Effect of PETTLEP Imagery Training on Learning of New Skills in Novice Volleyball Players

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ABSTRACT: This study conducted to compare the effects of (a) physical practice with PETTLEP-based (Physical, Environmental, Task, Timing, Learning, Emotion and Perspective; Holmes & Collins, 2001) imagery, and (b) physical practice with traditional imagery interventions, on new skill learning in novice volleyball players. Thirty six novice male volleyball players (M_{age} = 13.2 years, *SD* = 0.53 years) with 6-8 months practice experience were randomly assigned to one of three groups: physical practice + PETTLEP imagery (n = 12), physical practice + traditional imagery (n = 12), and physical practice only (control group; n = 12). Participants in the PETTLEP imagery group applied the seven components of PETTLEP imagery training ; whereas participants in the traditional imagery group engaged in a relaxation session before imagery and used response laden motor imagery scripts. The two groups completed 15 minutes of imagery training followed immediately by thirteen minutes of "passing" practice three times per week. The control group completed only thirteen minutes of "passing" practice three times per week. Each group performed their respective tasks for seven weeks. A pre-test took place during the first practice session in which "passing" was assessed. After the seven-week practice program, a post-test took place followed by a retention test, one "no-practice" week later. All groups improved significantly ($p < 0.05$) from pre- to post-test and retention test. Nevertheless, as hypothesised the PETTLEP group improved more ($p < 0.05$) than the traditional imagery and physical practice groups. The findings, therefore, support the effectiveness of PETTLEP in enhancing learning and performance of new skill when combined with physical practice.

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INTRODUCTION

Imagery can be defined as 'using all the senses to create or recreate an experience in the mind' (Vealey & Greenleaf, 2001), p.248. It is well-documented that imagery can be effective at improving performance of motor skills (Duncan, Hall, Wilson, & Rodgers, 2012; P. S. Holmes & Collins, 2001; D. P. L. D. T. Smith, 2001). Several studies have shown that imagery can be effective on sport psychology intervention (Coelho, De Campos, Da Silva, Okazaki, & Keller, 2007; Feltz & Landers, 1983); however, some researchers (Collins & Hale, 1997; Goginsky & Collins, 1996; Vealey, 1994) have criticized the lack of a theoretical and empirical base for scientific studies and applied work conducted on the topic.

Despite decades of research on sport imagery, the issue of how to conduct imagery for the best results remains controversial and many studies have used conflicting methods (Murphy, 1994; D. Smith, Wright, & Cantwell, 2008; Weinberg, Seabourne, & Jackson, 1981). Nevertheless, neuroscience research examining brain activity during imagery may provide useful information about how to conduct imagery. Studies using techniques such as electroencephalography and positron emission tomography have found similar cortical neuronal activity prior to and during imagery and physical performance, a phenomenon termed functional equivalence (J. Decety, 1996; Jeannerod, 1997). Decety and Jeannerod hypothesized that the phenomenon of functional equivalence may explain imagery's performance-enhancing effects. This line of research follows work such as (Lang, 1977, 1979) bioinformational theory and (Ahsen, 1984) triple code theory that have emphasized the similarity of psychophysiological responses to imagery and actual performance as well as the importance of meaning in imagery.

Holmes and Collins (2001) developed the PETTLEP model based on the aforementioned theories and research. PETTLEP is based on the discovery that the same neurophysiological processes underlie imagery and actual movement of the same task (Jean Decety & Jeannerod, 1995), and that this "functional equivalence" provides a possible explanation for the performance-enhancing effects of imagery (Jeannerod, 1995). PETTLEP aims to aid practitioners in producing functionally equivalent mental simulation. The PETTLEP acronym relates to important practical components that should be considered when implementing motor-based imagery interventions, namely; physical, environment, task, timing, learning, emotion and perspective components.

The “physical” component of the model is related to the athlete’s physical responses in the sporting situation. Some authors (Cabral & Crisfield, 1996; Williams & Harris, 2001) claim that athletes are best able to imagine a skill or movement vividly if they are in a completely relaxed and undisturbed state; however, the majority of studies of imagery combined with relaxation have not found any significant benefits from the use of relaxation (Gray, Haring, & Banks, 1984). If imagery is most effective when functional equivalence is high (D. Smith & Collins, 2004; D. Smith & Holmes, 2004) it seems unlikely that this approach will be beneficial in certain situations. Indeed, Holmes and Collins (2001) argued that, “the technique does not take into account the somatic influences of relaxation that would seem to be totally contrary to the somatic state of the performing athlete (p. 128).” They argue that imagery is more effective when it includes all of the senses that would be engaged, and kinaesthetic sensations that would be experienced, during actual performance. For example, images that include the burning sensation of lactic acid build-up in the muscles, the feeling of the heart pounding, and/or the smell of the grass pitch can be very evocative of actual performance for the athlete. Also, adopting the same posture as one would adopt when performing, holding any implements that would usually be held, and wearing the correct clothing could enhance the physical nature of the imagery. It is important to note that the individual should imagine performing the relevant skill correctly, and, if he or she is unsure of the correct technique, coaching advice should be sought prior to incorporating imagery so as to avoid the possibility of “ingraining” poor technique.

The “environment” component refers to the milieu in which the imagery takes place. To access the same motor representation, Holmes and Collins argued that imagery should be done in an environment similar to the one in which competition occurs. For example, a golfer could perform imagery while standing on grass to simulate being on a golf course. Studies with field hockey players and gymnasts supported this hypothesis and found better results when imagery was performed in the same environment as the competition (D. Smith, Wright, Allsopp, & Westhead, 2007). If it is not possible to perform imagery regularly in the actual performing arena, cues such as video and audiotape (D. Smith et al., 2008) can be used, which have been found to be more effective than a written script (D. Smith & Holmes, 2004).

The “timing” component of the PETTLEP model refers to the imagery being completed at the correct pace (i.e., the pace at which the action would be completed). This “real time” pace will serve to maximize the functional equivalence of the imagery intervention, as timing is often a crucial part of performing sports skills; however, some authors suggest that imaging in slow motion may be useful if the performer is new to the skill or trying to alter a poor technique (Syer & Connolly, 1984). Therefore, imaging in real time may be only sensible when performers have a degree of mastery that is necessary in performing the skill they are imaging.

“Task” refers to closely matching the imagined task to the actual one. The imagery content should be highly task-specific, with the performer focusing on the same thoughts, feelings, and actions as during competitive performance. To enable functionally equivalent imagery, a process known as “response training” (Lang, Kozak, Miller, Levin, & McLean Jr, 1980) should be done as advocated in bio informational theory (Lang, 1985). This involves focusing the participant on actual responses by eliciting and reinforcing verbal reports of physiological and behavioural involvement in the scene, thus emphasizing a kinaesthetic orientation toward the imagery. Smith and Collins (2004) measured movement-related brain potentials during computer game performance and found that a response-trained group produced more functionally equivalent imagery than the group receiving stimulus training (i.e., focusing on the stimuli in the imagined scene). Also, and perhaps more importantly, the response-trained group’s performance increased significantly more than the stimulus group.

The “learning” aspect of the model refers to the adaptation of imagery content in relation to the stage of learning. The motor representation and associated responses will change over time as learning takes place, so the content of the motor image must change to accommodate such learning to maintain functional equivalence. Analysing the motor areas, have shown that motor imagery of finger movements increased in congruence with motor preparation and execution over a one-week period (Pascual-Leone et al., 1995). Therefore, where motor imagery is combined with technical training or in intensive learning phases of a task, regularly reviewing content seems essential to retain functional equivalence. Unfortunately, this dynamic approach to imagery delivery is rarely seen in the popular sport psychology texts (Miller, 1991).

The "emotion" component has been referred to as the "missing link" in sports performance (Botterill, 1997). To achieve optimal functional equivalence, the athlete should try to experience all of the emotions and arousal associated with the performance. This is in accordance with other findings (Cuthbert, Vrana, & Bradley, 1991; Lang, 1985), who suggested that the performer's emotional responses and the meaning he or she attaches to the scenario, must be included in imagery if optimal behavioural change is to take place. For example, the possible excitement the performer feels during performance should be an important part of the imagery experience. Of course, care should be taken to ensure that the emotions felt during imagery are positive. Negative thoughts should be dealt with by replacing them as far as possible with positive ones. Though the main function of the PETTLEP model is skill enhancement, the focus on positive emotions should also prove beneficial in enhancing self-confidence and motivation.

The "perspective" component refers to whether the athlete completes the imagery from an internal (first person) perspective, or an external (third person) perspective. Whilst the paradigm of functional equivalence would suggest that an internal perspective would be most beneficial, some research has shown that for certain tasks an external perspective is preferable (Hardy & Callow, 1999; White, 1995). It has also been shown that more advanced performers will be able to switch from one perspective to another (D. Smith, Hale, & Collins, 1998) and subsequently gain advantages from using both perspectives.

Some elements of the PETTLEP model (e.g., Perspective) have been researched more than others (e.g., emotion); however, only one published study has tested the model as a whole. Smith et al. (2007) completed two studies focusing on a hockey penalty flick and a gymnastics beam skill. In the hockey flick task, they found that as more PETTLEP components were introduced in the imagery intervention, there was a stronger effect on performance. With the gymnastics beam skill, they found that the physical practice and PETTLEP groups improved significantly from pre- to post-test, with no significant difference between them. Additionally, they found that the stimulus only and control groups did not improve significantly from pre- to post-test. The effect sizes for this study were large for the physical practice and PETTLEP imagery groups but moderate for the stimulus only group.

Previous studies (D. Smith & Collins, 2004; D. Smith & Holmes, 2004) indirectly tested elements of the PETTLEP model using various methods to deliver imagery interventions, including written scripts, video- and audio-tape, and comparison effects of stimulus and response-driven interventions. Nevertheless, as Holmes and Collins (2001) noted, the model would benefit from explicit, comprehensive testing in a variety of settings. Responding to this suggestion, Smith et al. (2007) assessed the effect of PETTLEP imagery in hockey and gymnastics and found that the more PETTLEP components incorporated into the imagery, the greater the improvement in performance; however, the effects of combining PETTLEP imagery and physical practice in the learning of new skills has not yet been examined. Therefore, the aim of this study was to compare the effects of physical practice with PETTLEP-based imagery and physical practice with traditional imagery on the learning of new skills in novice volleyball players.

The study focused on the learning of new skills in novice volleyball players through the comparison of three interventions: (i) physical practice with PETTLEP imagery group, (ii) physical practice with traditional imagery group, and (iii) physical practice group (control group). We hypothesized that the physical practice with PETTLEP imagery group would improve more than the physical practice with traditional imagery and the physical practice groups. In this study, the PETTLEP intervention emphazised all seven PETTLEP components.

METHOD

Participants

Thirty six novice male volleyball players (M_{age} =13.2 years, *SD* = 0.53) with 6-8 months practice experience (*M* = 7.2 months, *SD* = 0.2 months) participated at the present study. For the purpose of this study, imagery was defined as "the cognitive rehearsal of a physical skill in the absence of overt physical movement; it can take the form of … engaging in visual and kinaesthetic imagery of the performance of a skill or a part of a skill (Magill, 2004).

Procedure

Participants after completing the MIQ-R Questionnaire (Movement Imagery Questionnaire Revised) (C. R. Hall & Martin, 1997), and a "passing" test (according to protocols outlined in AAHPERD, 1984) in indoor volleyball, were randomly placed into one of three groups: (a) physical practice with PETTLEP-based imagery training group (P-I-T, *n* = 12), (b) physical practice with traditional imagery training group (T-I-T, *n* = 12), and (c) physical practice group (control group)(PP, *n* = 12).

Verbal instructions on how to perform the skills were given before the beginning of the program. The instructor, the initial instructions and facilities in the practice sessions were not the same for three groups.

The participants were asked to not practice in addition to the three practice session per week. To avoid the interaction between athletes of three groups, the practice sessions were adjusted to be on different days of week, to minimise discussion of their sessions with each other.

Imagery training comprised a seven-week course. Participants in both imagery conditions (PETTLEP-based imagery training group and physical practice with traditional imagery training group) completed fifteen minutes of imagery training followed immediately by thirteen minutes of “passing” practice three times per week. Participants in the physical practice group participated in only thirteen minutes of “passing” practice three times per week. Participants in the traditional imagery group engaged in a relaxation session before imagery and used response laden motor imagery scripts. Participants in the PETTLEP imagery group applied the seven components of PETTLEP imagery training (P. S. Holmes & Collins, 2001).

Participants were instructed on perform their imagery standing in the volleyball court (environment), dressed in their volleyball clothing, and holding a ball. They were instructed to perform the movement to help make the imagery seem more realistic and authentic. The physiological responses and emotions associated with performance were incorporated into the imagery (task and emotion), as the physiological responses and emotions participants felt during performance were elicited and reinforced during the response training and incorporated into the imagery scripts. The participants were also instructed to perform the imagery in real time from an internal perspective (timing and perspective). The subjects were consulted once each week regarding the imagery effectiveness and asked if they wanted to make any changes or additions to their imagery scripts. These changes were then incorporated for use in subsequent imagery sessions (learning). Participants in the physical practice group completed “passing” drills without the use of imagery for seven weeks.

Measures

Data were collected at three time points. A pre-test took place during the first practice session. Participant “passing” was assessed consistent with the procedures outlined by AAHPERD’s (1984) test for “passing” in indoor volleyball. Test-retest reliability of the tests for passing has been examined and found to be quite satisfactory (r = .97) (Zetou, Giatsis, & Tzetzis, 2005). After the seven-week practice program, a post-test took place followed by a retention test, which was conducted one week later in which there was no volleyball practice (Schmidt, 1991).

Skill evaluation

The goal of the evaluation was to assess the participants’ ability to effectively pass a free-throw ball. The participants stood at the left or the right side of the court, on a marked point located 4 m from the side line and 2 m from the end line. The participants received a high throw from the assistant (who was standing within the opponent court) and executed a pass so that the ball went over the rope and into the target area. Throws which did not fall into the participant’s area were repeated. Each participant had to perform 10 trials (5 to each side). A trial was counted as valid, but no points were credited, if the ball touched the rope, if the ball did not fall into the target area, or if it went over the net into the opponent court. Points from “1” to “4” were awarded for each pass that went over the rope and landed in or hit any part of the target area, including lines. The maximum possible score was 40 points.

RESULTS

We hypothesized that PETTLEP-based imagery training and physical practice method would have a more positive effect on novice skill learning compared to the traditional imagery training and physical practice, and physical practice only methods. In order to test the above hypothesis, analyses of variance (Paired-sample t-test and one-way ANOVA) were conducted to compare scores on the skill test for groups under different treatment conditions for the three time points (pre-test, post-test and retention test). Pretest was used as a baseline for participants’ volleyball skill. The mean scores for all groups were greater in the posttest than in the pretest (see Table 1).

Table 1. Means (Standard Deviations) for PETTLEP-based imagery training, Traditional Imagery training, and Physical Practice Groups on two volleyballSkills.

	PETTLEP n = 12	Traditional n = 12	Physical practice n = 12
	M (SD)	*M (SD)*	*M (SD)*
Pre test	17.50 (1.14)	17.16 (1.11)	17.66 (1.23)
Post test	33.91 (0.99)	26.83 (1.11)	21.50 (1.78)
Retention test	34.75 (1.05)	27.25 (1.13)	21.75 (1.86)

The result of this research showed a significant difference in improvement between pretest and posttest of each groups. Three paired-samples t-tests were conducted to follow up the significant interaction. There were significant difference between mean ratings scores of pretest-posttest in physical practice and pettlep group (t(12 = 63.16, $p < 0.05$), physical practice and traditional imagery group ($t(12)= 21.50$, $p < 0.05$) and physical practice ($t(12) = 8.08$, $p < 0.05$) (see Figure 1).

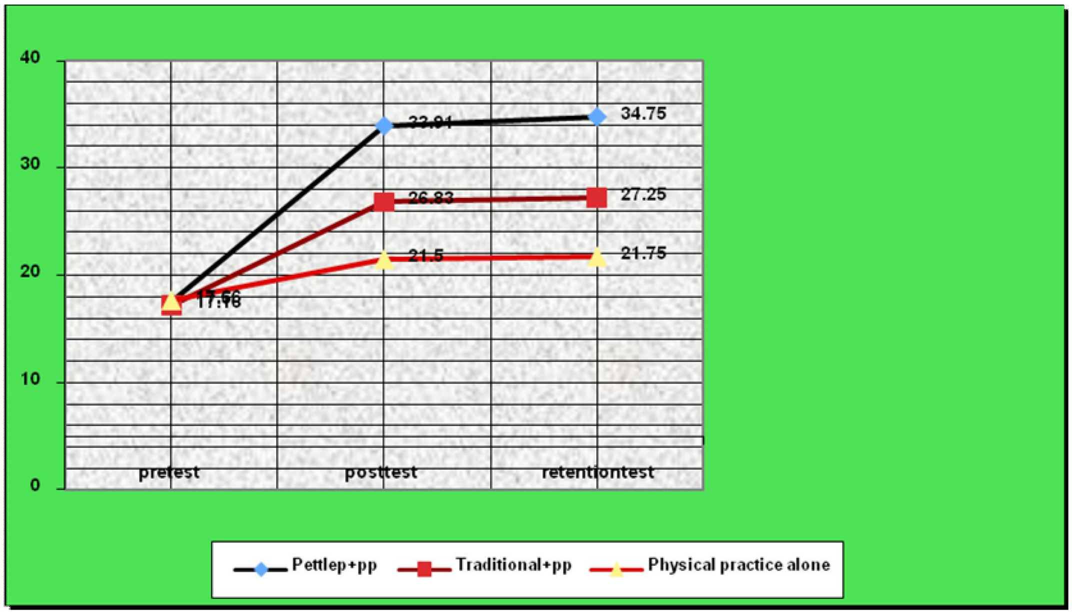

Figure 1. Performance evaluation of groups in passing skill.

Results of the one-way analyses of variance indicated that there was no significant difference between the pretest scores of three groups (F [3,28] = 0.68, $p < 0.05$). There was a significant difference between the scores on the posttest (F [3,28] = 258.84, $p < 0.05$) and retention tests (F [3,28] = 260.43, $p <$ 0.050] for the three groups. Tukey HSD tests revealed that significant development of physical practice and PETTLEP, was better than physical practice and traditional imagery and physical practice, and physical practice and traditional imagery, was better than physical practice only.

DISCUSSION

Imagery has been demonstrated to be an effective means of enhancing performance in the learning and performance in dance (Fish, Hall, & Cumming, 2004), sport (C. Hall, 2001) and music (P. Holmes, 2005); however, simply using imagery in isolation has been found to be insufficient in improving performance (Lee, 1990; D. Smith et al., 2007). Hence, the purpose of this research was the comparison of three interventions: (i) physical practice with PETTLEP imagery group, (ii) physical practice with traditional imagery group, and (iii) physical practice group only (control group). We hypothesized that the physical practice with PETTLEP imagery group would improve more than the physical practice with traditional imagery and the physical practice groups.

The findings of this research indicate that the rate of learning was greatest for the PETTLEP group, compared with the other groups. It seems, that mental practice (PETTLEP and traditional method) has a preparatory effect on the task, which increases the efficiency of subsequent physical training (Mulder, Zijlstra, Zijlstra, & Hochstenbach, 2004). The results of the study support the effectiveness of the PETTLEP approach to motor imagery in enhancing leaning and performance skill, especially when used in combination with physical practice. The physical practice with PETTLEP imagery group improved significantly from pre- to posttest (and that improvement was maintained until the retention test), which was superior to the improvement found for the physical practice with traditional imagery and physical practice groups. Moreover, scores for physical practice and PETTLEP, were better than physical practice with traditional imagery, and physical practice with traditional imagery, was better than physical practice. These findings are supported by Smith et al. (2007), who found PETTLEP imagery to be more effective than more traditional imagery interventions.

The significant improvement in the PETTLEP group appears to support Lang's bioinformational theory (1979), Ahsen's triple code theory (1984), and the findings of Smith and Collins (2004) and Smith et al. (2001), in emphasizing the importance of kinaesthetic imagery for enhancing performance. Perhaps PETTLEP with physical practice may also be useful in promoting confidence, which could also have a positive impact on performance. Another possible reason for the success of the PETTLEP is its emphasis on the imagery environment. Subjects in the physical practice with PETTLEP group performed imagery in an environment similar to the volleyball game without actually being on the volleyball court. Thus, they could perform relevant postural adjustments prior to imaging the volleyball pass and receive functionally equivalent kinaesthetic sensations.

The results of this study provide further evidence that PETTLEP-based imagery is an effective way to enhance learning and performance when used in combination with physical practice. The results indicate the PETTLEP approach has much to offer sport psychologists using imagery interventions. This finding is supported by extensive research (D. Smith et al., 2007; D. Smith et al., 2008; Wright & Smith, 2007).

Results support the view that stimulating the peripheral receptors associated with task execution during imagery, as advocated in the PETTLEP technique, produces significantly greater performance gains than traditional imagery techniques. This offers support for the findings of past research (Jeannerod, 1999; Jeannerod & Decety, 1995). It is suggested that peripheral stimulation assists in the production of a multisensory imagery experience, and ultimately strengthens the memory trace for successful task execution. Traditional imagery techniques that utilize relaxation prior to imagery are likely to generate a physiologically ready state that is incomparable with actual performance states. As such, traditional imagery techniques lack the functional equivalence that the PETTLEP technique strives to attain. Nevertheless, results indicate that a combination of traditional imagery training and physical practice produces significantly greater performance gains than physical practice alone. One widely accepted function of imagery is to direct and focus attention onto task relevant cues (P. S. Holmes & Collins, 2001), which is evidenced irrespective of the method of imagery training used; as such, this is a likely explanation for the performance gains demonstrated by the traditional imagery group.

CONCLUSION

In order to increase the effectiveness of imagery use, it is suggested that applied sport psychologists consider the physical characteristics of task execution, which should be integrated into imagery training thereby increasing the functional equivalence of imagery execution. This functional equivalence may be achieved by asking athletes to utilise imagery whilst wearing the relevant sports clothing, holding sports equipment, or adopting the physical stance involved in skill execution.

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