Hong Kong Physiotherapy Journal
Vol. 44, No. 1 (2024) 29–37
DOI: 10.1142/S1013702524500021

Hong Kong Physiotherapy Journal
https://www.worldscientific.com/worldscinet/hkpj

Effectiveness of motor imagery on sports performance in football players: A randomised control trial

Jaruwan Prasomsri[1,*], Bunthita Thueman[2], Pichamon Yuenyong[3], Chayanon Thongnoon[4], Naruepa Khophongphaibun[5] and Suppakorn Ariyawatcharin[6]

[1]*Physical Therapy Department, Faculty of Medicine Prince of Songkla University, 15 Karnjanavanich Road Hat Yai, Songkhla 90110, Thailand*

[2]*PSpine Clinic, Don Mueang, Bangkok 10210, Thailand*

[3]*Physical Therapy Department, Trang Ruampat Hospital, 61/39 Kokkhan Road Tambon Thap Thiang, Amphoe Mueang Trang, Trang 92000, Thailand*

[4]*PT Prachuap Football Club, Prachuap Khiri Khan 77000, Thailand*

[5]*Private Physical Therapy Clinic Bangkok 10210, Thailand*

[6]*Physical Therapy Department, Trang Hospital 69 Khuan Han Road, Tambon Thap Thiang, Mueang Trang District, Trang 92000, Thailand*

**jaruwan.pr@psu.ac.th*

Received 25 October 2021; Accepted 30 July 2023; Published 25 August 2023

Background: Nowadays, the development of training programs for speed, agility and reaction time responses in football players is increasing widely. Motor imagery is a new method that uses collateral with

*Corresponding author.

physical training. However, there is still a scarcity of evidence concerning the addition of motor imagery protocol to routine training programs.
Objective: The main objective was to compare speed, agility and reaction time after motor imagery training in university athletes and amateur athletes who received and did not receive motor imagery training for 2 weeks.
Methods: Participants were divided into 4 subgroups as follows: university athlete group with motor imagery training and control group, amateur athlete group with motor imagery training and control group. This study collected the training effects of speed, agility and reaction time. The Wilcoxon signed-rank test and the Mann–Whitney U test were selected to analyse the differences within and between groups, respectively.
Results: The result presented positive changes in all variables after training sessions for 2 weeks in all groups. Speed at 20 m, agility, and reaction time were found to be significantly different after motor imagery training in both university athletes and amateur athletes.
Conclusion: This finding demonstrated that the addition of the motor imagery training along with routine physical training promotes physical performance in athletes at all experience levels. In further studies, the retention effect after practice should be considered.

Keywords: Athletic performance; experience level; footballs; motor control; motor imagery.

Introduction

Football or soccer, a team sport, is the world's most popular ball game. Competitions are held at international, regional and national levels, thus, the level of competition could be the representation of the level of player's experience. Many studies also used the level of competition as a criterion of professional and amateur athlete groups.[1] Football skills such as running with the ball, first touch and striking the ball are required for ball control. These skills need speed, agility, strength and power. During the game, proper and effective decision-making is also needed.[2] Football is arranged as an open skill sport in which players are required to react in a dynamically changing, unpredictable and externally paced environment. Therefore, training programs that promote these sports skills emphasise motor performance together with neuromuscular function.[3] Nowadays, the development of training programs for speed, agility and reaction time responses in football players is increasing widely. Motor imagery (MI) is a new method that uses collateral with physical training.[3] This method is defined as "using all the senses to re-create or create an experience in the mind". Both motivational and cognitive functions are needed to experience specific sports skills and to plan strategies in the game.

MI training is well-established in sports, where athletes frequently utilise it to enhance performance during regular training or following sport-related injuries that require immobilisation.[4] Motor imagery is widely adopted in various sports disciplines, including swimming, baseball, basketball, and football. Reports indicate that MI offers several advantages, including increased self-awareness, self-confidence, facilitation and maintenance of skills, arousal control, emotional regulation, and improved preparation strategies. Including decreased response times, improved agility, and enhanced performance in tasks requiring speed and accurate responses, such as in volleyball, football, or team sports.[4] Additionally, MI has been shown to promote learning and performance of motor skills,[5] especially in open skill sports such as football. For these sports, external imagery is often utilised, where players visualise themselves from a third-person's perspective, rather than using internal imagery.[6–8]

According to Chiewchanpreechakul, the level of a player's experience is also a factor that influences MI training.[9] Hence, considering the level of experience is necessary as it may affect the results of the MI training program. Montuori *et al.* suggested that mental and physical practices shared the same neural circuit. Thus, both practices should be considered in training programs for enhancing sports performance. Improvement of sports performance in swimmer athletes was shown after engaging in physical and mental practice in their program. However, this was a finding in closed sport skills.[10] At present, there is an increasing number of studies concerning the effect of MI in athletes around the world.[7,8] In Thailand, MI was implemented as a motor relaxation program for football players before training sessions, and it was found to help athletes increase their focus during training.[11]

There is still a scarcity of evidence concerning the addition of MI protocol to routine training programs. Existing evidence about MI still needs to explore the dimension of experience level that affects MI. However, recent studies have reported on the effects of MI combined with physical practice on sports performance in a variety of protocols. Therefore, to the authors' knowledge, no study has reported clearly regarding the impact of additional MI on sports performance among football athletes at different experience levels. Thus, this study aimed to investigate the effect of MI on sports perforamance in speed, agility and reaction time in university athletes and amateur athletes who received and did not receive MI training for 2 weeks.

Methods

This is an experimental research study. Football athletes aged 18–25 years were recruited. The sample size was calculated using Gpower 3.1 software, considering a medium effect size of 0.25 and a power of 0.95. The total number of participants required for the study is 47. Twelve athlete subjects were needed per group, in the university athlete group with MI training and control group, and the amateur athlete group with MI training and control group, according to the sample size calculation.

All participants gave written informed consent. The experimental protocol was approved by the Ethics Committee for Human Research, Faculty of Medicine, Prince of Songkla University on January 17, 2019 (Certificate No. REC 61-348-30-2) and has been registered with the Thai Clinical Trials Registry under the ID TCTR 20230128001. This study was carried out at the Physical Therapy Department, Faculty of Medicine, Prince of Songkla University, Songkhla, Thailand. The study was conducted in compliance with the Declaration of Helsinki and the local ethics committee.

The inclusion criteria were male football players aged between 18 and 25 years old, score of the Movement Imagery Questionnaire-3 (MIQ-3) more than 62.28. In this study, MIQ-3 was used to evaluate the capacity of individual's ability to imagine our movements. For the university athlete group, participants had to attend inter-university sports or higher level competition and be a member of the university football team. In addition, in the amateur athlete group, participants had to attend only in-university sports events. The exclusion criteria were visual, neurological, cardiopulmonary or musculoskeletal impairments which affect MI training and intake of medicines with neurological effects 2 days before participating in the study. Termination criteria were applied on participants that were required to discontinue the training program if they suffered any injuries which rendered them unable to continue the training program.

In this study, only one researcher conducted all tests, and there were four researchers who trained participants in each group. All of them were blind to the group allocation. Inter-rater reliability was calculated before data collection, there was high reliability (ICC > 0.8, 95% CI, p-value < 0.05) between the tester and experienced coach in 10, 20, 40 m. speed test and agility test. Reaction time test was detected by reaction time tester produced by an engineer and accuracy was tested by computer program. University and amateur athletes who met the inclusion criteria were randomised into two groups: the control group and the MI training group. Each participant, both university and amateur athletes, was assigned to their respective training condition using simple random sampling (without replacement). This was done by picking a piece of paper that indicated their training condition. Therefore, in this study, we had 4 training groups comprising university athletes with control and MI, and amateur athletes with control and MI.

All participants were measured for speed followed by 10, 20, 40 m speed test, agility test and reaction time test for the baseline data. Speed was tested by running a single maximum sprint over a set distance with time recorded. Agility was measured using the T-Test, a running test that involves sprinting forwards, shuffling to the left, shuffling to the right, shuffling back to the left, and then running backward to return to the start/finish line. The total time taken to complete the test was recorded. Reaction time was detected by reaction time tester through eye–foot coordination, the best value was recorded after 2 times recording. In the reaction time test, participants were asked to sit on a chair with their hips, knees, and ankles flexed at a 90-degree angle. The setup consisted of a light monitor presenting the stimulus and foot switches attached to the foot pedal. Their dominant foot was placed next to the foot pedal. When a red light was presented on the monitor, participants were instructed to use their dominant foot to push the foot pedal as fast as possible.

All groups received training according to the specific condition of the group. All of the participants received information about the whole process of this study prior to signing the informed consent and the researcher started with baseline data collection. The speed, agility, and reaction times were measured to serve as baseline data in all groups. After baseline data were measured, participants received training appropriate to the specific condition of the group. Training sessions took place in a silent room with a controlled environment which was the same for every session. According to the PETTLEP approach to MI, participants should be in a relaxed state throughout the MI training for the most effective results.[12] Therefore, in this study, we measured the physiological responses to ensure that participants were in a relaxed state. Participants were asked to sit in a comfortable position and baseline physiological response as heart rate, skin conductant, respiratory rate and blood pressure was measured before training. The skin conductance test was used to detect changes in the electrical conductance of the skin. For this test, two electrodes were placed on the middle and index fingers of the dominant hand to measure sweat gland activity, which represents the functioning of the sympathetic nervous system. If participants were found to be in an excited or other inappropriate state, they were asked to rest until their physiological response variables returned to their relaxtion baseline.

According to the systematic review on the effectiveness of MI on sports performance, the intensity of training sessions ranged from 5 to 42 sessions over a period of 1 to 7 weeks.[4] However, the most common and effective number of training sessions was 12. Additionally, for more effective MI, the training sessions should be performed continuously.[13] Hence, we decided on a training program consisting of 12 sessions consecutively. The training session in all groups was 6 days per week for 2 weeks. In the control group, participants were asked to watch a video clip that consisted of natural pictures and relaxing music for 3 and 15 min, respectively. On the other hand, in the MI group, participants were asked to watch the video clip that consisted of football technique practice in speed and agility training for 3 min and they were asked to imagine that they were playing in the practice using these techniques for 15 min. The video clip of football techniques was filmed under the control of the Trang provincial football team coach and team athletes demonstrated the techniques. The speed, agility, and reaction times of all participants were measured at the end of the second week of training.

Before measuring the speed, agility, and reaction times, the researcher demonstrated the procedure of the test to the participants and allowed them to practice 3 times. All groups received a logbook to record their physical training for 2 weeks during the study. The number of practice repetitions was left up to the participant, and the participants recorded the number of practice runs themselves.

For the statistical analysis, normal distribution was tested using the Shapiro–Wilk test. The baseline characteristics data and time variables (speed, agility and reaction times) were analysed via the Mann–Whitney U test. Moreover, the Mann–Whitney U test and the Wilcoxon Signed Ranks test were selected to analyse the differences between and within groups, respectively. Statistical significance was set at a p-value of < 0.05.

Results

The aim of this study was to investigate the effect of MI on sports performance, specifically speed, agility, and reaction time, in football players, both university players, and amateur players. The training program was conducted 6 days a week for 2 consecutive weeks. A total of 55 participants who met the inclusion criteria were recruited for the study and provided signed consent forms. However, only 48 participants completed both the practicing and testing phases. The remaining 7 participants were excluded from the study; three due to ankle or knee injuries sustained during routine practice, and four due to their failure to complete the training sessions.

All participants were males, aged between 18 and 22 years old, and engaged in physical practice routines of 2–5 days per week for university players and 2–5 days per month for amateur players. In the university players, the intensity of physical practice was relatively in line with the routine training

Table 1. Baseline characteristics.

Variables	University football team athletes ($n = 24$)		Amateur athletes ($n = 24$)	
	Motor imagery gr. ($n = 12$)	Control gr. ($n = 12$)	Motor imagery gr. ($n = 12$)	Control gr. ($n = 12$)
BMI[a] (kg/m^2)	20.85 (19.05, 22.85)	22.3 (20.13, 23.68)	23.6 (21.4, 26.68)	22.7 (20.55, 24.95)
p-value	0.371		0.488	
Speed 10 m[a] (s.)	2.03 (1.76, 2.2)	1.91 (1.8, 2.15)	2 (1.94, 2.18)	2.09 (1.92, 2.22)
p-value	0.623		0.665	
Speed 20 m[a] (s.)	3.52 (3.31, 3.68)	3.34 (3.24, 3.47)	3.85 (3.41, 3.94)	3.59 (3.24, 4.02)
p-value	0.193		0.488	
Speed 40 m[a] (s.)	6.02 (5.63, 6.19)	5.77 (5.56, 5.96)	6.47 (5.87, 6.63)	6.13 (5.76, 6.47)
p-value	0.193		0.355	
T-test[a] (s.)	12.28 (11.56, 13.25)	12.35 (11.86, 12.84)	13.14 (12.78, 14.33)	12.64 (11.44, 13.82)
p-value	0.773		0.299	
Reaction time[a] (ms.)	333 (282.5, 376)	348.5 (298.25, 400.5)	329.5 (304.75, 377.5)	323 (312.25, 412.75)
p-value	0.452		0.564	

Notes: a = median (Q1, Q3). analysed via the Mann-Whitney U test, *p-value < 0.05.

program planned by their coach. In contrast, the physical practice routine for amateur players was dependent on their comfortable timetable. During the training sessions, the physiological responses of participants were monitored. All participants demonstrated a state of relaxation, as evidenced by stable heart rate, skin conductance, respiratory rate, and blood pressure, with no reported discomfort or harmful situations during training.

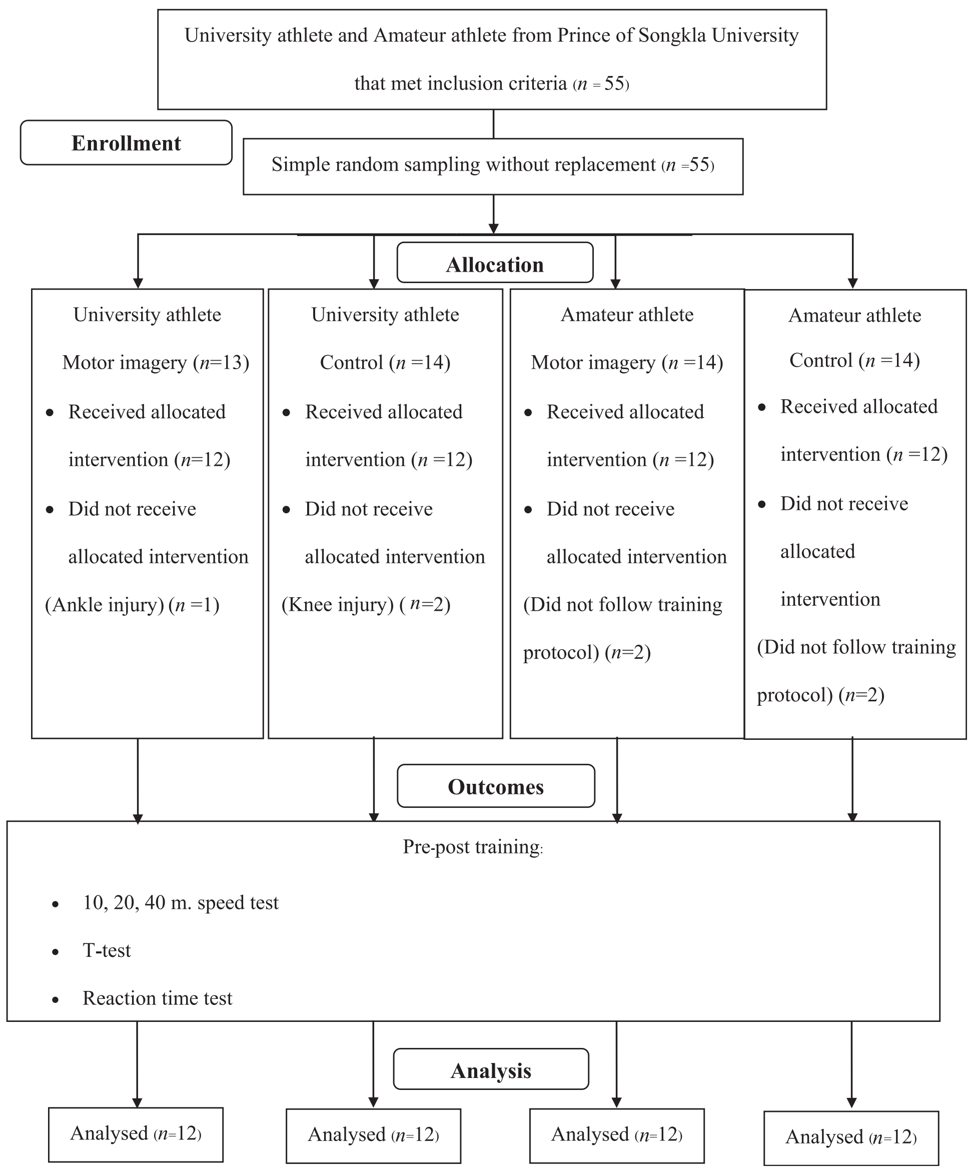
As presented in Table 1, the baseline data (median and quartiles 1 and 3) did not show any significant differences between the training groups with a p-value < 0.05. Comparisons were made within the university and amateur players' groups and between the training conditions within each group. The training results, including speed, agility, and reaction time, are presented in Table 2, which displays the comparison of these variables within and between the training groups.

Table 2. Comparison of speed (10, 20, 40), agility and reaction time within and between subgroups.

Variables	University football team athletes ($n = 24$)					Amateur athletes ($n = 24$)				
	Motor imagery gr. ($n = 12$)		Control gr. ($n = 12$)			Motor imagery gr. ($n = 12$)		Control gr. ($n = 12$)		
	Pre	Post	Pre	Post	*p*-value[b]	Pre	Post	Pre	Post	*p*-value[c]
Speed 10 m[a] (s.)	2.03 (1.76, 2.2)	1.94 (1.72, 2.02)	1.91 (1.8, 2.15)	1.98 (1.85, 2.11)	0.203	2 (1.94, 2.18)	2.06 (1.84, 2.16)	2.09 (1.92, 2.22)	2.2 (1.96, 2.45)	0.106
p-value[d]	0.48		0.844			0.48		0.114		
Speed 20 m[a] (s.)	3.52 (3.31, 3.68)	3.19 (3.06, 3.22)	3.34 (3.24, 3.47)	3.2 (3, 3.29)	0.954	3.85 (3.41, 3.94)	3.3 (3.09, 3.34)	3.59 (3.24, 4.02)	3.37 (3.23, 3.81)	0.248
p-value[d]	0.012*		0.012*			0.003***		0.062		
Speed 40 m[a] (s.)	6.02 (5.63, 6.19)	5.82 (5.58, 6.06)	5.77 (5.56, 5.96)	5.64 (5.55, 6.01)	0.470	6.47 (5.87, 6.63)	6.03 (5.87, 6.34)	6.13 (5.76, 6.47)	6.41 (6.02, 6.72)	0.126
p-value[d]	0.410		0.965			0.326		0.055		
T-test[a] (s.)	12.28 (11.56, 13.25)	11.24 (10.94, 11.95)	12.35 (11.86, 12.84)	11.52 (11.03, 12.73)	0.26	13.14 (12.78, 14.33)	12 (11.57, 12.83)	12.64 (11.44, 13.82)	12.18 (11.23, 13.41)	0.729
p-value[d]	0.006**		0.209			0.003***		0.308		
Reaction time[a] (ms.)	333 (282.5, 376)	286 (265, 345.5)	348.5 (298.25, 400.5)	326 (267.5, 351.5)	0.643	329.5 (304.75, 377.5)	299.5 (264, 335)	323 (312.25, 412.75)	294.5 (268.5, 355.5)	0.644
p-value[d]	0.041*		0.158			0.041*		0.065		

Notes: Pre = Pretraining, Post = Post-training, a = median (Q1, Q3), b = p-value between post-training of University football team athletes analysed via the Mann-Whitney U test, c = p-value between post-training of Amateur athletes analysed via the Mann-Whitney U test, d = p-value within subgroup analysed via the Wilcoxon Signed Ranks Test, *p-value < 0.05, **p-value < 0.01, ***p-value < 0.005.

Consort flow diagram



In the university groups, the improvement between the MI and control groups did not reach a significant level of difference. However, when comparisons were made between pre- and post-training measurements, significant differences were detected in the MI training group for speed at 20 m, agility, and reaction time. In the control condition of the university group, only speed at 20 m showed a significant improvement after 2 weeks of training.

For the amateur groups, no significant difference was detected between the MI and control training groups at the end of week 2, similar to the university group. However, the improvement after training was demonstrated in the MI training group for speed at 20 m, agility, and reaction time. The control group of the amateur players showed no enhancement in physical performance after training in all measurements.

Conclusion

In this study, we found that, in all MI groups, sports performance improved significantly more than in the control group. This finding demonstrates that MI can enhance sports performance at both levels of experience. Physiological responses during the training of all participants indicated that they were in a relaxed state. Increasing the work of the parasympathetic nervous system will provide an influence to enhance the performance of MI.[14,15] Therefore, this may have ensured that during the training sessions, all of our participants were engaged with their training protocol.

Time of speed at 20 m was decreased significantly in MI groups at both levels of experience, university football team athletes and amateur athletes, at p-values 0.012 and 0.003, respectively, and also in the control group of university football team athletes at p-value of 0.012. However, speed at 10 and 40 m presented no significant difference after training in all groups. Little *et al.* suggested that the performance of speed tests at different distances also requires common physiological and biomechanical factors in football players.[16] Improvement after training found only at 20 m could derive from specific qualities of acceleration and maximum speed required during the game at approximate average distance, 17 m, which is close to the 20 m tested. So, players may apply the MI method to their performance requirement more effectively than at other distances. Additionally, for routine training of the university football team, athletes were to be fast at 20 m.

In this study, T-test time represented agility performance and reaction time and was significantly different after receiving MI training at p-values 0.006 and 0.003 in university football team athletes and amateur athletes, respectively. However, there were no differences detected in control groups in both university and amateur teams. Fekih *et al.* found that male tennis players who received MI-based training program presented significantly reduced agility, speed, and reaction time performance compared with the control group.[17] McNeil *et al.* studied reactive agility performance, which is the athlete's perceptual and response time performance, in female athletes who engaged in imagery training. They found that imagery training improved Stimulus-Decision Time and Stimulus-Foot performance compared with the control condition. On the other hand, physical training only showed improvement in decision time components and overall reactive agility performance.[18] This is similar to our finding that MI training promotes the improvement of agility and reaction response in athletes at different levels of experience.

Motor imagery in sport perspective is the main section of mental training.[19] This stimulates sensations and other types of experiences that contribute to improving motor performance.[20] During MI performance, participants need to visualise target action and kinesthetic imagery, including the force and effort perceived during movement. Their attention during MI performance may contribute to the connection between their exteroceptive effects and movements.[20] So, skill acquisition, motivation and performance were seen to be improved.[19] In this study, we detected the physiological response during the training of all participants to assure that they were in a state of relaxation and engaged with motor imagination.

The physical improvements that can be detected after MI practice could be explained by the activity in the brain. Previous studies that assessed brain activity reported increased cerebral blood flow in non-primary motor regions of the cerebral cortex during imagery, without evidence of activating the primary motor cortex. These findings support the idea that MI can activate brain activity associated with movement. Additionally, one of the pathways of MI involves learning through closed conditions of practice where movement patterns are predictable. Studies have reported that nerve signalling in the brain, especially in the frontal lobe, is stimulated during MI performance, as detected via brain imaging.[13,21] Therefore, movement performance can be enhanced through this pathway of signalling, even without motor execution.[13] During MI performance, optimal synaptic linkages are stimulated, and this area is responsible for agility ability during movement.[21] Thus, this study's findings are consistent with the improved agility ability seen in both groups after receiving MI training. Furthermore, frequent practice helps speed up and organise signal transmission through the corticospinal tract to the target limbs.[13] As a result, the improvements observed in this study may be attributed to the training program arranged 6 days a week consecutively.

According to Schmid's Schema Theory, during physical practice, both planning and modifying movement performance are required. The cognitive stage, the first stage of motor learning, consists of MI process. Leaners must work to understand and pay attention to the movement's aim of how they have to move.[22] Therefore, MI has affected the planning process before real movement occurs. This method encourages and/or creates a mental plan during physical practice, so it helps in the storage and retention of that movement and also accelerates the learning process.[23]

Speed, agility and reaction response are also required in the performance of an individual in pushing forward or moving the whole or a part of body in the space in the shortest possible time.[23] Thus, the shorter planning time influences the shorter time of performing the movement. Speed and agility test method that we used in this study also fixed the procedure of testing. So, significant improvement of speed and agility detected in athletes at both levels of experiences who received MI training may result from this linkage. Reaction time consists of premotor time and motor time. According to the process of MI, premotor time must be improved after training, so the time of reaction response in this study was found to decrease after training. Speed and agility consist of the process of reaction response.[23] Thus, the time of speed, agility and reaction decreased significantly after MI training. This study showed that even at different levels of experience, MI can enhance the sports performance of football players in aspects of speed, agility and reaction response which is one of the manifested factors for athletes to win competitions. Motor imagery is valuable for training and rehabilitation to facilitate their performance. In sport skill training methods, MI is used as a supplementary method for learning sport skills without physical movement or together with them. This technique involves lower costs and no harmful side effects. However, MI enhances sports performance, but not sufficiently to replace physical practice. According to Gentili *et al.* after physical practice, motor performance was higher than after mental practice.[24] The shortness of the planning process time is important but physical performance of movement is also important. Both physical and mental performances are required for sport skills. Moreover, a combination of mental and physical practice has the highest impact on learning and mental practice has a higher effect than only physical practice.[23]

In this study, after 2 weeks of training, with the time of speed at 20 m, agility and reaction time test decreased significantly in university athlete groups and amateur athletes who received MI training compared to the control group. This finding demonstrates that MI can enhance sports performances at both levels of experience. MI should be integral to routine training and even form part of the rehabilitation process. This study investigated only the training effects of MI in terms of speed, agility and reaction time, so the retention effect after practice remains unknown. In further studies, the retention effect after practice should be considered.

Conflict of Interest

The authors have no conflicts of interest relevant to this paper.

Funding/Support

This study was supported by a scholarship from the Faculty of Medicine of Prince of Songkla University.

Author Contributions

All authors were actively involved in the planning and design of this study. CT carried out all the measurements, ensuring accurate data collection. PT, PY, NK, and SA administered the treatments in their respective groups, ensuring the proper execution of the intervention. The analysis of the data and the initial drafting of the manuscript were a collaborative effort involving all authors. The manuscript was critically reviewed and refined for publication by JP, who contributed to its intellectual and editorial enhancement. All authors contributed significantly to the development and completion of this work.

Acknowledgements

We would like to express our deep gratitude to all participants in this study for their cooperation. We would also like to extend our thanks to the International Affairs Officer, Faculty of Medicine Prince of Songkla University for their help in improving the language of this manuscript.

References

1. Swann C, Moran A, Piggott D. Defining elite athletes: Issues in the study of expert performance in sport psychology. Psychol Sport Exerc 2015; 16:3–14.
2. Kemarat S. Profiles of anthropometric, body composition and motor fitness in Thai youth futsal players. Bangkok: Department of Physical Education, 2014.

3. Ribeiro J, Madeira J, Días C, Ross-Stewart L, Corte-Real N, Fonseca A. The use of imagery by Portuguese soccer goalkeepers. J Imag Res Sport Phys Act 2015;10:11–7.
4. Morone G, Ghanbari Ghooshchy S, Pulcini C, Spangu E, Zoccolotti P, Martelli M et al. Motor imagery and sport performance: A systematic review on the PETTLEP model. Appl Sci 2022; 12(19):9753.
5. Parnabas VA, Parnabas J, Parnabas M, Parnabas AM. Internal and external imagery on sports performance among swimmers. Eur Acad Res 2015;11:14735–41.
6. Yu Q-H, Fu ASN, Kho A, Li J, Sun X-H, Chan CCH. Imagery perspective among young athletes: Differentiation between external and internal visual imagery. J Sport Health Sci 2016;5:211–8.
7. Guillot A, Desliens S, Rouyer C, Rogowski I. Motor imagery and tennis serve performance: The external focus efficacy. JJ Sports Sci Med 2013;12:332–8.
8. Robin N, Dominique L, Toussaint L, Blandin Y, Guillot A, Her M. Effect of motor imagery training on service return accuracy in tennis: The role of imagery ability. J Sport Exerc Psychol 2007;5:177–88.
9. Chiewchanpreechakul T. The study of imagery of Thai karatedo players. J Phys Educ 2013;16:44–54.
10. Montuori S, Curcio G, Sorrentino P, Belloni L, Sorrentino G, Foti F et al. Functional role of internal and external visual imagery: Preliminary evidences from pilates. Neural Plast 2018;2018:1–8.
11. Channarongsak T. The effects of imagery relaxation training upon heart rate variavility. Bangkok: Srinakharinwirot University, 2011.
12. Holmes PS, Collins DJ. The PETTLEP approach to motor imagery: A functional equivalence model for sport psychologists. J Appl Sport Psychol 2001;13(1):60–83.
13. Cameron MH, Monroe L. Physical Rehabilitation — E-Book: Evidence-based Examination, Evaluation, and Intervention. UK: Elsevier Health Sciences, 2007.
14. Pearson J, Naselaris T, Holmes EA, Kosslyn SM. Mental imagery: Functional mechanisms and clinical applications. Trends Cogn Sci 2015;19:590–602.
15. Morris T, Spittle M, Watt AP. Imagery in Sport. United Kingdom: Human Kinetics; 2005. pp. 29–56.
16. Little T, Williams AG. Specificity of acceleration, maximum speed, and agility in professional soccer players. J Strength Cond Res 2005;19:76–8.
17. Fekih S, Zguira MS, Koubaa A, Ghariani I, Zguira H, Bragazzi NL et al. The impact of a motor imagery-based training program on agility, speed, and reaction time in a sample of young tennis athletes during ramadan fasting: insights and implications from a randomized, controlled experimental trial. Nutrients 2020;12:1–14.
18. McNeil D, Spittle M, Mesagno C. Imagery training for reactive agility: Performance improvements for decision time but not overall reactive agility. J Sport Exerc Psychol 2019;19:1–17.
19. Taneja K, Zutshi K, Ram C, Solanki A. Effect of mental imagery coupled with plyometric on vertical jump and agility. J Recent Adv Psychol Psychother 2019;2:3–11.
20. Guillot A, Desliens S, Rouyer C, Rogowski I. Motor imagery and tennis serve performance: The external focus efficacy. J Sports Sci Med 2013;12:332–8.
21. Vickers JN. Perception, Cognition, and Decision Training: The Quiet Eye in Action. Illinois: Human Kinetics, 2007.
22. Shumway-Cook A, Woollacott MH. Motor Control: Translating Research Into Clinical Practice. Pennsylvania: Lippincott Williams & Wilkins, 2007.
23. Mohammadpour M, Hashemian S, Yaghoubi H, Vahid I, M Arm Nia. The effect of mental practice on response time via Nelson's speed of movement test. Eur J Exp Biol 2012;2(6):2444–50.
24. Gentili R, Papaxanthis C, Pozzo T. Improvement and generalization of arm motor performance through motor imagery practice. Neuroscience 2006;137:761–72.