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PETTLEP imagery and tennis service performance: an applied investigation

Abstract: Tennis is one of the most popular and widely played sports enjoyed by players of different age groups and genders as a profession as well as a mode of recreation. A novel method, PETTLEP imagery combines both conventional and non-conventional style of training of an athlete and improves one's performance. This study aimed to analyze the tennis service performance of junior tennis players based on PETTLEP imagery training. Forty-four junior male tennis players (M_{age}=13.22 years, SD=0.42) were selected for the study. The investigator handed over the MIQ-R questionnaire to all the participants in which they scored 16 and above points as per previous research. The participants were equally divided (n=11) into three experimental groups (E1, E2, and E3) and a control group. The service performance outcomes of all the players were compared before and after a training session. The three experimental groups were assigned with service-specific training, service-specific training combined with PETTLEP imagery training, and PETTLEP imagery training alone, respectively, for three days per week for 12 weeks. They were tested on their service accuracy based on the International tennis number (ITN) manual on-court assessment test. The data were assessed for normality and analyzed using non-parametric methods to reveal main effects (each training method alone) as well as to calculate the combined effect of PETTLEP and service-specific training. Certain significant improvements in tennis service were observed with service-specific training alone. Though it marginally outperformed the PETTLEP imagery method, the most improved services were observed with both PETTLEP and service-specific training utilized together. This implies an additive effect when both methods are used together.

Keywords: PETTLEP imagery, tennis service, international tennis number (ITN), novice tennis players.

Introduction

Imagery, a form of simulation used by the athletes to improve their ability in sports, is now a part of modern sports training. It promotes mental visualization (mental rehearsing), which aims to lead to the development of more considerable attention to detail (Weinberg & Gould, 2014). The imagery combines all the wisdom and logic of the athletes, which enhances their performance (Moran & MacIntyre, 1998). It helps to create more versatile and real images in mind (MacIntyre & Moran, 2010). Many of the best athletes (e.g., Jack Nicklaus, Michael Phelps, Ronaldinho, and Chris Evert, etc.) had used the imagery technique to put great efforts into their professional careers. Many studies have proved the use of the imagery process for recovering athletes from severe injuries. Murphy, Jowdy, and Durtschi (1990) performed a survey of the participants, they reported that all of the sport psychology consultants and about 90% of Olympians selected as participants used imagery techniques in one way or the other, and 97% admitted that the method turned out to be fruitful. Orlick and Partington (1998) found in their study that 99% of Canadian Olympians used imagery. These percentages were found out to be legitimately consistent over the years.

Some case studies have focused on the magnitude of influence of imagery technique, such as one using a field-goal kicker (Jordet, 2005). Wakefield and Smith (2011)

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examined the effect of imagery on the strength performance in which they reported several advantages of using the method to improve performance along with the betterment of psychological variables, including coping with anxiety and confidence (e.g., Evans, Jones, & Mullen, 2004; Post, Muncie, & Simpson, 2012). On the other hand, many other studies focus on psychological interventions. Suinn (1997) and Seabourne, Weinberg, Jackson, and Suinn (1985) used the VMBR (Visuo-Motor Behavior Rehearsal) technique, which combines relaxation with the imagery used in skiing and karate performers. Many studies have suggested that imagery intervention has positive feedback about the usage of the method in tennis players, golfers, triathletes, swimmers, etc. It has also been noticed that any improvement notified cannot be considered due to the imagery method alone (Thelwell et al., 2010; Weinberg & Williams, 2001). A few research studies highlight the positive aspects of using imagery to improve athletes' performance (e.g., Hanton & Jones, 1999; MacIntyre & Moran, 2007; Munroe, Peter, Giacobbi, Hall, & Weinberg, 2000; Thelwell & Greenlees, 2001). Several studies were conducted in a variety of games including tennis, basketball, football swimming, track and field, golf, skiing and volleyball that have shown enhancement in the positive abilities in the athletes' performances by using imagery technique (Martin, Moritz, & Hull, 1999; Morris, Spittle, & Perry, 2004; Murphy, Nordin, & Cumming, 2008; Weinberg, 2008).

Holmes and Collins (2001), in their research, have put forward specific guidelines to implement the method more effectively, named as PETTLEP imagery programme (PETTLEP). The main aim of PETTLEP is to assist practitioners in producing functionally equivalent mental simulation. PETTLEP imagery method correlates crucial practical components that are at the heart of motor-based imagery interventions, namely physical, emotional, task, learning, environment, and perspective components. Wakefield and Smith (2012) have taken the most relevant points of the same model and provided individual-specific recommendations for practitioners. Smith, Wright, Allsopp, and Westhead (2007) tested the PETTLEP model and found enough support to include the same in training sessions for athletes. This study also discovered an essential factor that explained the use of the same clothes and surrounding environment, which players used during both training and the game, and it boosted their confidence and improvised the presentation in the game. In another study, Wright and Smith (2007) found that the PETTLEP imagery group performed better than how the traditional imagery group and the control group (physical practice) performed on a cognitive task. The obtained results support the use of PETTLEP principles to enhance the effectiveness of imagery. Later, the studies of Wright and Smith (2009) and Ramsey, Cumming, Eastough, and Edwards (2010a) provided further support for the PETTLEP approach to imagery.

Ramsey, Cumming, Edwards, Williams, and Brunning (2010b) conducted a study in which participants were instructed to perform imagery in a soccer penalty kick. Two different variations of PETTLEP imagery were used, stimulus propositions and response propositions based on surrounding environmental factors and emotions, respectively. The overall performance of the players from both groups was found to improve significantly as compared to the control group. Smith, Wright, and Cantwell (2008) identified the use of PETTLEP among the professional golfers to maximize the results compared to other golfers who had continued practicing a full quota of physical practice shots. Wright and Smith (2009) compared a traditional imagery group and a PETTLEP imagery group, which performed a strength task on a biceps curl machine while executing imagery method to ensure functional equivalence. The result indicates that the PETTLEP imagery group performed significantly better on the strength task than the traditional imagery group. Wakefield, Smith, Moran, and Holmes (2013) reviewed PETTLEP imagery research for 15 years. They concluded that most studies in this field appear to support the efficacy of PETTLEP imagery with a wide variety of tasks and populations.

In their in-depth study, Anuar, Williams, and Cumming (2018) demonstrated the impact of PETTLEP imagery (e.g., imaging in the environment), prior-observation (i.e., observing prior-imaging) and traditional imagery (e.g., imaging in a quiet room) on the ease and vividness of external visual imagery, internal visual imagery, and kinesthetic imagery of movements. Another related study focused and investigated on the elements of the PETTLEP model on the ease and vividness of imaging movement (Anuar, Cumming, & Williams, 2016, Anuar, Williams, & Cumming, 2017). The results emerged in favor of the PETTLEP imagery in comparison to the traditional imagery techniques. In addition to this, the influence of physical and environmental elements of PETTLEP imagery on its capacity to image five types of sports imagery (i.e., skill, strategy, goal, affect, and mystery) was also analyzed (Anuar et al., 2017). Moreover, it has been deduced from the results of systematic reviews and meta-analyses, which conclude that PETTLEP imagery has more advantages over the enhancement of motor performance (Collins & Carson, 2017).

In many recent studies, several researchers have been attempting to focus on the effects of PETTLEP imagery on the skill acquisition of different disciplines. Quinton et al. (2014), in their study, examined the results of a five-week

layered-PETTLEP intervention (i.e., the addition of PETTLEP elements progressively) on movement imagery ability and performance of a soccer task in children. Besides, they analyzed the potential of a sport-specific nutritional intervention to benefit as an efficient control condition. While on the other hand, the effectiveness of PETTLEP imagery on the performance of passing skills in volleyball was also assessed (Afrouzeh, Sohrabi, Haghkhan, Rowshani, & Goharrokhi, 2015). In a different study, there was an evaluation of the effects of four-week PETTLEP imagery intervention on learners' skill acquisition of standing long jump (Post, Williams, Simpson, & Berning, 2015). Moreover, the effect of PETTLEP imagery on the acquisition and retention of the short-service badminton skill was studied with an emphasis on handedness (Roshana & Bahrami, 2016). Cherappurath and Elayaraja (2017), in their study, intended to look at intensifying the new skills of young tennis players through a set of three training interventions. More recently, another study looked into the effects of PETTLEP imagery integrated with action observation on bicep curl performance. It turned out that observational aids combined with PETTLEP imagery effects on bicep curl performance (Smith, Romano-Smith, Wright, Deller-Rust, & Wakefield, 2019). Norouzi et al. (2019) determined the effects of external and internal PETTLEP imagery on a football pass skill acquisition in contrast to a control condition for improving motor learning among novice players.

Out of the many findings in the review of literature, the investigator has made a perusal of a selected few. After an extensive literature survey, the investigator narrowed down to studies that focus on the use of imagery techniques on tennis players. It was decided upon to study it as the research in this area is explicitly scarce, and especially studies on effects of PETTLEP imagery on tennis players is substantially lacking. Therefore, a new study on this research is the need of the hour and could well be a primary gateway for advanced techniques and improvements in the game. Tennis players, including professionals, may now look forward to astonishing results after incorporating PETTLEP imagery in their training. The method can be utilized by personals in diverse conditions throughout the world as the studies have also taken into consideration various environmental aspects along with other essential factors that affect the player's performance. In this study, we analyzed the tennis service performance of players through the comparison of three interventions, service-specific training (SS) group, PETTLEP imagery group (PETTLEP), combined PETTLEP imagery, and service-specific training group (Both) and control group (regular tennis practice). All seven PETTLEP components are included in this study.

Methods

Participants

The participants for this study were invited from the Ramanathan Krishnan Tennis Academy, Trivandrum, Kerala, India. Forty-four, junior male tennis players M_{age}=13.22 years, SD=0.42 (Participants in the age range of 13–14 years old), were selected for the study. Participants had a mean training background of M=4.22, SD=1.36 years. On average, they practiced tennis for one to 2 h per day. The investigator circulated the MIQ-R questionnaire to all the participants in which they scored 16 and above points, as per previous research (Smith & Collins, 2004). The participants had participated in various state-level and national-level tennis tournaments like junior ranking tournaments, inter-school tournaments, etc. All the participants were ranked under 300 in their respective national ranking category. The participants and their guardians were well informed about the training protocol, and their signed consent forms were collected. The permission to conduct this study was obtained from the Pondicherry Central University (Institute Ethics Committee-Human Studies), Puducherry, India (Table 1).

Experimental design

In this study of four groups, non-random selection, pre-test, the post-test experimental design was used. The 44 participants were equally divided (n=11) into three experimental groups (E1, E2, and E3) and a control group. The service performance outcomes of all the players were compared before and after a training session. The three experimental groups, E1, E2, and E3, were assigned with service-specific training, PETTLEP imagery, and combined service-specific training & PETTLEP imagery training, respectively, for three days per week for 12 weeks. Even though the participants showed improvement in performance during training, the involvement of various essential factors, i.e., maturation, history, and regular physical training, cannot be denied.

Procedure

After the completion of the MIQ-R questionnaire, verbal instructions were given to participants before the training schedule. The three groups were given different initial instructions, facilities, and tennis coaches who were certified by International Tennis Federation (ITF)

Table 1: Descriptive statistics and general characteristics of the subjects.

Measurements	Minimum	Maximum	Mean	SD
Age (years)	13.00	14.00	13.22	0.42
Training (years)	2.00	6.00	4.08	1.29
Body weight (kg)	42.00	64.00	49.97	5.83
Body height (cm)	141.00	173.00	157.02	8.16
BMI (kg/m^2)	18.60	22.50	20.08	0.92

Note: SD = Standard deviation, BMI = Body mass index.

for the training programme. All the participants regularly practiced the game on the synthetic tennis courts, along with the professional trainers. Service-specific training group participants were assigned with tennis-serve oriented drills designed by the investigator. The duration of the training programme was 45–60 min, thrice a week for 12 weeks.

All the participants were given imagery script and diary (to assess the participant's use of imagery intervention Smith et al. (2019) and Smith et al. (2007) made use of an imagery diary which turned out to be successful) to document every imagery session that they completed. The imagery script and its audio were created in consultation with an expert sports psychologist and was distributed a day before the commencement of the training session. This enabled the participants to come prepared before each session. The imagery script and its audio were developed in the native language to make the training more effective. The stimulus-response training was provided to the participants after the pre-test in the first session, which enabled them to be more aware of what they were experiencing in their imagery training (Lang, Kozak, Miller, Levin, & McLean, 1980; Quinton et al., 2014). The imagery training lasted 10–15 min in each session. The imagery script was comprised of all the seven key components of the PETTLEP imagery, and the players were instructed to follow it. All sessions of imagery training were performed on a synthetic tennis court (environment) with all the participants dressed in tennis-clothing along with racquet and ball (physical). Further exercise equipment such as resistance bands, light medicine balls, etc. was provided by the instructor. The participants were instructed to make their movements more authentic and realistic by incorporating natural emotions and physiological responses (task and emotion) to make the exercise more realistic and fruitful. The participants were encouraged to include their usual performance into their imagery to replicate the real tennis serving scenario as much as possible (timing and perspective). Feedback and suggestions were collected from the participants at regular intervals to know whether they wanted to make any necessary changes in the imagery script. These changes were then incorporated into the imagery script and in the subsequent imagery sessions (learning). The combined group completed three service-specific training and three PETTLEP imagery training per week, and the combined group practiced it on alternative days. The control group participants were asked to carry on with their regular tennis practice and were not involved in any specific training programme.

Measures

Movement imagery questionnaire-revised (MIQ-R): The assessment of the participant's imagery ability was done using the MIQ-R questionnaire, which had acceptable concurrent validity coefficients with both the visual 0.88 and kinesthetic 0.87 subscales, respectively (Hall & Martin, 1997). The eight-item inventory, out of which four inventories measure the individual's ability to perform kinesthetically and the remaining inventories, measure the visual imagery. The investigator initially made the participants perform specific movements and asked them to visualize the precise movement. The capability of the participants to recollect the specific movement was measured and rated as per the subject's score. Based on the previous researchers such as Callow, Hardy, and Hall (2001); Hall (2001); Smith and Collins (2004); Smith et al. (2007), the participants who

scored lower than 16 in MIQ-R were eliminated from the programme. MIQ-R analysis highly relies on an individual score of athletes, which depends on their kinesthetic and visual subscales.

International tennis number (ITN) manual on-court assessment: International tennis number (ITN) manual on-court assessment test was introduced by the International Tennis Federation to rate the level of tennis players. This assessment serves as a motivational tool to measure the improvement in accuracy and power on their keystrokes among the tennis players. The test involves the measurement of groundstroke accuracy, groundstroke depth, service accuracy, volley depth, and mobility of the players. In this study, the accuracy, power, and consistency of the service are measured. The assessment begins when the player hits 12 serves, of which three serves are to the widescreen area of the first service box, three serves to the middle area of first services box, three serves to the central area of the second service box, and three serves to the wide area of the second service box. Points are awarded based on where the ball lands on the first and second bounce. If the serve lands anywhere in the correct service box, the second service is not required, and if the service is a let, the service is repeated. Total points are calculated by adding up the points awarded for accuracy, power, and consistency of the service.

Statistical analysis

Before analyzing the data, the Shapiro–Wilk test of normality was performed on all raw data in order to recognize whether the data were normally distributed, in which case parametric inferential testing would be performed or whether the data was not normally distributed, in which case non-parametric inferential testing would be performed. The Shapiro–Wilk test of normality was performed on data pre-test, post-test, as well as on the changes between them, and all three sets of data failed the Normality test (Table 2).

To avoid multiple analysis errors, and since our dependent variables failed the normality test, the four groups were checked for differences using the Kruskal–Wallis test for multiple independent groups. In the cases that the Kruskal–Wallis test for multiple independent groups identified differences, pairwise comparisons were performed between the four groups using the Mann–Whitney U test. In order to identify any interactions, we first used the adjusted rank transform test as discussed by Peterson (2002) and followed the procedure outlined by Leys and Schumann (2010), where the data was first adjusted by subtracting the sum of the marginal mean of both tests, on a cross-tabulated table, from each observation thus isolating the interaction by removing the main effects, ranks were then assigned to the

Table 2: Tests of Normality.

	Shapiro–Wilk	
	Statistic	**p-Value**
Pre-test	0.948	0.045
Post-test	0.930	0.011
Change	0.844	0.000

adjusted observations. Finally, a factorial ANOVA was performed on the adjusted ranked data.

Results

The four groups were checked for differences in the pre-test, post-test as well as for the changes between them using the Kruskal–Wallis test for multiple independent groups. In pre-test, no statistically significant differences were identified (χ^2=2.32, p=0.509) whereas in post-test, statistically significant differences were identified (χ^2=29.084, p<0.001) as well as in the changes between pre-test and post-test (χ^2=30.159, p<0.001). Given that the Kruskal–Wallis test for multiple independent groups identified differences in post-test data as well as on data on changes between pre-test and post-test, pairwise comparisons were performed between the four groups in post-test data (Table 3) as well as for data on changes between pre-test and post-test (Table 4) using the Mann–Whitney U test. For post-test data, differences between the service-specific training group and the PETTLEP training group were found to be significant (MWU=17, p=0.003) between the service-specific training group and the group with both trainings were found to be significant (MWU=20.5, p=0.007), between the service-specific training group and the control group were found to be significant (MWU=9, p<0.001), between the PETTLEP training group and the group with both trainings were found to be significant (MWU<0.001, p<0.001) and finally between the control group and the group with both trainings were found to be significant (MWU<0.001, p<0.001). For changes between pre-test and post-test differences between the service-specific training group and the PETTLEP training group were found to be significant (MWU=11, p=0.001), between the service-specific training group and the group with both trainings were found to be significant (MWU=19.5, p=0.005), between the service-specific training group and the control group were found to be significant (MWU=10.5, p<0.001), between the PETTLEP training group and the group with both trainings were found to be significant (MWU<0.001, p<0.001) and finally between the control group and the group with both trainings were found to be significant (MWU<0.001, p<0.001) (see Figures 1–3).

Since for post-test data as well as data for changes between pre-test and post-test, the differences between the PETTLEP group and the control group were not statistically significant whereas the differences between the control group and the group of players with both SS and PETTLEP were extraordinarily significant and even more significant than the differences between the SS group and the control

group, we performed an analysis for the interaction of the two tests using the adjusted rank transform test followed by a factorial ANOVA. This gave us a significant interaction (F=12.58, p=0.001), meaning that the impact of SS is significantly higher when PETTLEP is also applied. The partial effect sizes were calculated as η^2=0.24, and the power to detect the effect was 0.935.

Discussion

This study showed significant changes in the service-specific training group and the combined group. In the case of comparison between the groups, the combined group showed better improvement in service performance than the PETTLEP imagery group, service-specific training group, and control group. The combined group improved more than the other groups (service-specific, PETTLEP imagery, and control group), with service-specific and PETTLEP alone showing less improvement in comparison. The control group displayed no changes at all.

Some studies have found that imagery and physical practice both improve the athlete's performance equally (Driskell, Copper, & Moran, 1994; Hinshaw, 1991) but our study concluded that the combination of both imagery and physical training could improve both the physical

Table 3: Pairwise comparisons of the four groups in post-test data using the Mann–Whitney U test.

	PETTLEP	Both	Control
SS	MWU=17.00, p=0.003	MWU=20.50, p=0.007	MWU=9.00, p<0.001
PETTLEP	–	MWU<0.001, p<0.001	MWU=53.50, p=0.652
Both	–	–	MWU<0.001, p<0.001

Note: SS = Service-specific training, MWU = Mann–Whitney U test.

Table 4: Pairwise comparisons of the four groups in changes between pre-test and post-test data using the Mann–Whitney U test.

	PETTLEP	Both	Control
SS	MWU=11.00, p=0.001	MWU=19.50, p=0.005	MWU=10.50, p<0.001
PETTLEP	–	MWU<0.001, p<0.001	MWU=50.50, p=0.519
Both	–	–	MWU<0.001, p<0.001

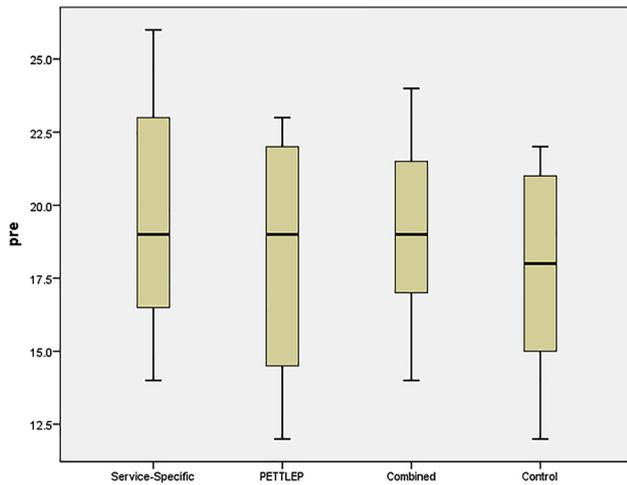*Note:* S = Service-specific training, MWU = Mann–Whitney U test.

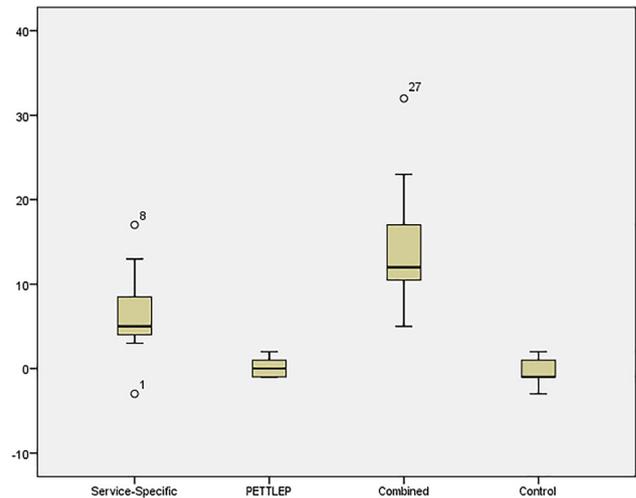**Figure 1:** Boxplot for the player's performance for the four groups pre-test.

Figure 3: Boxplot for the player's performance for the four groups for the change between pre-test and post-test.

strength and performance of the players far better than the imagery or physical practice alone. The findings of the present study supported by Post et al. (2015) shows that physical practice plus imagery and physical practice group significantly outperform the control group and the group with imagery practice alone. Combining physical practice and mental practice is better than physical practice alone if the mental component takes time away from the physical practice, as reported by Hird Landers, Thomas, and Horan (1991). Based on a previous study, Norouzi et al. (2019), in their research, found that the most significant improvement in football pass skill performance resulted when external PETTLEP imagery was combined with physical practice. Finn, Grills, and Bell (2009) found that a combination of PETTLEP imagery and physical

Figure 2: Boxplot for the player's performance for the four groups post-test.

practice had a significant impact on the acquisition of kicking accuracy. Afrouzeh et al. (2015) and Smith et al. (2007) supported that the combination of PETTLEP imagery with physical practice could have better improvement than traditional imagery with physical practice. PETTLEP imagery without the combination of any physical practice has a significant impact on the acquisition of sport-specific skills. The research found that there is no significant change occurred in tennis service through PETTLEP imagery alone. This result is consistent with earlier research, which also shows the ineffectiveness of imagery alone in novices for acquiring motor tasks (Gomes et al., 2014; Post et al., 2015; Smith & Collins, 2004; Smith & Holmes, 2004; Smith et al., 2007).
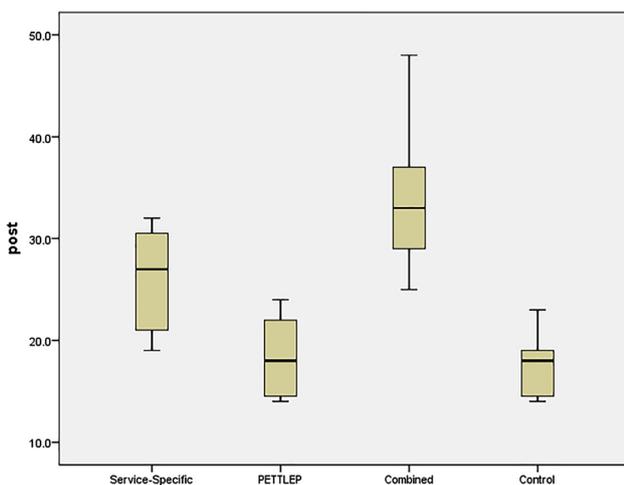
The study focused on junior level tennis players. After 12 weeks of training, the player's ability to service and perfection improved. A sudden change in the performance may be due to the quick learning of the novice players. The participants were in their growing age with pubertal modifications in their bodies with both mental and physical development. Pubertal changes and growth hormone secretion may have an additional positive effect on the performance. Hall (2001) suggested the benefits of imagery method to novice athletes with fast improvement in the game. According to Weinberg & Gould, 2014, novice and highly skilled performers who used imagery on cognitive tasks showed the most positive effects. Several studies conducted on children and adolescents have pointed out that they do use the imagery in sports contexts. The results of the current research as well are in line with those of previous intervention studies which show that PETTLEP imagery has had a positive effect on the motor and learning performance of novice athletes (Afrouzeh et al., 2015;

Anuar et al., 2016; Cherappurath & Elayaraja, 2017; Collins & Carson, 2017; Norouzi et al., 2019; Simonsmeier & Buecker, 2017; Simonsmeier, Frank, Gubelmann, & Schneider, 2018; Smith et al., 2007; Wakefield & Smith, 2009). Moreover, it might be one of the reasons behind the success of the present study.

Another possible reason for the success of the PETTLEP imagery with the service-specific training group would be that the researcher included service practice and specific drills in training. Also, a similar script (service and exercises) was added to the PETTLEP imagery training. The combined group had a better change due to the influence of PETTLEP imagery performed in a similar environment. The specific method helped to perform relevant postural adjustments and imagination of the skill through kinesthetic sensation before the execution of skill physically, which can be an additional significant reason for the great success of the combined group while their body is responding positively towards the feedback and functional equivalency of the kinesthetic sensation. One of the key factors, the kinesthetic sense, was explained by Callow and Waters (2005) and stated that kinesthetic imagery significantly improved the confidence and the performance of flat race jockeys. Kinesthetic sense plays a crucial role in the enhancement of the players' sports performance. It involves all the body senses of the player that contributes to enhanced performance in the game by creating intensified figures to make it more realistic (MacIntyre & Moran, 2010; Moran & MacIntyre, 1998).

Motivation and self-confidence have a crucial role in maximizing tennis service performance in novice players. The significant difference between the performance of combined, individual, and control group was affected by numerous factors, regular exercise, and drilling during a training session within a specific period. Individual groups completing service-specific training or PETTLEP imagery training might cope with difficulties in their performance as they were not involved in combined mental and physical parameters while practicing. The issue was not considered as one of the parameters during the study (Pre or Post). Therefore, due to a lack of evidence, the statement could not be further proved by the investigator.

The long duration of the training programme has played a vital role in effective results when compared to a short period of the training programme. The training was conducted on three days per week for 12 weeks duration and implemented a service-specific training programme and combined sessions. Wakefield and Smith (2012) practiced imagery training on the players and showed a positive impact on the strength and routine of the players during the game. They divided players into three different groups and assigned each group to practice for once, twice, and thrice in a week, respectively, and compared the results. In the analysis, the players achieved better performance that practiced for thrice/week compared to twice/week and once/week training groups. Wright and Smith (2007) also support the theory of an elongated period for training sessions to achieve the goal. Finn et al. (2009) conducted a study on football kicking on target three times a week for six weeks that highly influenced the performance. More recently, a few researchers in their study indicated that (e.g., Norouzi et al., 2019; Post et al., 2015; Smith et al., 2019) short duration of PETTLEP imagery training creatednote-worthy results in the performance. Further research must be done on a particular method to find how long-duration PETTLEP imagery training influences performance.

There are several limitations to the present study, which should subsequently be addressed. First, there were only limited participants available in the study. However, these were enough to achieve statistical significance in the hypothesis testing, and future work could benefit from more participants that would also enable the use of more parameter testing. It could reveal more significant detail in the underlying factors of performance improvement when comparing training methods. Although potential participants were excluded from the study if they scored lower than 16 on either the kinesthetic or visual subscales of the MIQ-R, random allocation to training groups can be conducted according to imagery ability to reduce imagery ability bias in any one group. Moreover, participants' imagery ability could have been re-tested during post-tests to monitor any changes in imagery skill. Second, although participants were beginner tennis players and randomly assigned to training groups, the researchers could have intensified the group allocation process.

Conclusions

In conclusion, the present study provides evidence that PETTLEP imagery can be used effectively in combination with service-specific training to enhance tennis service performance. The main findings of this study suggest that PETTLEP imagery is an effective method for improving players' performance and the perfection of skills. Most of the evidence showed that the more functional equivalent imagery interventions provide more impressive results compared to less functional equivalent intervention. The limitations of this study may have restricted our capacity to illuminate the potential of PETTLEP imagery in improving performance in closed-skill tasks like tennis service

performance. However, coaches should consider PETTLEP imagery with physical practice (specific) to be another tool in their armory. PETTLEP imagery with physical practice (specific) could provide an effective and novel tool to help coaches impact on the area of performance. Future research could examine the PETTLEP imagery on different skills in tennis as well as in different sports or compare the effects across gender, age group, and abilities.

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