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# Research Paper: The Effects of Mental Imagery and Physical Practice on Learning Dart-Throwing in Children with ADHD

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## Abstract

The effects of motor imagery and physical practice on motor learning in individuals with ADHD received very little attention. Therefore, in the present study, we aimed to examine the effects of motor imagery and physical practice on motor performance and learning dart-throwing in adolescents with ADHD. The current research was based on a causal-comparative approach. The participants included 60 adolescents with ADHD (with the age range of 12 to 17 years) randomly and equally assigned into four groups: 1) motor imagery, 2) physical practice, 3) combination of motor imagery and physical practice, and 4) control. The motor task involved dart-throwing, in which the accurate throw score was measured as the dependent variable. The participants performed the pre-test (ten throws) and the retention test (ten throws). ANOVA was run to analyze the throwing accuracy. Results showed that all groups had similar throwing scores in the pretest, however, in the retention test, the results indicated that combination group had significantly better throwing scores than all other groups (in all groups, P=0.000). In addition, physical practice group had significantly better throwing scores than motor imagery and control groups (both P=0.000). Finally, motor imagery group had significantly better throwing scores than control group (P=0.000). Individuals with ADHD benefit from motor imagery, indicating that they have the necessary mechanisms to learn new skills through motor imagery. Moreover, a combination of motor imagery and physical practice would be a better strategy for learning new motor skills.

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## 1. Introduction

Researchers working on motor learning are always trying to increase the ability of teachers and trainers by introducing new scientific methods. For this purpose, motor behavior scientists have tried to identify the factors affecting the harnessing and learning of these skills for years (Magill, 2007). Today, sports psychologists as well as people who participate in the field of sports and physical activity pay attention to mental skills as an evolutionary part, with a significant role in the success of outstanding athletes. During the past decades, the motor learning scientists examined the effects of various techniques and strategies for facilitating the process of motor learning in different age groups. Some of them include observing a model (Ghorbani & Bund, 2014; Ghorbani et al., 2020; Farsi et al., 2016), motor imagery (Afsanepourak et al., 2012), self-talk (Eskandari Nejad et al., 2015), enhanced expectancies (Ghorbani, & Bund, 2020), and adopting an external focus of attention (Ghorbani et al., 2020).

One of these mental techniques that is often used by teachers and coaches to facilitate the learning of sports skills is motor imagery. Motor imagery is a conscious experience using all senses to create or recreate an experience in the mind (Amasiatu, 2013; Weinberg & Gould, 2011). One of the effects of imagery is to improve learning and performing motor skills; it is also used in sports for various reasons such as reducing anxiety, improving performance, learning skills, increasing self-confidence (Bohan et al., 1999). Additionally, motor imagery can improve the time of doing a task or exercise. Athletes use skill training in two main ways: physical practice and mental practice (Mulder, 2007). Mental practice is considered to be a special form of imagery, and mental imagery is one of the main interventions in sports psychology, including the use of one or more senses to create or recreate sports skills or timing (Driskell et al., 1994). Athletes can use mental imagery to improve their learning. Studies conducted over the past years have revealed that mental practice, similar to physical practice, improves people's motor skills; on the other hand, they have determined that the same neural mechanisms that are activated in learning through physical practice are also activated in mental practice (Hale et al., 2003). This issue confirms why mental training, like physical training, leads to learning motor skills. Using methods such as magnetic resonance imaging (MRI) and tomography through positron emission, has determined that the cerebral cortex and subcortical areas that play a role in motor planning and control are also activated during mental practice (Decety, 1996). Research has pointed out the positive role of mental imagery in improving the performance of athletes, and concluded that people using mental imagery performed better than people who has not used imagery (Mulder et al., 2004). In addition to the positive effects of motor imagery in improving the motor performance and learning in various sports disciplines, some studies have shown that combination of physical and mental practice are more effective on motor performance and learning than mental practice alone (Papadelis et al., 2007). However, the effects of a combination of motor imagery with physical practice is not exercised on people with different mental and motor disabilities (Dana et al., 2019). For example, one of the disabilities that has rarely been studied in the field of mental practice and motor imagery is attention deficit hyperactivity disorder (ADHD). ADHD is a mental health disorder that includes a combination of persistent problems such as difficulty in paying attention, hyperactivity, and intrusive

behavior (Farhangnia et al., 2020). ADHD can lead to unstable relationships, poor performance in school, low self-esteem, and other problems. Symptoms of hyperactivity begin in childhood and continue into adulthood. It has also been stated that individuals with ADHD often exhibit deficits in learning motor and sport skills (Eskandarnejad et al., 2015). Thus, findings the ways and procedures that may facilitate learning new motor skills in individuals with ADHD seem to be necessary. As mentioned earlier, the effects of motor imagery and physical practice on motor learning in individuals with ADHD received very little attention. Therefore, in the present study, we aimed to examine the effects of motor imagery and physical practice on motor performance and learning dart-throwing in adolescents with ADHD. We hypothesized that each motor imagery and physical practice would lead to better motor performance and learning compared to control condition. In addition, a combination of motor imagery and physical practice would lead to greater motor performance and learning than each one alone in adolescents with ADHD.

## 2. Method

The current research was based on a causal-comparative approach. The participants included 60 adolescents with ADHD (with the age range of 12 to 17 years) and randomly and equally assigned into four groups: 1) motor imagery, 2) physical practice, 3) combination of motor imagery and physical practice, and 4) control.

### 2.1. Motor task

In this study, a dart-throwing skill was selected as a motor task. To do this, a standard dart board made in China, (JDB 61 model), and standard darts were used. In this task, the participant started throwing darts towards the clockboard while placing his or her foot behind the oche at a standard distance from the dart board (which was 7.77 Inch clockboard). The aim of this motor task was to throw darts towards the clockboard to get the highest possible score. In this assignment, the place where the dart hit was recorded on the clockboard, which was a score between 0 and 10.

### 2.2. Procedure

First, by referring to the participant's profile at school, a demographic information sheet was completed for each child. Participants were tested separately in the room set up for this study in their respective schools. Before the start of the protocol, the examiner provided the preliminary explanations related to the present study to the participants. Then, an experienced instructor taught the participants the rules of throwing darts, how to throw darts and score points. In order to familiarize the participants with the protocol implementation environment and the motor task, they were asked to perform a dart-throwing skill two times. Afterwards, in the pre-test, the participants performed the dart-throwing skill ten times without any specific instructions. In the acquisition phase, the protocol used for each group was different. For mental imagery group, the participants were asked to imagine the dart-throwing for five minutes. The participants in the physical practice group were asked to throw the dart for five minutes. The participants in the combination group were asked to participate in three intervals, including one minute of motor imagery and one minute of dart-throwing practice. Finally, those in control group did nothing during the protocol. One day after the protocol, the participants participated in a retention test, which consisted of performing the dart-throwing skill ten times. Before and during the retention test, no instructions were provided.

### 2.3. Data analysis

In this study, the dependent variable was throwing accuracy in the pre-test and retention test. ANOVA was used to analyze the throwing accuracy in the pre-test and the retention test. In addition, Tukey's post hoc test was run as a post hoc test. The level of statistical significance was at $P < 0.05$.

## 3. Results

In this part, the demographic characteristics of the participants in this study, including the age, height, weight, and BMI in each group, are presented in Table 1.

Table 1

*Demographic characteristics of the participants*

| Groups | Age | Height | Weight | BMI |
|---|---|---|---|---|
| Motor imagery | 14.22±1.87 | 164.55±7.22 | 58.49±6.94 | 19.85±1.47 |
| Physical practice | 14.69±2.07 | 166.39±6.98 | 57.29±6.97 | 20.31±1.50 |
| Combination | 15.22±2.17 | 169.65±9.08 | 60.22±7.24 | 19.54±1.95 |
| Control | 15.96±2.52 | 162.74±7.59 | 59.67±8.63 | 19.78±1.85 |

Descriptive statistics including the mean and standard deviation of throwing scores in the groups are presented in Table 2 and Figure 1.

Table 2

*Mean and SD of dart-throwing scores in pre-test and retention test across groups*

| | Motor imagery | Physical practice | Combination | Control |
|---|---|---|---|---|
| Pretest | 1.85±1.69 | 1.98±1.54 | 1.78±1.66 | 1.81±1.39 |
| Retention test | 3.29±2.47 | 4.05±3.07 | 5.22±2.47 | 2.01±1.71 |

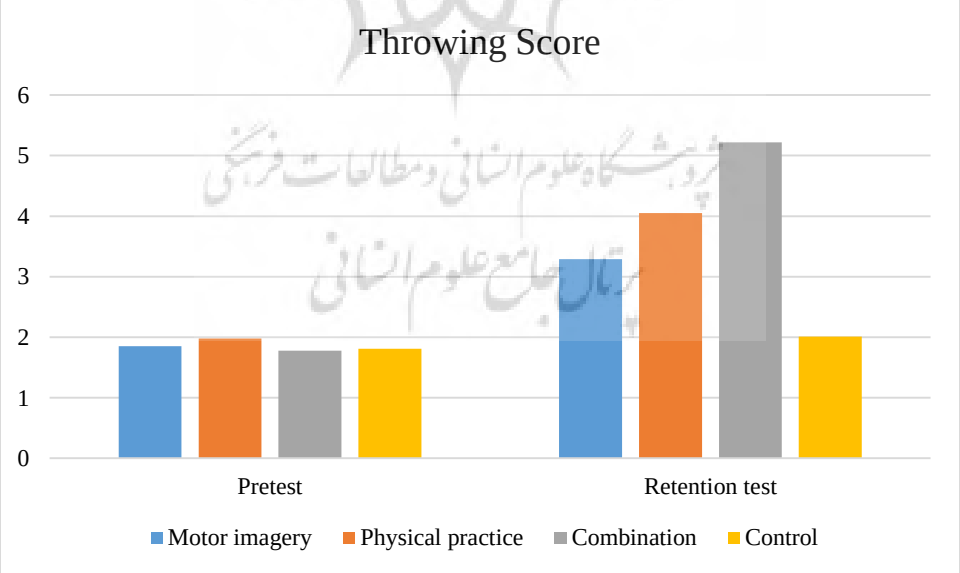


Figure 1. Means of throwing in the pretest and retention test across groups

As can be seen, the average scores of the all groups in the pre-test were very close to each other. Before presenting the inferential statistics related to the research hypotheses, it

is necessary to mention that the results of the Kolmogorov-Smirnov test as well as the results of the Levin test showed that the research data had the two assumptions of normality of data distribution and homogeneity of variances, because the values of the z statistic for all groups were not significant. In the following, ANOVA employed to test the research hypotheses. Results of one-way ANOVA highlighted that all groups had similar throwing scores in the pretest, $F = 0.58$, $p = 0.89$. However, in the retention test, there were significant differences between groups, $F = 8.97$, $p = 0.000$. According to the results of Tukey test, combination group had significantly better throwing scores than all other groups (P=0.000 in all groups). In addition, physical practice group had significantly better throwing scores than motor imagery and control groups (P=0.000 in both groups). Finally, motor imagery group had significantly better throwing scores than control group (P=0.000).

## 4. Discussion

The effects of motor imagery and physical practice on motor learning in individuals with ADHD has not been studied a lot. Therefore, our aim in the present study was to examine the effects of motor imagery and physical practice on motor performance and learning dart-throwing in adolescents with ADHD. We hypothesized that each motor imagery and physical practice would lead to better motor performance and learning than control group. In addition, a combination of motor imagery and physical practice would lead to greater motor performance and learning than each one alone in adolescents with ADHD.

The findings indicated that the experimental groups, i.e., the groups of motor imagery, physical practice and the combination of mental imagery and physical practice, performed better than the control conditions in the retention test, revealing the effect of each type of practice compared to the no-practice condition. Additionally, these highlighted that adolescents with ADHD were able to use motor imagery for improving their performance in the retention test. The results of this study confirm our first hypothesis and are in accordance with the results of previous studies indicating that any practice (including physical practice, mental practice, a combination of mental and physical practice) would have a positive effect on learning sports skills (Amasiatu, 2013; Weinberg & Gould, 2011; Hale et al., 2003). Dart-throwing skill is a cognitive-motor skill requiring physical and mental skills, creating concentration, having self-confidence, paying attention to the goal, reducing anxiety about the result of the throw; consequently, it can have a significant effect on the successful harnessing this skill. It can be stated that it is because of these important psychological factors that motor imagery is effective in dart-throwing (Mulder, 2007; Mulder et al., 2004). Mentally correcting one's mistakes in the process of motor imagery can help a person to increase concentration and self-confidence, as well as to generate confidence in the result of the throw. In addition, imagining successful throws results in creating a sense of victory and a positive attitude towards the work result, reducing anxiety and worry about the mistake and the result of the throw, controlling negative emotions, controlling stress and excessive arousal; therefore, using visualization can improve one's motor performance (Papadelis et al., 2007). Accordingly, it can be concluded that employing motor imagery was the most important reason for learning and developing the dart throw skill.

In addition, the findings showed that a combination of mental imagery and physical

practice was better than each factor alone in the retention test, indicating that although mental imagery, as an effective strategy, plays a significant role in learning movement skills, it is not enough to learn these skills alone, and a skill that is well acquired must be used in practice (Mulder, 2007; Mulder et al., 2004). It should be exercised until it is internalized in the person and becomes a skill. The possibility of physical practice after motor imagery has strengthened and stabilized the dart-throwing skill in the retention test. Therefore, it is suggested that sports coaches in educational classes use motor imagery as an educational aid tool based on its psychological aspects (Amasiatu, 2013; Weinberg & Gould, 2011; Hale et al., 2003). A coach's attention to motor imagery as one of the useful psychological skills in the field of sports, and physical factors, can help novices learn and perform better motor skills.

## 5. Conclusion

To conclude, the results of current study demonstrated that individuals with ADHD could benefit from motor imagery to learn a dart-throwing skill. This result indicate that these people may have the necessary mechanisms to learn new skills through motor imagery. In addition, a combination of motor imagery and physical practice would be a better strategy for learning new motor skills. Therefore, it is suggested that sports coaches in educational classes use motor imagery and physical practice together.

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## Conflict of interest

The Authors declare that there is no conflict of interest with any organization. Also, this research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

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