100%. At the univariate level, results showed a
21 significant difference in vividness, $F(2, 102) = 8.51, p < .001, \eta_p^2 = .14$, observed power =
22 96%, and ease, $F(2, 102) = 5.23, p = .007, \eta_p^2 = .09$, observed power = 82%. Post hoc
23 analysis indicated that participants created significantly more vivid imagery during the
24 PETTLEP imagery ($M = 3.69, SD = 0.72$) and observation imagery ($M = 3.61, SD = 0.72$)
25 conditions compared to the traditional imagery condition ($M = 3.37, SD = 0.66$). For ease of

1 imaging, participants found it significantly easier to image during the PETTLEP imagery
2 condition ($M = 3.77$, $SD = 0.73$) compared with the traditional imagery condition (3.49 , $SD =$
3 $.78$). However, there was no significant difference in ease between the observation imagery
4 condition ($M = 3.66$, $SD = 0.66$) and both the PETTLEP and traditional imagery condition.

5 **Internal visual imagery.** Results of the repeated measures MANOVA revealed a
6 significant multivariate effect, Pillai's trace = .98, $F(2, 50) = 1207.65$, $p < .001$, $\eta_p^2 = .98$,
7 observed power = 100% on ease. The univariate level revealed a significant difference for
8 vividness, $F(2, 102) = 19.603$, $p < .001$, $\eta_p^2 = .28$, observed power = 100%; and ease, $F(2,$
9 $102) = 15.26$, $p < .001$, $\eta_p^2 = .23$, observed power = 100%. Post hoc analyses revealed that
10 participants reported better vividness and ease during the PETTLEP imagery (vividness: $M =$
11 4.01 , $SD = .68$; ease: $M = 4.07$, $SD = .62$) compared with observation imagery (vividness: M
12 $= 3.66$, $SD = .63$; ease: $M = 3.73$, $SD = .67$) and traditional imagery (vividness: $M = 3.62$, SD
13 $= .63$; ease: $M = 3.71$, $SD = .61$). There were no differences in ease and vividness between
14 observation imagery and traditional imagery.

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

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

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

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

11 However, the results for ease of imaging also showed a significant difference between
12 the PETTLEP elements, $F(4, 204) = 19.72, p < .001, \eta_p^2 = .28$, observed power = 100%.

13 Following the same pattern, post hoc analyses revealed that participants found adopting the
14 physical characteristics of the task ($M = 6.39, SD = 0.11$) significantly more helpful than any
15 of the other elements. Means and standard deviations of how helpful all elements were for
16 vividness and ease are reported in Table 3.

17 **Discussion**

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

24 Results of the experiment partially supported our first hypothesis. The higher ease
25 and vividness ratings of IVI and KI during PETTLEP imagery compared to more traditional

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

17 Participants’ ratings of how helpful they perceived the different PETTLEP elements
18 to be replicated the findings by Anuar et al. (2015). That is, although all elements were
19 perceived as being helpful (i.e., ratings above the mid-point of the scale), the physical
20 element was rated as the significantly most helpful element of the PETTLEP model followed
21 by the environment element. These findings support a recommendation to combine multiple
22 PETTLEP elements to create more effective images (Holmes & Collins, 2001), and the
23 notion that there are additive benefits of incorporating multiple PETTLEP elements (Smith et
24 al., 2007). Results also add to the growing body of evidence that suggest physical and
25 environment elements could play a more important role in enhancing the movement

1 imagery's effectiveness; in this case, through improving ease and vividness of the imagery
2 (e.g., Smith et al., 2007; Callow et al., 2006). The post-experiment PETTLEP evaluation
3 result also suggests individuals are aware of the extent to which different PETTLEP elements
4 may be more or less effective at improving ease and vividness of their imagery (Anuar et al.,
5 2015).

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

18 In partial support of our hypothesis, observation imagery was more effective for
19 priming EVI vividness compared to traditional imagery. However, these differences did not
20 emerge for ease of imaging. Findings for vividness support literature proposing that
21 observation can prime imagery and help enhance imagery ability (Holmes & Calmels, 2008;
22 Lang, 1979; Williams et al., 2011). That is, observing a model perform in the same
23 perspective that is imaged, helps to create a clearer, richer and more lifelike image. Because
24 the observation clips were filmed from a third person perspective, this finding therefore also
25 supports the notion that observation may only prime visual imagery ability when the

1 observation clips are congruent with the imagery perspective (Williams et al., 2011).
2 Unexpectedly, observation imagery did not prime ease of imaging EVI as there were no
3 differences between this imagery condition and traditional imagery. In further contrast to the
4 findings of Williams et al. (2011), observation also did not prime ease or vividness of KI.
5 While the finding for KI has been replicated in other research (Wright et al., 2015), overall
6 the results do not support observation imagery to be as effective at enhancing ease and
7 vividness of imaging as was anticipated.

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

23 A second explanation could be that some increases in imagery ability previously
24 attributed to observation imagery may have been a result of including PETTLEP elements
25 within the imagery (see Williams et al., 2011). To the best of our knowledge this is the first

1 study to directly compare the effects of observation and PETTLEP imagery conditions on
2 EVI, IVI, and KI ease and vividness. By comparison, previous research has on occasion
3 combined the two techniques. For example, Williams et al. (2011) asked participants to
4 image the movement previously observed in the same environment where the video clip was
5 performed and while adopting the physical position of the movement (i.e., incorporating the
6 environment and physical PETTLEP elements). Consequently, increases in ease of imaging
7 may have been partly due to incorporating these PETTLEP elements. This explanation is
8 even more convincing when the perceived helpfulness of the physical and environmental
9 elements found in the present study (also see Anuar et al., 2015) is also considered, and that
10 PETTLEP imagery was found to be more effective than observation imagery for enhancing
11 KI and IVI ease and vividness, and EVI ease. Future research should compare the conditions
12 used within the present study with a combined PETTLEP and observation imagery condition
13 to further understand the interaction effects that these techniques can have on ease and
14 vividness of movement imagery.

15 When comparing observation imagery and PETTLEP imagery as techniques to
16 enhance ease and vividness of EVI, IVI, and KI, the present study suggests that PETTLEP
17 imagery may be superior for imaging movements due to its capacity to inflate ease and
18 vividness scores of both visual perspectives and KI. However, it is important to note that
19 certain factors may have meant PETTLEP imagery leant itself better to improving ease and
20 vividness. Other studies have demonstrated that observation can be effective for complex
21 movements that individuals are less proficient at performing (e.g., Wright et al., 2015).
22 Indeed it has been proposed that observation may aid individuals' imagery by providing them
23 with a representation of what to image (Lang, 1979; Nordin & Cumming, 2005).
24 Consequently, observation imagery's effectiveness at enhancing imagery ability may be due
25 to multiple factors including skill level, complexity of the movements, and characteristics of

1 the observation clips (Williams et al., 2011; Wright et al., 2015). It also unknown what
2 effects PETTLEP and observation imagery might have on other types of images commonly
3 experienced by athletes (e.g., strategy, goal, affect, and mastery; Williams et al., 2011).

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

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

24 In conclusion, the present study examined the effects of PETTLEP imagery and
25 observation imagery compared with traditional imagery on ease and vividness of EVI, IVI,

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

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4

1 Table 1

2 *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	$r : .58^{**}$	$r : .62^{**}$	$r : .76^{**}$

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

1 Table 2

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

	PETTLEP imagery						Observation						Traditional imagery					
	<i>Vividness</i>			<i>Ease</i>			<i>Vividness</i>			<i>Ease</i>			<i>Vividness</i>			<i>Ease</i>		
	α	<i>M</i>	<i>SD</i>	α	<i>M</i>	<i>SD</i>	α	<i>M</i>	<i>SD</i>	α	<i>M</i>	<i>SD</i>	α	<i>M</i>	<i>SD</i>	α	<i>M</i>	<i>SD</i>
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

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

4

1 Table 3

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

	Vividness		Ease	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
“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

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

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5 Words count: 8059 words

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