

## Effects of Attention Span Symptoms and Attention Feedback on Children's Motor Skills Learning

Nasibesadat Hoseininasab<sup>1</sup>, \*Mehdi Namazizadeh<sup>2</sup>, Mohammad Vaez Mousavi<sup>3</sup>

<sup>1</sup> Department of Motor Behavior, Physical Education Faculty, Central Tehran Branch, Islamic Azad University, Tehran, Iran.

<sup>2</sup> Department of Motor Behavior, Physical Education Faculty, University of Tehran, Tehran, Iran.

<sup>3</sup> Department of Physical Education and Sport Sciences, University of Imam Hossein, Tehran, Iran.

### Abstract

**Background:** The aim of this study was to investigate the effects of focusing instructions (internal and external) and attention feedback (internal and external) on learning free throwing skills of basketball in children aged 9 to 11 years.

**Methods:** For this purpose, 70 female students aged 9 to 11 years were selected from District 18 of Tehran and randomly divided into five groups of 14 individuals, including one Control Group (CG), along with four Experimental Groups (EGs) of Internal Attention (EG 1), External Attention (EG 2), Internal attention feedback (EG 3), and External attention feedback (EG 4). After learning some basic instructions and watching the instructional video, the pre-test was performed including a 10-item set (10 blocks). The acquisition phase consisted of two sessions on two consecutive days and each session consisted of 5 blocks of 10 attempts with two minutes of rest between the blocks. Immediate retention test was performed immediately after the acquisition phase and delayed retention test was conducted 48 hours after the last acquisition session. Data analysis was performed using repeated measures one-way Analysis of Covariance (ANCOVA), and LSD post hoc test using SPSS software version 20 and Excel at a significant level of  $P < 0.05$ .

**Results:** The findings revealed that both attention-grabbing methods improved children's motor functions ( $P < 0.05$ ). In combination of data related to internal and external attention as well as external and internal attention feedback, the findings showed that there were significant differences between the effects of interventions on children's motor skills learning, to the advantage of the external attention feedback ( $P < 0.05$ ).

**Conclusion:** The present findings in support of the hypothesis of limited practice in order to learn the motor skills of children's basketball free throwing, recommend the use of feedback and attention signs, especially the external ones.

**Key Words:** Attention Feedback, Children, Focus, Motor Skills.

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### \* Corresponding Author:

Mehdi Namazizadeh, Department of Motor Behavior, Physical Education Faculty, Central Tehran Branch, Islamic Azad University, Tehran, Iran. Email: Mnamazizadeh@gmail.com.

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## 1- INTRODUCTION

The performance and learning of complex motor skills require some level of attention. With regard to limitations of prior attentional resources in learning, it is necessary that research studies determine the effects of attentional focus on learning. Previous studies have shown that the skill instructions presented during the participants' performance have not had considerable effects on their performance (1). Wulf suggested an alternative approach. He has shown, through empirical and nonempirical evidence, that the external attention focuses which direct attention to the final result are more useful than the internal attention focuses that direct attention to the way of performing the action (2). Following Wulf's approach, the participants in McNevin et al. (3), chose the external or internal attentional focus in a balanced assignment. They found that the participants who chose the external focus, showed better results in retention, in comparison to the others who chose the internal focus. In addition to the balanced activities, the advantages of the external focus have been reported in learning golf throwing (1, 2), free throwing of basketball (4, 5), dart throwing (7, 6), ace in volleyball and pass in football (8), the vertical high jump (2, 9), swimming (10), tennis (11), sprint (12), and long-distance running (13). The constrained action hypothesis is used as the conceptual framework to express the effect of attention on motor learning and performance (3, 14, 15). The constrained action hypothesis developed as an alternative to the main conceptual framework, the common coding theory which is too subjective and can't anticipate different effects of attentional focus on learning. According to the constrained action hypothesis, the person's focus on the effects of this/her performance (external focus) allows him/her to unconsciously manage the reflection control process. In contrast, the focus on a

person's performance (internal focus) disorganized the automatic process through the constrained motor system. Although there is extensive literature on the beneficial effects of the external attention focus, few studies have been conducted on the effects of attentional focus in children (9, 16-19). There are considerable information processing differences between children and adults that have potential influences on motor learning and performance. Some of the affecting factors include age contributing to the improvement in processing speed (20, 21), performance labeling (22), using rehearsal strategies (23, 24), mental organization (25), and selective attention (26).

Despite the above mentioned evidence, there are few studies which have shown that the instructions on the internal focus of attention lead to better performance in children (27, 28, 29). There are controversies in the findings of different studies, and some have shown evidence of the beneficial effects of both approaches (9, 17, 28). Some studies have mentioned that it is difficult to determine which kind of attentional focus feedback is better for learning a skill in children. One reason related to the inconsistency in results is the cognitive constraint of children in comparison to adults (28, 29). A number of studies have shown the benefits of instructional attention in children; as in the research of Emmanuel (2008) and Roshandel et al. (2017) found that external attention is more effective than internal attention in the accuracy of dart throwing skills in adults, but children benefited more from internal attention (16). In regard to children, it is shown that the effectiveness of the type of instructions for focusing attention or using feedback is less known for this age group, so that children may not have the necessary attention capacity to follow the instructions while performing motor skills and instead use them. They benefit from the instructions of

external attention due to their natural tendency to focus on the result of work (2). Children up to 11 years old are unable to use information processing techniques as quickly as adults (20). They spend more time absorbing and calling information that is given to them. Children have limited ability in processing information, don't have developed calling strategies and are unable to collect and write the newly presented information (23). The developed learning strategies are important in motor learning, because they allow the individual to add new information to the present one. When this ability is completely undeveloped, the child is unable to do new activities; furthermore, the deficiency in organization of children in comparison adults leads to their weak performance (23). In present, there is evidence expressing that children and adults are differently influenced by attentional focus instructions (28), feedbacks (30, 31), and contextual interference (32, 33).

The aim of the present study is thus to determine the effects of instruction (cues), attentional focus (focus) and feedback on motor skill learning in children. The main question of the study is as follows: Are the internal and external attention focus cues effective on motor skill learning and performance? If yes, which kind of internal and external attention focus instructions and feedback lead to better learning and performance in motor skills among children?

## **2- METHODOLOGY**

### **2-1. Method**

The present study was aimed to determine the effect of attention focus cue and attentional feedback. To this end, two experiments were designed. In the first experiment, the effects of internal and external attention focus, and in the second one, the effects of attentional feedback cues were examined. The present study was quasi-experimental with pretest and

post-test design and it was conducted in one control and four experimental groups.

### **2-2. Participants**

The population of the study included all third and fifth grade students in the age range of 9 to 11 at 18 districts of Tehran. 70 female students, not familiar with free throwing in basketball, were selected randomly and then filled out the consent forms. They were divided into 5 groups: one control group and four experimental groups focusing on the internal attention group, external attention, internal attentional feedback, and external attentional feedback. The control group didn't receive any instructions, attentional cues and feedback.

### **2-3. Instrument**

The intended activity, in the present study, was free throwing in basketball. The activity was conducted by a ball with 28.5 circumference, based on instructions of basketball equipment for amateur athletes. The free throw was thrown from a 12-foot distance to a basket with a height of 9.5 feet. The performance of throwing was scaled on three points. The correct throwing scored 2, the throwing near the basket (when the ball strikes to the basket) scored 1, and the wrong throwing 0 (zero).

### **2-4. Implementation**

After grouping the participants, the pre-tests were administered and the instructions were performed. The control group just attended the primary instructional session as well as the pre- and post-tests. The tests and exercises were the same in all groups, but the difference was in the related instructions. The acquisition phase and retention test was done through three days that included 2 similar exercise sessions in consecutive two days as acquisition phase and then 48 hours, the test session was taken. Before starting the exercise session, all participants were introduced to primary and basic instruction

about throwing. At first, they watched the correct free throwing on the screen along with the related verbal instructions. Then, they watched it again and received verbal cues as reminders. Finally, they performed throwing for 5 times to become familiar with techniques and equipment (29). After these primary instructions, the participants took a pre-test consisting of 10 blocks of free throwing, during which they didn't receive any additional instructions or feedback. Then, the experimental groups, before the main throwing, received the internal and external verbal cues. The participants threw for 50 times from 100 throwing in the acquisition phase at the first session (5 ten-throwing sets) and to avoid exhaustion in the test, the participants took a rest after each 10-throwing pack. The participants in the groups focusing on internal and external attention reviewed the internal and external instructions and cues before performing, and then did their throwings in each set (10 blocks). They didn't receive any feedback during their performance, although they received KR as internal feedback and outcome (first experiment). The participants in internal and external attentional feedback groups received feedback after three throwings. The presented feedback was based on the person's performance in the three throwings and the attentional feedback group. Along with the internal and external instructions, attentional feedback and its effect on the next throwing were emphasized in the feedback groups. The participants attended a retention test instantly after completing throwings in the acquisition phase. In addition, they attended a delayed test after 48 hours of the second exercise session. Each of the instant and delayed retention tests included 10 throwings in one set (10 blocks). Then, the internal and external instructions (first experiment) and verbal cues of internal and external attentional feedback (second experiment) were presented.

**a) The verbal instructions of internal attention cues:**

They included cues about the internal attention focus instructions on how to move the organs, which the participants knew beforehand. Some instances of the internal attention cues are as follows: focus on wrist and its motion, focus on bending and stretching your wrist, focus on knee and haunch in throwing, focus on stretching your arm in throwing, focus on forming your arm as L form before throwing (29).

**b) The verbal instructions of external attention cues:**

They included verbal cues about external attention focused on how to do the performance, which the participants knew beforehand. Some of the external attention cues are as follows: focus on the ball at hand, focus on the basket, pay attention to the bow shaped direction of throwing, focus on the ball, and focus on the ball rotation (29).

**c) The verbal cues of external attentional feedback:**

The following instructions were presented to the participants in order to pay attention to something out of body gestures: 1. The ball is balanced on your hands as a waiter holds the tray in his hands. 2. Focus on the point at the top of the basket. 3. Throw as you are passing the ball on the net in a volleyball game. 4. Try to rotate back the ball when throwing (29).

**d) The verbal cues of internal attentional feedback:**

The following instructions were presented to the participants in order to pay attention to body gestures: 1. Make an L form by your hands and hold the ball between your fingers. 2. Raise your hands up and look at the basket. 3. Open your hands and knees when throwing. 4. Move your wrist forward when throwing (29).

**e) Feedback frequency:** The feedback is presented to the person after 3 throwings, based on her performance (29).

## 2-5. Statistical Methods

Kolmogorov–Smirnov test was used to analyze whether the data were normality of distributed, Levene's test to analyze homogeneity of the variances, ANCOVA to compare the groups in different variables in the pre-test, repeated measure ANCOVA to compare the effects of the exercises on different groups in the acquisition phase, the ANOVA to compare the effects of exercises on different groups in the instant and delayed retention tests,

and LSD test to examine the intergroup differences. The data was analyzed by SPSS 20 with the significance level of < 0.05.

### 3- RESULTS

The demographic information included mean and standard deviation of the participant's age, height, and weight which are presented in **Table 1**.

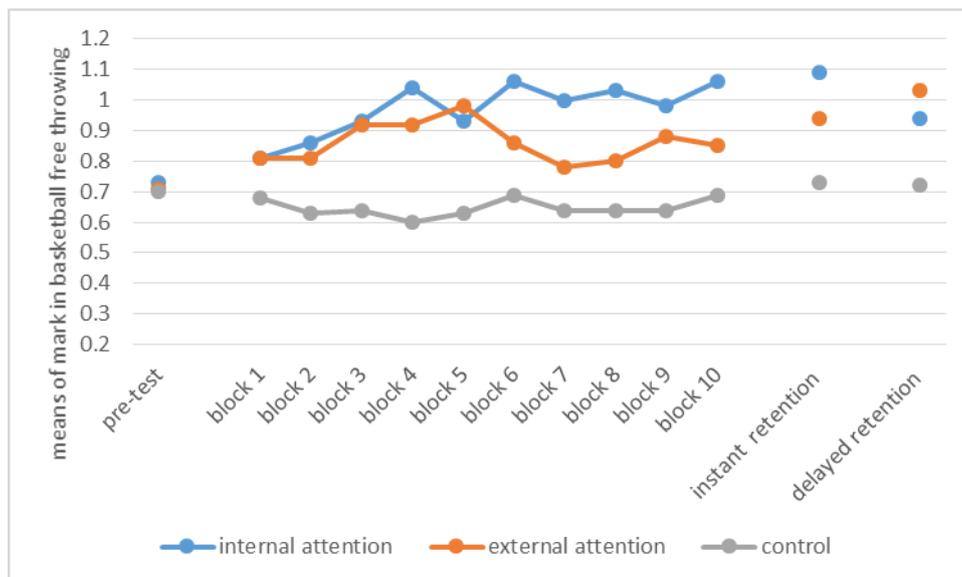
**Table-1:** descriptive information related to age, height, and weight of the participants

Group	Characteristic	Mean	SD
Internal attention	Age (years old)	10.15	0.38
	Height (centimeter)	142.4	6.25
	Weight (kg)	38.5	7.41
External attention	Age (years old)	10.25	0.21
	Height (centimeter)	143.2	6.62
	Weight (kg)	39.7	5.84
Internal attentional feedback	Age (years old)	10.28	0.41
	Height (centimeter)	142.17	5.68
	Weight (kg)	39.24	6.92
External attentional feedback	Age (years old)	10.38	0.29
	Height (centimeter)	143.41	6.10
	Weight (kg)	40.10	5.24
Control group	Age (years old)	10.20	0.32
	Height (centimeter)	144.1	6.12
	Weight (kg)	37.8	6.54

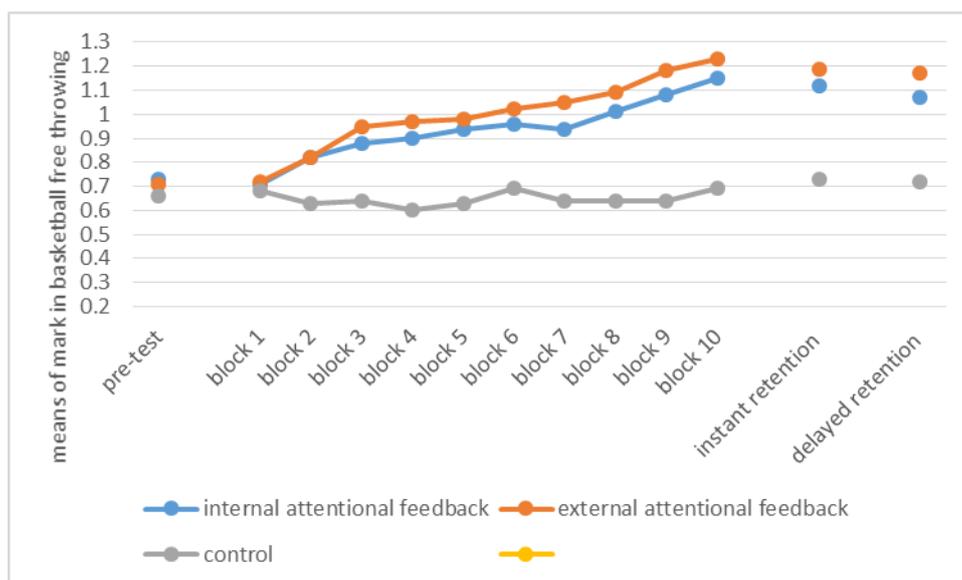
The descriptive statistics presented the performance of different groups in free throwing with regard to the related attentional instructions in different exercises and retention phase (**Fig. 1 and 2**). As shown in **Fig. 1**, there has been no difference between the performance of the internal and external attention groups in the primary session; however, the performance of these groups has been different from that of the control group in different phases. The internal and external groups had better performance in instant and delayed retention tests in comparison to the control group. The performance of

the external attention group was better than the internal attention group in these tests.

As shown in **Fig 2**, the performance of different groups was not different in the first session; however, the performance of internal and external attentional feedback groups improved along with the progress of the instruction; and their scores maximized at the end of the exercise sessions. In comparison to the internal attentional feedback group, the external one showed better performance in acquisition, instant and delayed phase. Both groups had better performance at all phases in comparison to the control group.



**Fig. 1:** Mean scores of free throwing in different phases of test- first experiment



**Fig. 2:** Mean scores of the groups in free throwing in different test phases- second experiment

**Fig. 2:** Mean scores of the groups in free throwing in different test phases- second experiment

### 3-1. Integrating two experiment

In this section, the performance of the groups is compared using the analysis of covariance method with repeated measurements and controlling the pretest effect. **Table 2** shows that the groups were

significantly different in different test phases. So, it can be said that different groups have different progressions in test phases.

Because of the significant differences between groups and phases, the LSD test was used to specify the difference points; its results are presented in **Table 3**.

**Table-2:** Summary of ANCOVA in the delayed retention phase in different groups

source	Total squares	df	Mean squares	F	Sig	Partial Eta squared
Corrected model	2086.488	2	1043.244	65.20	0.001	0.84
Intercept	372.201	1	372.201	24.54	0.001	0.79
Pre-test	3.415	1	3.415	0.840	0.125	0.001
Error	1683.04	67	25.120			
Total	58421.21	70				

**Table-3:** results of LSD test – comparing the group performances in different test phases

Group	Group	P
External attentional feedback	Internal attentional feedback	0.01
	External attention	0.01
	Internal attention	0.01
	Control	0.001
Internal attentional feedback	External attention	0.081
	Internal attention	0.001
	Control	0.001
External attention	Internal attention	0.01
	Control	0.001

As presented in **Table 3**, the external and internal cues and attentional focus groups, in comparison to the control group, have had better performance in the retention phase. It means that the attention focus cues and attentional feedback affected significantly on the participants' motor performance ( $p < 0.05$ ). The findings showed that there are significant differences between effects of attention focus cues and external and internal attentional feedback on motor learning ( $p < 0.05$ ). Based on the mean scores obtained from the exact examinations in different phases, it is clear that there is a significant difference between external attentional feedback cues and other methods of attentional feedback and attention focus with the advantage of the external group ( $p = 0.001$ ). In addition, the findings showed that the external attention focus cues in comparison to the internal ones were more useful for learning free throwing in basketball and motor skills ( $p = 0.01$ ).

#### 4- DISCUSSION

A common source of information available to learners about skill execution is feedback. Typically, feedback is provided after skill execution and is based upon the learner's prior performance. Feedback has been shown to have informational properties in that it helps learners reduce errors, correct them more quickly, and bring their movement patterns closer to the goal. This is achieved by directing learner attention to the most relevant aspects of the task. The predominant form of augmented feedback provided to learners by teachers and coaches is knowledge of performance. Given the emphasis on movement form and technique, this type of feedback tends to focus learners' attention on specific aspects of their movements. However, directing attention in this way is not necessarily the most advantageous technique for motor learning. In fact, a substantial body of evidence supports the use of an external focus of attention, whereby one directs attention to the effects of the movement, rather than an internal

focus of attention, whereby one directs attention to body movements (34).

Using feedback and directing the learners' focus of attention (internal and external attention focus) is more applicable than common methods in teaching motor skills and more important, especially in children. The aim of this study was to investigate the effects of focus instructions (internal and external) and attention feedback (internal and external) on learning the free throwing skill in children aged 9 to 11 years. The findings revealed that both internal and external attention focus improved motor performance in children. The internal attention was found to lead to better results in instant retention tests. Nonetheless, the result showed that both internal and external attentional feedback improved motor performance in children, while the external attention was better in this regard. Moreover, there are significant differences between internal and external attentional feedback to the advantage of the external one.

Despite many studies have indicated the facilitating effect of external attentional focus on motor learning among a variety of skills, there has been an important limitation. Most of the studies are limited to adults. Thus, the findings of the present study were to be discussed in line with the few studies about children. We found significant differences between internal and external attention in retention tests, and the advantages of using internal attention in the acquisition phase. So, the findings didn't confirm the anticipations achieved from adult studies. The results were aligned with those of Emanuel et al. (28) who explained the advantage of internal attention to learning throwing darts in children. The results were, further, aligned with those of Lawrence et al. (35) that confirmed the advantage of internal attention in adults. They were also consistent with Perrault's study (36) that examined the kind of thinking in learning

with regard to the kind of attention focused. There wasn't any significant difference between groups in the retention phase. However, our findings weren't in line with those of Thron (17) and Roshandel et al. (37) who reported the advantage of external attention to learning balanced activities and throwing darts in children. It seems that the findings don't support the constrained action hypothesis (38) and action effect principle (15), since the constrained action hypothesis can express specially the effect of internal learning against external attention focus. Both hypotheses agree that adopting external attention focus increases the efficiency of motor programming through reinforcement of the cooperation between motor plan and output. The action effect principle emphasizes the effects of initiative motor plans. It is logical that when the participants concentrate on motor effects, the motor programming organization increases leading to an increase in performance. So, for improving performance, it is important to attend to the clear motor effects related to the goal. Accordingly, it is suggested that if there isn't any clear motor effect to be presented in assignments, the advantage of adopting external attention may be perceived; a perception that supports the present findings. Thus, the lack of focus on motor effects in internal attention and lack of clear goal may lead to reducing the cooperation between motor planning and the final result. So, the advantage seen in adopting external attention has not been observed in the internal one (35).

The findings of the present study were aligned with Fathi khatab (39), Pahlavan et al. (40), Baniasad et al. (41), Marchent et al. (42), Naderirad et al. (43), and Dana (44). Naderirad et al. (43) examined the effects of transcendental task focus on height control learning in 9- to 12-year-old boys. Their result confirmed applying attention instructions as an efficient strategy for improving learning. Moreover,

the study by Fathi khatab et al. (39) entitled “The effect of focus instructions on dart throwing performance in children with and without developmental coordination disorder”, didn’t report any difference between two kinds of attention focus in children with developmental coordination disorder. While based on the constrained action hypothesis, the external and internal attentions lead to better performance in adults and children. Also, the present findings were aligned with those of femke van abswoude et al (45). Their result showed that both internal and external attention focus lead to better performance in children. The findings emphasized that children can use attention focus instructions, and internal and external attention in short-time to improve motor performance. Although children performed optimistically based on their focus, the priority on individual and special focus of activity influenced the performance of instructions. The results showed that the individual differences are the main factors influencing the effectiveness of motor performance in children. The exact and basic mechanisms in this study necessitated more research.

The present findings indicated the improvement of performance through using external attentional feedback in the second experiment. Evidence is presented expressing and confirming the advantages of external focus in motor learning during the presentation of feedback. Hence, the research evidence related to adults is confirmed. Wulf confirmed the advantages of external focus in learning football throwings when feedback were presented completely (against 33%). The present study found the same advantages when feedback was presented. It is, however, considerable that the expressed external advantages have been concluded based on the obtained scores. Since in most cases other contributing factors have not been exactly controlled, the changes in scores

can be due to other factors rather than the presented feedback, even though the feedback was emphasized in the interventions. So, further studies are required to know about the effects of attentional focus feedback in children and in relation to other variables.

Furthermore, the present results confirmed the findings of Thron (17) asserting the advantage of external focus in learning balanced activities among children. However, they aren’t consistent with those of Emanuel (16) and Perault & French (36) that didn’t find any advantage for external focus in learning Dart throwing and basketball free throwing in children. Moreover, in the study by Hoseininasab et al., the results of free throwing performance scores did not show any significant difference between the groups during retention, but showed the advantage of using internal attention in the acquisition stage (46). This difference was attributed to the existence of feedback. This conclusion can be reliable, due to the methodological advantages of this research over the other similar studies. For example, the findings of other studies didn’t present any advantage of external focus on cues and instructions learning 5 times during 50 trial exercises, while Hoseininasab et al. provided feedback 15 times during trial exercises. The highly accessible feedback was easy to achieve for children who had the related information in their working memory; sine they have less complex control processing abilities than adults. The person is enabled to access and use feedback to make more stable progress in his/her performance, along with harder trying and more enjoyment.

The present findings showed that external attentional feedback led to improvements in learning and performance of children in basketball free throwing. The findings were aligned with those of Martin et al. (46) and Shams (47), as Martin et al. (46)

examined the influence of an altered focus of attention and augmented feedback on ace speed in tennis players. The results showed that the integration of augmented feedback and external attention focus led to the best performance. They concluded that augmented feedback is useful in improving the ace performance in tennis. The evidence emphasized that the special level and related instructions influenced the kind of attention focus affecting motor performance.

Despite previous literature indicating the facilitating effects of external attentional focus on motor learning among a variety of skills, it should be considered that most of the studies have been limited to adults; and thus, the result could not be appropriately generalized to children. Different processing skills between children and adults differently influence their motor learning and performance. The main source of difference in information processing between adults and children is the speed of processing. The other important source is the performance (control process) of working memory (active) in children and adults. That is, as they grow up, they can make better use of strategies and knowledge in their storing memory. For example, children cannot easily use coding strategies for restoring information.

## 5- CONCLUSION

In general, the findings confirmed the use of internal and external attentional feedback and cues, especially external cues in free throwing among children and supported the constrained action hypothesis. The significant advantage was observed in participants who received external attentional feedback in children as anticipations in adults. The performance was improved through purposeful contents of external focus and adding the advantage of feedback in instruction based on quantity, motivation, and reinforcement. Overall, the studies showed that there isn't

any unified formula for presenting instructions to learners in all contexts and activities. The role of presenter, duty and environment should be taken into account as important reciprocal limitations in learning and performance. The practitioners have to understand the goal of duty in designing activity limitations for learning. Some factors such as the limitation of the main presenter including level of skill, model of learning, etc. can influence different situations of attention focus. It is necessary to examine how and when the instructors can more beneficially apply internal and external attention instructions to different levels of learning. So, with regard to the presented information, it is suggested that conceptual understanding be provided for teachers and instructors on how different focuses can help learners to gain skills; and how the changes in learning processes affect performance. The instructors have to adopt a facilitating role in guiding learners to find executive solutions for motor learning regardless of the presented kind of focus in different learning contexts. The future studies have to extend the present findings to other activities, age groups, related variables (such as frequency of feedback); and apply verbal reporting to examine the kind of mental processes occurring during performing activities.

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