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Effects of visualized PETTLEP imagery on the basketball 3-point shot: A comparison of internal and external perspectives

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ABSTRACT

By adopting Holmes and Collins'(2001) PETTLEP imagery approach, we used participants' individual videos of successful basketball shooting to examine the effects of internal and external imagery on basketball players' 3-point shot. We sampled 49 intermediate level college basketball players (males = 26, *M*age = 21; females = 23, *M*age = 20) and assigned them into internal imagery (n = 15), external imagery (n = 14) and control groups (n = 20). Using a quasi-experimental design, experimental groups participated in an 8-week visualized PETTLEP imagery training plus physical training, but the control group only participated in physical training. The two-way ANOVA mixed design statistical analyses found the two visualized PETTLEP groups not only performed better than pretest, but also performed better than the control group after training. However, there was no difference between internal imagery and external imagery on basketball 3-point shot performance. We concluded that the characteristics of the motor task and participants' skill level may influence the efficacy of the imagery perspective on performance. Theoretical implications, limitations, future research directions, and applications are discussed.

In basketball, the 3-point shot has its long history and critical role in competition (Csataljay, Hughes, James, & Dancs, 2011; Gómez, Alarcón& Ortega, 2015; Navarro, Lorenzo, Gómez, & Sampaio, 2009). When the 3-point shot came to the NBA in 1979, it changed the nature of the game. Many NBA professional basketball players such as Steve Kerr, Hubert Davis, and Stephen Curry became well known because of their outstanding 3-point shot performance (Bailey, 2019). Mathematician and basketball analysis expert Stephen Shea (2020) indicated that in the past few years 3-point shots in the NBA increased to an average of 29 shots per game. He explained that many teams increased use of the 3-point shot because on average, 100 mid-range shots can only win 79 points for the teams, but 100 3-point shots will provide 105 points on average for the teams. Another basketball expert, Shane Young (2019), found that the 3-point shot in NBA is approaching 38% in the year 2019–2020. Many teams won games, such as Golden State Warriors with a record-breaking 73-wins 9-loses season in the year 2015–2016, because they used 3-point shots as a major strategy.

Because the 3-point shot is so important, basketball coaches and trainers use all types of methods to improve basketball players' 3-point shot performance. These training methods include increasing training speed (Fryer, 2017), visual control training (Oudejans, 2012), software and navigator (Guo, Li, & Xin, 2012) and resistance training (Varghesea & Shelvam, 2014). Specifically, sport psychology researchers have suggested that imagery may enhance basketball players' performance (Gould, Voelker, Damarjian, & Greenleaf, 2014; Morris, Spittle, & Watt, 2005). Thus, it is imperative to empirically examine how imagery training affects basketball players' 3-point shot.

Imagery is a cognitive simulation process of recreating or creating an experience by recalling memories stored in mind and shaping related information into a meaningful image (Weinberg & Gould, 2018). In the sports domain, there are many terms for imagery such as visualization, mental practice, mental imagery, mental rehearsal, and covert practice … etc. Imagery is so popular and widely used by sports performers because evidence shows that imagery is an effective strategy to enhance performance in different sports such as high jump (Olsson, Jonsson, & Nyberg, 2008), gymnastics (Smith, Wright, Allsopp, & Westhead, 2007), golf (Brouziyne & Molinaro, 2005), and basketball (Fazel, Morris, Watt, & Mahr, 2018). Therefore, researchers have suggested that sports coaches and athletes should regularly include imagery in sports training (Morris et al., 2005).

To gain the best results from imagery, Holms and Collins' (2001) proposed an innovative approach termed "PETTLEP" as an imagery

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guide in sports settings. Holms and Collins (2001) contended that imagery is a cognitive process that prompts the brain to prepare, plan/-program, and execute the movement in the mind before an overt motor performance, and is equivalent to actual motor performance (Holms & Collins, 2001, p. 62). Based on theoretical and empirical evidence from neuro-motor studies, they proposed the "PETTLEP" imagery model when implementing imagery in sports training. P- Refers to the "*physical*" component of the imagery, which requires imagers to focus on physical responses as actual movements. E− Stands for "*environment,*" which suggests that when practicing imagery, imagers should be situated in a real environmental setting as much as possible. T- Means "*task,*" which suggests that imagers focus on the task component that is performed. T- Refers to the "*time*" component, which suggests imagers should image the whole process in the real-time of the actual movement. L-stands for "*learning,*" which suggests that motor images should focus on the learning process. E− Refers to the "*emotion*" component, which emphasizes that imagers should feel what they feel in real sports settings. P- Stands for the "*perspective*" component of the imagery, which refers to the way imagery is viewed. According to research (e.g., Callow, Edwards, Jones, Hardy, & Connell, 2018; Hardy & Callow, 1999), there are two types of imagery perspectives - internal and external. Internal perspective refers to imaging the whole process of the movement from an internal perspective, which is kinesthetic in nature (also called the first-person perspective). External perspective refers to imaging the whole process from an outsiders' perspective, which is visual in nature (also called third-person perspective).

After Holms and Collins (2001) proposed the PETTLEP model of imagery, studies found this method better than traditional imagery training (Anuar, Williams & Cumming, 2016). Compared to traditional imagery training, PETTLEP is much easier for athletes to practice, produces more vivid images, and enhances sports performance (Smith et al., 2007; Wakefield & Smith, 2009). Also, the research found combining PETTLEP with physical training improves performance better than PETTLEP imagery or physical training alone (Afrouzeh et al., 2015; Battaglia, 2014; Pocock er al., 2019). More importantly, research supports that PETTLEP imagery improves performance in diverse sports such as netball (Wakefield & Smith, 2009), long jump (Post, Williams, Simpson, & Berning, 2015), golf (Baughman, 2017; Swainston et al., 2012), and soccer (Norouzi et al., 2019; Pocock, Dicks, Thewell, Chapman, & Barker, 2019).&

Despite these efforts, PETTLEP research rarely compares the effects of the internal and external imagery perspectives. As mentioned earlier, the last letter "P" of PETTLEP stands for the perspective of imagery. Imagers can imagine sports movements either from an internal perspective (i.e., first-person perspective) or external perspective (i.e., third-person perspective). Research suggests that the efficacy of the internal or external perspective depends on whether the motor task requires "form" or "perception" for successful execution (Hardy & Callow, 1999, p. 96). For example, if the goal of imagery is for performers to learn a specific motor task such as a novel skill of Karate, external perspective imagery is more beneficial (e.g., Hardy & Callow, 1999). For example, Norouzi and colleagues' (Norouzi et al., 2019) sampled 45 male adolescent novice football players randomly assigned to external PETTLEP imagery, internal PETTLEP imagery, and a control condition to examine effects on pass skill performance. They found both external PETTLEP and internal PETTLEP performed better than the control group. However, external PETTLEP imagery had the highest pass skill performance compared to the other two groups.

In contrast, if the goal of imagery is to make participants "feel" the motor movement (e.g., high jump, diving) internal perspective imagery seems helpful. (Olsson et al., 2008). For example, Dana and Gozalzadeh (2017) examined internal and external imagery with novice tennis players' forehand/backhand strokes and serve accuracy. They sampled 36 summer camp junior tennis players and assigned them to internal, external, and control groups with 6 weeks of imagery training except for the control group. They found serve accuracy was better with internal imagery, and forehand accuracy was better with external imagery. Dana and Gozalzadeh (2017) explained that because participants need to feel the movement in tennis serves, the internal perspective of imagery is helpful. In contrast, novice players need more information about forehand strike, and external imagery provides more information.

Recently, Montuori and colleagues' (Montuori et al., 2017) examined the effects of internal and external imagery on Pilates exercise with expert, novice and no-practice participants. They found imagery time was similar to execution time for the expert group. However, if the expert group used external imagery for the Pilates exercise the imagery time was significantly slower than the execution time. In the novice group, the results were the opposite - imagery time was similar to execution time when using external imagery but not internal imagery.

Based on the above literature, it seems that PETTLEP is applicable to basketball players' 3-point shot performance. However, the problem remains as to which imagery perspective will be the most beneficial to the basketball 3-point shot. It seems that external imagery is beneficial to novice participants. However, if participants were inexperienced or novice in the basketball 3-point shot it would take a lot of time to build their basic shooting techniques, which could cause a "floor effect" of the training (Thomas, Nelson, & Silverman, 2015). Thus, recruiting experienced players as participants to examine which imagery perspective is more effective seems logical.

Further, past PETTLEP imagery research mostly used "imagery scripts" during intervention (e.g., Norouzi et al., 2019; Swainston et al., 2012; Wakefield & Smith, 2009; Wright, Hogard, Ellis, Smith, & Kelly, 2008). We believed this method would cause an "imagery gap" between "imagery scripts" and "real images" because transferring verbal instruction into real images needs more cognitive processing (Kosslyn, 2005). This cognitive processing includes reading the imagery scripts, then recognizing, interpreting, and creating motor task images. Performers who are dyslexic or have hearing problems would have difficulty using imagery. Thus, we attempted to apply a visualized PETTLEP imagery approach to examine the efficacy of internal and external imagery on the basketball 3-point shot with intermediate skill level basketball players. The visualized PETTLEP imagery approach used participants' own video of the 3-point shot as an intervention instead of imagery scripts. We hypothesized that intermediate skill basketball players would benefit from visualized PETTLEP imagery after training with both internal and external imagery. Further, because intermediate skill basketball players have experience in the 3-point shot we hypothesized that the internal PETTLEP imagery group would perform better than the external imagery group.

1. Method

1.1. Phase I. Pilot study

Prior to the formal study, we adopted Connelly's (2008) suggestion to conduct a pilot study to make sure our procedures and interventions were suitable for participants, and to identify feasible dates, venues, and target participants. We visited potential schools and coaches, and gained permission from two universities with sufficient basketball players. Because the coaches of the target schools only agreed to two times a week for the study, we revised Wakefield and Smith's (2009) protocol to two times a week but extended the training session to 8 weeks. In the pilot stage, 6 intermediate-level of basketball players performed all the experimental procedures. All 6 participants were able to perform the required 3-point shots and imagery. In contrast, when we asked 6 inexperienced college students to perform the 3-point shot and imagery, they could imagine the process of basketball shooting but 5 out of 6 were unable to touch either the rim or backboard. After the pilot study, we decided to sample intermediate-level of basketball players and started our formal study. We used G* Power 3.1 (Faul, Erdfelder, Buchner, & Lang, 2009) to estimate the sample required for moderate magnitude ($\alpha = 0.05$, power = 0.8, ES = 0.40; groups = 3, numbers of measurement =

2, the correlation among repeated measures = .05) in a repeated-measures analysis of variance (ANOVA). It was indicated that at least 42 participants were required (14 per group) to examine the interaction and main effects of the factorial design (G* Power 3.1, 2017, p.26).

1.2. Phase II. Formal study

1.2.1. Participants

Participants were 49 college basketball players (males = 26 with *M*age = 21 ± 1.40; females = 23 with *M*age = 20 ± 1.67) recruited from two universities in Taiwan. None of the participants were elite basketball players. They played at the Level-II University Basketball Association (UBA) in Taiwan and had not received any imagery training or other psychological skills training before.

1.2.2. Measures

We use the revised Chinese Version of the Movement Imagery Questionnaire-Revised (MIQ-R; Lin, 2011) to assess participants' imagery ability. The Chinese version of MIQ-R, revised from the 8-item MIQ-R (Hall & Martin, 1997), was used to assess movement imagery ability of four basic movements including knee lift, jump, arm movement, and waist bend in both visual and kinesthetic modalities. Participants are asked to read through each statement and perform the movement described. Participants rate the ease or difficulty of imaging the movement on a 7-point Likert scale ranging from 1 (very hard to see/feel) to 7 (very easy to see/feel). A higher score represents greater imagery ability. Lin (2011) reported that the internal reliability of the revised Chinese MIQ-R was assessed by composite reliability (CR)- visual imagery = 0.88, and kinesthetic imagery = 0.82; and average variance extracted (AVE) -AVE: visual imagery = 0.65, and kinesthetic imagery = 0.53. All showed adequate reliability.

1.2.3. Procedures and tasks

Prior to data collection, the researchers gained ethical approval from a local institutional ethical committee (TSMHIRB-2-R-030-2.1). Then, we contacted target schools' coaches to gain permission to recruit their players as participants. After we gained permission we met coaches and players at an appointed date. First, we introduced the purpose and process of the experiment to the participants. Those who were interested then signed the participation consent and followed the experimental arrangements. On the first day of the meeting, all participants completed the MIQ-R to assess their imagery abilities. Further, all participants, including experimental and control groups, were asked to perform a 3-point shot from 5 spots at the angles of 0, 45, 90, 135, and 180 of the basketball court (see Figure 1). The distance of the 3-point shot is 15 feet from the plane of the backboard according to FIBA rules. We used FIBA's designated brand Molten's No. 7 ball (Size 7) for male players and No. 6 (Size 6) for female players.

To assess participants' 3 point-shot performance, we revised Wakefield and Smith (2009) scoring system as follows: touching neither the rim nor the basket board = 0 points; hitting the backboard first but no goal = 1 point; hitting the rim first but no goal = 2 points; hitting the backboard first then goal = 3 points; hitting the rim first then goal = 4 points; directly shooting into the basket = 5 points.

After all the participants completed the pretest of imagery ability and baseline performance of a 3-point shot, 29 college students from one university were randomly assigned into either the PETTLEP internal imagery group (males = 9, females = 6) or external imagery group (males = 7, females = 7). Because all experimental participants were from one university, they were asked not to discuss or talk about imagery contents. The other 20 college students from another university were assigned as the control group (males = 10, females = 10) (see Fig. 1).

1.2.4. Intervention

Imagery Video Preparation: A week before the experiment we filmed each participant's successful 3-point shot in the 5 shooting spots. To film external imagery of the 3-point shot, the photographer stood at the top of the triangle position among participant's shooting spots, basket stand, and photography spot. Then the photographer filmed all the successful 3-point shot videos for participants. To film internal imagery of the 3-point shot, we asked participants to wear a head-set as in Fig. s2 and Fig. s3. The head-set is an 8 cm width elastic band where the iPhone can be inserted into the head-set when filming. With this photography, we successfully filmed participants' internal imagery video of a 3-point shot as Fig. s1 illustrates; Fig. s4 illustrates how we did the video for external imagery. From Fig. s1 and Fig. s4, you can see participants performed the 3-point shot by receiving a teammate's pass, then shooting the basket. This process reflects the real situation in competition. All these personalized videos were filmed at 5 spots at the angles of 0, 45, 90, 135, and 180 of the basketball court. We used these individualized successful videos for each experimental participant when he/she participated in intervention each week.

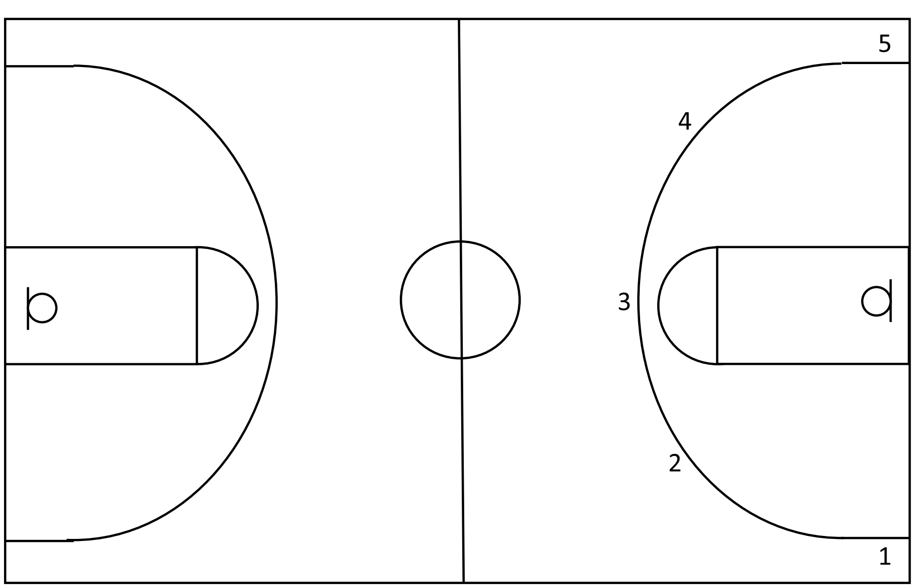

Fig. 1. Basketball court for experiment.

Intervention Execution: For the intervention, participants were contacted individually. The experimenters (one PI and one assistant) waited for the participant in a basketball court located at a corner of the gym to avoid social facilitation and distraction. When the participants came to the experiment, they first warmed-up to avoid injury. Then, they practiced 2 shots from the 5 shooting points. Once they were ready, we started our intervention with following steps: (1) participants viewed their personal films that had already been made; (2) they were asked to view these videos then imagine it in their mind as in real-time and a competitive situation; (3) when participants were ready, they performed the 3-point shot five times at each angle (0, 45, 90, 135, and 180°). To obtain the best results, we adopted Bourne and Archer's (1956) suggestions for motor learning and allowed participants to have 60 s of rest before proceeding to the next shooting spot. The participants fully integrated PETTLEP components into intervention including receiving and holding the basketball (Physical), and ready to perform a 3-point shot (Task), as quick as real competition (Timing), with similar feelings as in competition (Emotion) and emphasizing learning the 3-point shot (Learning). The control group did the same procedure as the experimental group except for no imagery. The total time to complete an individual session was about 35 min for the experimental group, and 25 min for the control group.

1.2.5. General information about experiment

All experimental participants came to the experiment twice a week (i.e., if they came on Monday they came again on Thursday; and if they came on Tuesday, they came on Friday). To control for potential confounds, we asked coaches not to teach 3-point shot during the experiment period. Also, experimental assistants were asked not to teach, comment or talk about participants' 3-point shot. After completing 8 weeks of training, all experimental participants completed a 3-point shot posttest, which was identical to the pretest, on the last day of the experimental sessions. The participants rested for 5 min after the last experimental session. Then, they performed the posttest. For the control group, the posttest was on the last date when they completed 3-point physical training without imagery. The content and procedure of the posttest were identical to the experimental group. Further, to avoid the experiment being interrupted by tournaments, we started our experiment in the off-season and ended at the pre-season. Overall, participants were engaged in the experiment for 8 weeks.

Manipulation check: We adopted Smith and Holms' (2004) suggestions by asking 3 questions for the experimental groups - whether they were performing their imagery as instructed, whether they perceived the intervention as effective, and whether they had experienced any problems while performing their imagery. Research assistants recorded all the answers for later analysis.

1.3. Statistical analyses

Before formal statistical analyses, we screened all data by examining means, standard deviations, skewness, kurtosis, and outliers. Further, we used one-way ANOVA to examine between-group differences in age, weight, height, training hours/day, training days/week, year of experience, and imagery ability. To assess the effects of the visualized PETTLEP imagery training on the basketball 3-point shot, we used a two-way ANOVA mixed-model factorial design with 3 groups (internal, external imagery and control) × 2 times (pre-test vs. post-test). Tests of simple main effects were followed-up when significant interaction effects appeared. The effect size was computed and reported as a partial η^2 value. Significant effects were followed-up with multiple comparisons with Bonferroni correction and Greenhouse Geisser correction in order to meet the sphericity assumption. The significance level was set at an alpha level of .05 prior to Bonferroni correction.

Table 1
Descriptive statistics for all participants on 3-point shot scores.

3-point shot scores		
Variable	Pre-test	Post-test
Internal imagery group (n = 15)	64.60 ± 14.16	79.87 ± 16.21*
External imagery group(n = 14)	69.34 ± 8.84	82.79 ± 7.77*
Control group (n = 20)	61.95 ± 13.40	63.55 ± 17.66
Total group (N = 49)	64.88 ± 12.68	74.04 ± 17.18

Note: *p < .05

2. Results

2.1. Self-report data and preliminary analyses

One-way ANOVAs revealed no significant differences between groups in their ages (M = 18–22 years, SD = 1.23–2.85), F (2, 46) = 0.12, p > .05; weight (M = 63.2–68.4 kg, SD = 9.60–14.65), F (2, 46) = 0.39, p > .05; height (M = 168.30 cm–171.07 cm, SD = 9.07–9.84), F (2, 46) = 0.68, p > .05; training hours/day (M = 2.66–2.90 h, SD = 0.57–2.00), F (2, 46) = 0.65, p > .05; training days/week (M = 3.10–3.42, SD = 0.71–1.40), F (2, 46) = 0.38, p > .05; year of experience (M = 5.07–5.86, SD = 2.46–4.05), F (2, 46) = 0.30, p > .05; or MIQ-R scores (M = 15.9–18.34, SD = 2.08–3.25), F (2, 46) = 2.65, p > .05; indicating no between-group differences in terms of age, weight, height, training hours/day, training days/week, year of experience, and imagery ability. Further, experimental participants reported that they didn't discuss imagery with teammates. They imagined as their assigned perspective of imagery, and all perceived imagery to be effective in enhancing performance and experienced no problem with their imagery processes. The control group reported that they didn't receive any extra 3-point shot training or psychological interventions including imagery during the experimental period.

2.2. Performance data

The 2 by 2 mixed design ANOVA analyses showed a significant group × time interaction on 3-point shot scores, F (2, 46) = 7.90, p = .001, η^2 = 0.256, as Table 1 and Fig. 2 illustrate. Further, the Scheffe's post hoc test revealed that the internal and external imagery groups performed better than control group on 3-point shot scores (for internal imagery p = .010, for external imagery p = .003), but there was no significant difference between two imagery conditions (p = .873). Paired t-tests showed that internal imagery group, t (14) = −5.066, p < .001, Cohen's d = 2.62, and external imagery group, t (13) = −4.593, p = .001, Cohen's d = 2.46, performed better after training. The control group performance was not significantly different between pre- and post-test, t (19) = −0.659, p = .518, Cohen's d = 0.30.

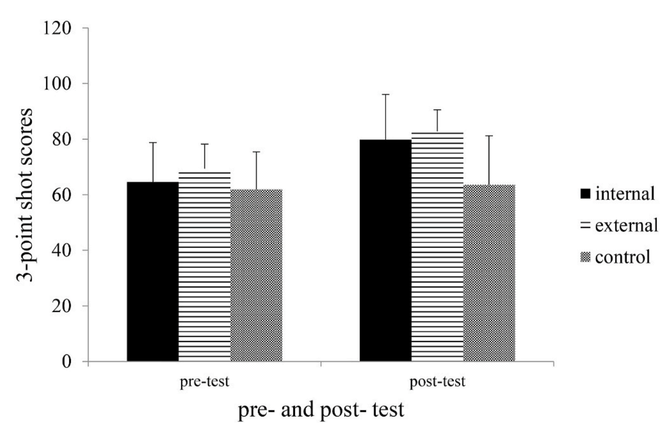

Fig. 2. Effects of visualized PETTLEP on 3-point shot scores.

3. Discussion

3.1. Theoretical implications

Basketball experts report that the 3-point shot is a very important skill/strategy in basketball competition. However, very few studies empirically examined the effects of internal and external imagery on the 3-point shot. We sampled intermediate level college basketball players and trained them with 8 weeks of internal or external imagery using the visualized PETTLEP approach. Results indicated that both types of imagery improved 3-point shot performance, with no difference between internal and external imagery. These findings provide several implications for researchers.

First, our results confirmed that imagery is an effective strategy to enhance motor performance (e.g., Gould et al., 2014; Morris et al., 2005). Specifically, we found that both types of imagery are beneficial to intermediate level college basketball players' 3-point shot. Thus, the visualized PETTLEP approach with internal and external imagery can help experienced basketball players' 3-point shot performance. Surprisingly, we didn't find internal imagery superior to external imagery as hypothesized. Although past research supports that experienced participants would benefit more from internal imagery than external imagery (e.g., Dana & Gozalzadeh, 2017; Montuori et al., 2017; Olsson et al., 2008), our results failed to support this prediction.

According to current research on internal imagery and external imagery (e.g., Dana & Gozalzadeh, 2017; Hardy & Callow, 1999; Norouzi et al., 2019; Olsson, et al., 2008), internal imagery provides performers' kinesthesis perception of the movement; therefore it is beneficial to those who have experience with motor skills to upgrade their performance (Montuori et al., 2017). However, motor behavior researchers suggest that the external perspective is still very useful because it provides key information about how movement is accomplished (Schmidt & Lee, 2011, pp. 57–95). Further, according to biomechanical analyses of the 3-point shot, the trajectory of the shot is a pivotal part of shooting success (Okazaki, Rodack, & Satern, 2015). Thus, it seems that external imagery is still helpful for those intermediate level basketball players on a 3-point shot. We suggest future research to examine the effects of internal and external imagery on different motor skills with participants of different skill levels. Specifically, there are many different classifications of motor skills including discrete, continuous, serious, open skill, and closed skills (Schmidt & Lee, 2011). Also, in sports, movements and motor tasks in competition are diverse. Some events require whole-body movements executed in a serial manner (e.g., gymnastics, diving, figure skating, javelin throwing, long jump, high jump … etc.) while some sports require accuracy (e.g., golf, archery, and dart). Thus, which imagery perspective is particularly beneficial still needs more research.

The unique feature of our study was using a visualized PETTLEP imagery approach to train participants on the 3-point shot. The PETTLEP imagery approach has been recommended by many researchers (Collins & Carson, 2017; Wakefield, Smith, Moran, & Holmes, 2013). However, to best of our knowledge, past PETTLEP imagery research mostly used imagery scripts (e.g., Norouzi et al., 2019; Swainston et al., 2012; Wakefield & Smith, 2009; Wright et al., 2008). We suggested that directly using vivid video of the motor task would provide a more solid scenario for participants to prepare and execute the motor skills in their minds before the overt motor performance. Further, performers with dyslexia or hearing problems can easily imagine the motor tasks through video.

The other unique feature of our study was the use of the participant's own successful shooting video as an imagery tool during the intervention. Generally, sports psychologists would suggest athletes using experts or elite athletes' performance as a model for imagery (Karageorghis & Terry, 2011, p. 177). However, Pavio (1985) proposed that imagery has both cognitive and motivational functions. Thus, if imagers image their own successful performance, they can not only understand the exact features of the motor skills (cognitive function) but also gain confidence that they are able to complete the motor tasks successfully (motivational function). Thus, it is worthy of further investigation to compare the effects of imagers' own successful performance and experts' performance in imagery research.

3.2. Limitations and future suggestions

Despite these significant and unique findings, several limitations should be addressed. First, because our participants were sampled from college basketball intermediate players we cannot conclude that our results can be applied to the younger or different level players (i.e., novice or elite players). Further, our participants included both male and female players, and we cannot be certain the findings are the same for both female or male players. Future studies might compare the effects of visualized PETTLEP imagery for male and female performers. Furthermore, because of time limits, we didn't examine the retention effects of the intervention. Future studies may examine how long the effects of visualized PETTLEP imagery can last. Moreover, because our study was the first study using visualized PETTLEP with the basketball 3-point shot, whether this approach is better than traditional imagery scripts in different sports needs more research.

3.3. Applications

Athletes, PE teachers, coaches, and sport psychology consultants can apply our results in various settings. To facilitate students' or athletes' motor skills performance, they can film sport participants' own successful performance for imagining it before sports training and competition. By so doing, sports participants can not only gain correct information about motor skills but also can be inspired to develop their motor skills. Also, when using visualized PETTLEP imagery, we suggest instructors include all components of PETTLEP in imagery. Further, it is suggested to arrange an appropriate practice-rest ratio during imagery intervention to avoid physical and mental fatigue.

4. Conclusion

In considering that the basketball 3-point shot is a very important skill/strategy in competition, we adopted a visualized PETTLEP imagery approach and trained college basketball players using their own successful shooting performance from either an internal or external imagery perspective. Results indicated this visualized PETTLEP imagery improved participants' 3-point shot performance. We suggest sport professionals use such video-based imagery for sports performers. Future study is needed to examine whether the visualized PETTLEP imagery is better than traditional imagery scripts. Furthermore, we suggest that future studies may examine the effects of internal vs. external imagery on motor tasks, and athletes with different skill levels.

Funding

No! This is a self-initiated study.

Ethical approval

All procedures performed in this study involving human participants were in accordance with the ethical standards of the Antai- Tian-Sheng memorial Hospital Institutional Review Board (TSMH IRB No.19-100-B) and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent

Informed consent was obtained from all individual participants included in the study.

Declaration of competing interest

All authors, including Frank J. H. Lu, Diane L. Gill, Yu-Chen Lee, Yi-Hsiang Chiu, Sean Liu, and Hong-Yu Liu declare has no conflict of interest.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.psychsport.2020.101765.

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