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The effects of imagery training pre-sleep's on dart throwing skill

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Mohsen Afrouzeh[1ABCD], **Ferman Konukman**[2ABCD], **Mohammad Sadegh Afroozeh**[3ABCD], **Rabiu Muazu Musa**[4ABCDE]

[1] Department for Management of Science and Technology Development, Ton Duc Thang University, Ho Chi Minh City, Vietnam
[2] College of Arts and Sciences, Sport Science Program, Qatar University, Doha, Qatar
[3] Faculty of Humanities, Department of Sport Sciences, Jahrom University, Jahrom, Iran
[4] Centre for Fundamental and Liberal Education, University Malaysia of Terengganu, Kuala Nerus, Terengganu, Malaysia

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Abstract

Background & Study Aim: The evidence obtained from several research studies showed that night sleep increasing motor performance. However, there is a limited information about night sleep's impact on mental imagery (MI). Therefore, the purpose of this study was knowledge about the effects of PETTLEP (based physical, environmental, task, timing, learning, emotion and perspective) imagery training pre-sleep on dart throwing motor performance skill.

Material & Methods: Subjects were thirty male ages 16 to 18 years old and randomly placed into three groups as consolidated PETTLEP MI group (n = 10), preliminary MI group (n = 10) and physical exercise only group (n = 10). A pre-test and post-test design applied and Movement Imagery Questionnaire-Revised (MIQ-R) was used to measure participants' imagery ability. The alpha level was set at $p<0.05$. Paired t-test was used to follow up the significant interaction.

Results: The results showed that there were significant differences between mean ratings scores of pre-test post-test in PETTLEP MI consolidated group ($t12 = 4.588$, $p<0.05$) and there were no significant difference between mean ratings scores of pre-test post-test in Preparatory PETTLEP MI ($t12 = 0.671$, $p<0.05$) and physical practice groups ($t12 = -0.529$, $p<0.05$). Results of the one-way analyses of variance indicated that there were significant differences between the post-test scores of three groups ($F = 4.711$, $p<0.05$).

Conclusions: Such findings highlight the reliability of MI in learning process, that is assumed consolidated when related to sleep. Further research is thus needed to confirm the present results by recording polysomnographic data. Whether the sleep related neural mechanisms involved in the consolidation process following mental practice are similar to those following physical practice should thus be confirmed.

Keywords: effect of PETTLEP • Movement Imagery Questionnaire-Revised • Pittsburgh Sleep Quality Index

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Author's address: Mohsen Afrouzeh, Department for Management of Science and Technology Development, Vietnam National University Ho Chi Minh City, Ho Chi Minh City, Vietnam; e-mail: M_afrozeh@yahoo.com

INTRODUCTION

Mental imagery (MI) has been studied during recent decades in the field of sport psychology. It has been defined that MI facilitates motor performances [1] and used in numerous mental skill practice programs [2, 3]. MI is not just studied for physical activities but also extremely studied for mental training skills [4].

Holmes and Collins [5] believed that functional equivalent is important element for effective mental imagery. However, more recently Wakefield et al. [6] have argued that PETTLEP imagery might be able to optimize the efficacy of an imagery intervention through the concept of 'behavioural matching'. Therefore, matching the imagery and performance of the situation as closely as possible. The proposal about the effectiveness of PETTLEP is through is matching between physical and mental imagery movement. It is rather better than neutrally based functional equivalence between imagery and action.

Holmes and Collins [5] introduced PETTLEP pattern for evaluating the equivalence of mental images to physical ones. Drawing from Lang's bio informational theory [7, 8], the pattern also emphasizes the importance of including personally meaningful stimulus (i.e., details of the situation) and response (i.e., emotional and physiological responses to the situation) propositions into the imagery. For eliciting the benefits of mental imagery, these proponents are important [9]. When used together, stimulus and response propositions can also enhance the vividness and ease of imaging [10]. The PETTLEP model is consisted of seven parts: *physical*, *environment*, *task*, *timing*, *learning*, *emotion*, and perspective (for a detailed description of each element see) [11].

The word physical in this model refers to physical responses within the sport context [12]. The word environment in this model means that the imager for both imagery and actual doing of the task should be in the same environment. When a person use imagery for tasks that are all individual and focus on it, the actual task should be match with imagery task. This is possible through the focus of each individual on elements that are related to throwing dart. About timing, this element refers to movements' time precisely [12, 13]. Adjusting imagery use with learning rate (sleep) during intervention is another important section of this model. Participants can progress in both field, more learning about imagery and their throwing dart during the study. Adjusting imagery use for this effect is an important case. Imaging process include the imager's whole emotions during tournament in Emotion's part of this model [14]. This section has been known as missing link [15]. Imager's perspective which can consist of both first person (internal) and third person view (external) is related to the last section of the model, perspective [16].

Effectiveness of PETTLEP model on performance gain's produce toward physical practice and traditional imagery has been discovered [14, 17, 18]. Performance of mental imagery before performance of task means preliminary mental imagery and its effectiveness, despite the little real practice of task has been shown in performance gains making. Several experiments have been employed through preparatory mental imagery including tennis, basketball, football swimming, track and field, golf, skiing, volleyball and dart throwing that have shown enhancement in the positive abilities in the athletes' performances by using imagery technique [19-21, 1, 22, 23]. Unlike several researchers, it showed the ineffectiveness of this factor on performance of task. Therefore, other variable's influence such as timing of the MI, on effects of MI on performance has been investigated. Sleep's profits on learning of a motor task has been proved many decades ago [22]. A method known as consolidation protects achieved some information through other competing sensory information's interference [24]. Comparison of the participants with 8 hours sleep with participants who sleep 8 hours after 16 hours of awakening, first group shows higher level of recall and fewer temporal fluctuation (during 24 hours period), a little time after learning list of paired-associated words toward the second group, this information discovered by Benson and Feinberg [25] comparison of two groups, brief sleep group (lasting about 90 minutes) and non-sleeping group was also compared to measure sleep and sleep deprivation's impact after learning [26]. The consolidation method's timeline according to which during the overnight sleep's primary session the essential stage for augmented performance occurs released by Walker et al. [27]. Due to increase the speed and accuracy during task of finger tapping it has been discovered. In order to impact learned information's consolidation late stage sleep is not enough but in order to achieve performance improvement all stages of sleep is crucial [28].

PETTLEP – based on: physical, environmental, task, timing, learning, emotion and perspective.

Mental imagery – refers to the ability to create visual, auditory, or other sensory experiences in one's mind without any external stimuli. It is also known as mental visualization or mental rehearsal.

Movement Imagery Questionnaire-Revised – is a tool used to assess an individual's ability to imagine and visualize movements in their mind. It is a self-report questionnaire that asks individuals to rate their ability to imagine themselves performing a series of different movements.

Performance – *noun* the level at which a player or athlete is carrying out their activity, either in relation to others or in relation to personal goals or standards [39].

Skill – *noun* an ability to do perform an action well, acquired by training [39].

Motor skill learning – *noun* the acquisition of new motor skills, either as a child or as part of sports training [39].

NREM – non-rapid eye movement sleep (also known as **quiescent sleep**, is, collectively, **sleep** stages 1–3, previously known as stages 1–4.

REM – rapid eye movement sleep is a unique phase of **sleep** in **mammals** (including **humans**) and **birds**, characterized by random rapid movement of the **eyes**, accompanied by low **muscle tone** throughout the body, and the propensity of the sleeper to **dream** vividly.

SE – 'standard error' is used to refer to the **standard deviation** of various sample statistics, such as the **mean** or median.

Sig(2-tailed) – item in the output is the two-tailed **p-value.** The p-value is the evidence ***against*** a **null hypothesis**. The smaller the p-value, the strong the evidence that you should **reject the null hypothesis.** If you have a small p-value in this area then the test has a **significant** result; You can

The role of sleep within the mental imagery session's profits was investigated for the task that need new skill learning. In order to evaluate the sleep's role in execution gains produce, some items such as compared traditional imagery, physical practice, control groups were compared [29]. In order to discover the performance baseline score there was a pre-test, then groups 1 and 2 get their assigned practicing condition and after that they did post-test one. In order to became ready for the post-test two, participants of each group slept 8 hours. The lack of increasing of the second group's performance after sleep and the speed and accuracy increase of the first group on the pointing task was shown as a result of this study. So sleep has impact on learning consolidation of group one but not on group two and three [29].

The purpose of this study was knowledge about the effects of PETTLEP (based physical, environmental, task, timing, learning, emotion and perspective) imagery training pre-sleep on dart throwing motor performance skill.

We verify the hypothesis: PETTLEP MI administered before to sleep will yield the most profits than Preparatory MI and physical practice only for execution. The principle for this belief lies within the consolidation effects resulting from a period of sleep. The results of a PETTLEP MI intervention before sleep and therefore the consolidation of images and memory that occur throughout sleep are expected to outweigh the positive effects of PETTLEP MI delivered right away before to the task throughout the preparatory MI condition.

MATERIAL AND METHODS

Participants

Subjects were thirty high school male students with dart throwing experience. All selected participants were right-handed, between the ages 16 to 18 years old and randomly placed into three groups as consolidated PETTLEP MI group (n = 10), preliminary MI group (n =10) and physical exercise only group (n = 10). Each participant signed an informed consent form.

The study was approved by the Ethics Committee of the Ferdowsi University of Mashhad (number IR.FUM.ICBS.98.1543).

Apparatus and task

Movement Imagery Questionnaire-Revised

The MIQ-R questionnaire with its eight items evaluating participant's visual and kinesthetic ability. The incipient version of MIQ-R known as MIQ with values of 77 and visual, kinesthetic subscale and overall score with values of 77 show that MIQ-R had synchronic validity that related to with the two items mentioned above [30]. The MIQ-R in this research was used as a means for testing.

Sleep Quality and Quantity

PSQI، (the Pittsburgh Sleep Quality Index) was used in both pre-test and post-test in the first [31] one used in order to measuring quality of sleep and in the latter it is following the post intervention test also it used in order to achieve information about disturbances and determine predisposition of students.

In order to measuring quality and disturbances of sleep there is a self-related questionnaire known as PSQI، the test with items like sleep delay, sleep period, effectiveness of regular sleep, disorders of sleep, using soporific and disorders during the day Consist 7 scores. Global score creates through adding those 7 scores. These 7 element's reliability was 0.83 this number shows that the degree of internal consistency is high [31]. Furthermore, the sleep quality of participants on previous night was measured through a questionnaire.

Task

Performance assessment was performed through throwing of a dart to the target. The dart board had characteristics such as standard 0.75 cm bull's eye in the centre, 1.70 meters' height from the floor, distance of dart from the centre of the bull's eye in millimetres was scoring criteria in order to assessing performance [32] (Figure 1).

Procedure

Participants randomly assigned 30 members of one group among three groups of consolidated PETTLEP MI group (n = 10), preliminary MI group (n = 10) in which 8 hours of 12 hours before post-test was assigned to sleep and the only physical practice group after filling out the MIQ-R questionnaire (n = 10). Between 8-11 am was the time of administrating of post-test. Participants filled the informed consent and questionnaire related to mental imagery and sleep 24 hours before post-test. The MIQ-R was conducted in order to achieve each participant's ability of imaging

reject the null hypothesis that the **mean** is not equal to a specified mean. A "small" p-value is one that is less than your chosen **alpha level; If you didn't choose an alpha level, then use 5% (0.05).** The "specified mean" is the one you stated in the "hypothesized mean difference" box when you ran the test.

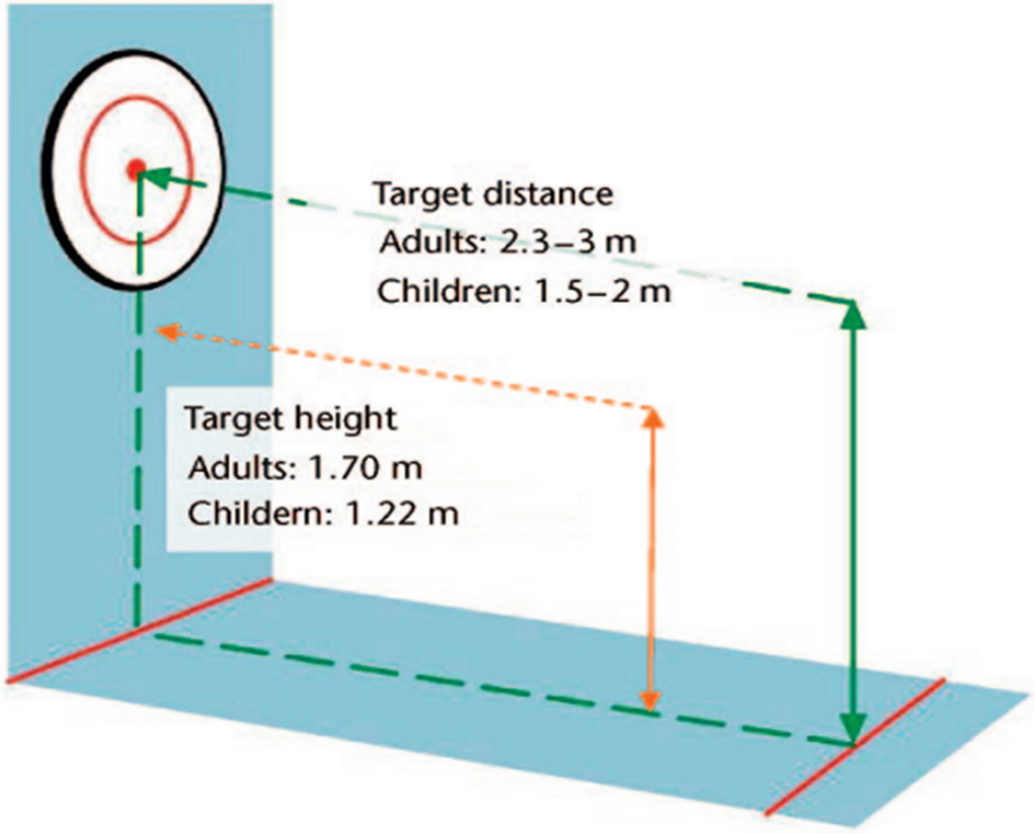

Figure 1. The task setting.

after signing informed consent. MIQ-R's scores below 25 percent of the total score was excluded from the data analysis, because of lacking inclusion criteria.

In order to measuring quality of sleep, PSQI was conducted too. Simple questionnaires asking details related to previous night's amount of sleep was conducted in order to assessing quantity of sleep. Evaluating participant's dart throwing when they listen to a recorded audio. Therefore, in order to assessing experience and ability of dart throwing they asked participants filling a short questionnaire. Participants became members of one group among those three groups that mentioned previously. While participants listening a recorded audio they received a brief instruction related to techniques of dart throwing correctly.

Before starting pre-test, participants had 30 chance of throwing. They have taught the participants how to throw the dart to the target point on the centre of the dartboard.

In each test, mean pre-test and post-test the participants can have dart throwing 10 times. Distance of the darts from x and y-axis measured and recorded by researcher. Measurement done through using Pythagorean Theorem. Measuring the distance to the bull's eye in order to determine accuracy also done through Theorem. In order to measure performance's consistency and evaluating dart throw's clustering bivariate variable error can be use.

In session 2, twelve hours before post-test members of group 1 while listening to the audio with close eyes, practicing dart throwing in their mind. Then asked them to sleep good without any dart throwing practice physically.

On session 3, a questionnaire related to quantity of sleep completed by all participants. They asked group 1 reading magazine 10 minutes, asked group 2 while listening to the audio with close eyes, practicing dart throwing in their mind for 5 minutes with 10 chances to practice dart throwing and then all groups start to completing the post-test.

Data analysis

All statistical computations were made using a transformation (log) to fit the usual normal distribution assumptions. Two-by-two comparisons were further carried out using paired t-tests when the interaction reached the 5% threshold. Finally, all behavioural test scores (MIQ-R, Dart throwing Test, and Pittsburg Sleep Quality Questionnaires) were compared using paired t-tests. The results were presented as: mean (M); standard deviation values (SD or ±); standard error (SE); F-Snedecor statistics; result of the analysis of variance (*F*); degrees of freedom (*df);* Sig (2-tailed) (see glossary and the alpha level was set at $p<0.05$.

A one-way ANOVA was used to determine whether groups differed from each other in improvement of Dart Throwing Skill. Finally, post hoc multiple comparisons assessed which groups differed significantly from each other using Tukey test. All tests were performed with a 95% reliability confidence interval.

Cohen's d (d) we used in estimating sample sizes for statistical testing: 0.2 weak, 0.5 average, 0.8 strong.

RESULTS

Participants average sleep score, as measured by the PSQI was 4.9 ±2.1. Mean MIQ-R scores (SD) were 48.66 ±4.28 out of 56 possible points for all participants. The MI consolidation PETTLEP group mean was 48.9 ±2.18 and the preparatory PETTLEP MI group mean was 49.1 ±2.56, indicating no significant ($p<0.05$) difference between groups. Individual scores on the MIQ-R were all above the threshold excluded from the current study.

Table 1. Paired Samples Test of the Dart's Throwing for the PETTLEP MI Consolidated Condition.

Consolidated PETTLEP	Paired differences					t	df	Sig(2-tailed)
	M	SD	SE	95% Confidence Interval of the Difference				
				lower	upper			
pre-test÷ post-test	0.9342	0.7053	0.2036	0.4861	1.3823	4.588	11	**0.001**

Table 2. Paired Samples Test of the Dart's Throwing for the Preparatory PETTLEP MI Condition.

Preparatory PETTLEP	Paired differences					t	df	Sig(2-tailed)
	M	SD	SE	95% Confidence Interval of the Difference				
				lower	upper			
pre-test÷ post-test	0.1767	0.9115	0.2631	0.4025	0.7558	0.671	11	0.516

Table 3. Paired Samples Test of the Dart's Throwing for the Physical Practice Only Condition.

Physical Practice	Paired differences					t	df	Sig(2-tailed)
	M	SD	SE	95% Confidence Interval of the Difference				
				lower	upper			
pre-test÷ post-test	0.1158	0.7579	0.2188	0.5974	0.3657	0.529	11	0.607

The result of this research showed a significant difference between pre-test and post-test of consolidated PETTLEP MI group (Table 1), but there was no significant difference in improvement between pre-test and post-test of preparatory PETTLEP MI and Physical practice group (Table 2 and 3). However, the mean score's preparatory PETTLEP MI group was better than the mean score's Physical practice group. Three paired-samples t-tests were directed to follow up the significant interaction. There was significant difference between mean ratings scores of pre-test post-test in PETTLEP MI consolidated group (t 12= 4.588, p<0.05, Cohen's d: 1.32) and there were no significant difference between mean ratings scores of pre-test post-test in Preparatory PETTLEP MI (t 12= 0.671, p<0.05, Cohen's d: 0.19) and physical practice groups (t 12= −0.529, p<0.05, Cohen's d: 0.15).

Results of the one-way analyses of variance indicated that there was significant difference between the post-test scores of three groups (F = 4.811, p<0.05, partial Eta squared: 0.238), (Table 4). Tukey HSD tests revealed that significant development of consolidated PETTLEP was better than preparatory PETTLEP MI and physical practice condition (Table 5 and 6).

Table 4. The one-way analyses between the post test scores of three group.
Groups Post-test Scores

Relation	Sum of squares	df	M Squer	F	Sig(2-tailed)
between groups	8.366	2	4.183	4.811	**0.015**
within groups	28.696	33	0.870		
total	37.062	35			

Table 5. Tukey test (HSD) of the pre-test scores of three groups and post-test scores.

(I) Groups	(J) Groups	(I-J) Mean difference	SE	Sig(2-tailed)	95% Confidence Interval	
					lower	upper
1	2	**−0.9958***	0.3807	0.035	−1.9300	−0.0617
	3	**−1.0475***		0.025	−1.9816	−0.1134
2	3	−0.0517		0.990	−0.9858	0.8825
3	1	**1.0475***		0.025	0.1134	1.9816

*the mean difference is significant at the 0.05 level

Table 6. Test of between-subjects effects. Dependent Variable: Groups Post-test Scores

Score	Type III sum of squares	df	M square	F	Sig(2-tailed)	Partial eta squared
Corrected model	8.912	2	4.456	5.153	**0.011**	0.238
Intercept	2,823.505	1	2,823.505	3.265E3	**0.000**	0.990
Groups	8.912	2	4.456	5.153	**0.011**	0.238
Error	28.533	33	0.865			
Total	2,860.950	36				
Corrected total	37.445	35				

R squared = 0.238 (Adjusted R squared = 0.192)

DISCUSSION

PETTLEP involving with efficacy of MI consolidation following a time of overnight sleep on dart throwing performance, investigated by the researchers. The assumption was about overtaking group one from group 2 and 3 [29, 33, 34]. It had been hypothesized that the consolidation group would outstrip the preparatory mental imagery and physical practice only groups. The results of the present study support this hypothesis.

The current results showed that PETTLEP MI enhanced the subsequent motor performance in real time following training. Additionally, the main finding of this research indicated that the participants engaged in PETTLEP MI condition significantly enhanced their motor performance following a night of sleep. The results of the current study are in line with the findings of several research studies [27, 26, 33, 35, 36]. Enhancing subsequent motor performance after training through PETTLEP MI has been proven. The performance of motor of participants involving with PETTLEP MI, after a night of sleep will rise significantly.

Absence of significant enhancement on group 2 and 3 about dart throwing performance from pre-test to post-test was one of the results of this research. In effectiveness of group 2 on future performance has been shown by researchers. Consolidation method of MI are able to explain results so in order to studding this methods single session PETTLEP MI can be used. This item used in order to define there is not any chance of sleeping overnight for group 2 (preparatory group).

Wakefield a Smith [11] have found that the more training sessions per week are (three times a week) the greater the progression of PETTLET MI is. Several weeks of education and generic training of PTTLEP MI should be done in order to studying MI consolidation by future researchers. There were 4 to 6 PETTLEP MI training in prior research before performance testing [37, 18, 38].

This age long training also has another application for performance gains and it is essential for further studies about how does sleep effect on benefits of final session of MI. The effect of MI on motor memory has been shown. The fact that the long range retention of behaviours that have been mastered through MI due to memory impairment may be at risk is obstacle to success of MI. However, research related to sleep and MI effect on memory is very low. Delayed gains on throwing of dart due to night of sleep following MI is as a result of prior studies. The results of the current study are in line with the research findings [26, 27, 33].

Data has shown that improvement of dart throwing performance through subjects in group one compared with group two and three has been remarkable. In terms of motor learning literature through following both physical and mental practice, participants increase their performance. Significant improvement in performance after sleep was one of the results of viewing consolidation of offline motor memory after physical practice. The result that mentioned above related to helping of sleep to increasing motor performance has been proved in prior studies. Functional correlation between MI and motor performance was supported through the pervious studies' result regarding the effect of sleep after mental imagery. The fact that performance gains after MI depends on sleep is as a general result of this research [14, 18, 38]. Consequently, discoveries about sleep's impact on motor memory consolidation after mental imagery confirmed and amplified functional correlation's principles between MI and physical practice.

The incorporation of MI to benefit from offline motor consolidation is possible through physical therapy and prior to periods of sleep. Predictions suggest that studies with polysomnographic recording data are needed to determine whether stage 2 sleep is similarly modulated after MI or not. Similarly, a connection may exist between consolidation, NREM sleep, and slow wave sleep. The stages of sleep that are crucial for memory consolidation after MI should be the subject of future research [37].

CONCLUSIONS

Although it is premature to draw definitive conclusions about the sleep-related consolidation processes following mental practice, the present study demonstrates that the participants engaged in MI training improved their motor performance after a night of sleep. Based on sleep data and motor skill learning literature, these preliminary findings may suggest that the consolidation processes remained effective following mental practice as well, hence supporting the principle of functional equivalence between MI and motor performance.

Finally, there are still numerous debates regarding the role of REM sleep versus other sleep indicators (e.g. spindles in NREM phases) in motor learning process. Further research is thus needed to confirm the present results by recording polysomnographic data. Whether the sleep related neural mechanisms involved in the consolidation process following mental practice are similar to those following physical practice should thus be confirmed.

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