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The Role of Task Constraints in Learning Football Chip Shot though Observation

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Abstract

The purpose of this study was to investigate the role of task constraint in learning football chip through observation. For this purpose, 20 children (with the mean age of 11.6±1.7) participated in this study and were randomly divided into two groups (each with10 individuals). At the acquisition stage, one group watched the model and they were told nothing about kicking the ball, while the other group was told that the task was to kick a ball that should land on a specified target. At the acquisition stage, participants performed 30 attempts (three blocks of ten attempts each) whose model's film they watched five times before the first attempt, and again, after each attempt they watched the film. After 24 hours, participants were recalled to the lab and performed ten attempts as a reminder. The kinematic movement of the participants was recorded in order to compare it with the model. The results showed that the non-ball group had a more similarity to the model than the group with the ball. However, these results showed that in the speed variable, the movement of the group with the ball was more similar to the model. These results were explained in terms of goal-directed imitation theory as well as the existence of an external goal in the task.

Keywords: Observational learning, Goal-oriented imitation, Coordination, External goal

Introduction

In the context of motor learning, learning is defined as the inner process associated with practice and experience (Schmidt & Lee, 2005). Based on this definition, learning is a process that requires practice and experience. Motor behavior experts use different methods to provide this type of experience. The most common method of training that trainers use to train skills is through physical practice. Sometimes, trainers use a model to transfer the information they need to teach. The trainers believe that novices can easily learn the skills they want through a model observation and then imitate it. Some view this process as observational learning. More specifically, observational learning can be defined as a process by which the observer tries to imitate the behavior displayed by the model (Williams, Davids, & Williams, 1999). The researchers believe that a cognitive representation form by observing, in which the observer will use this representation for making the next movement (Bandura, 1977). Although, human beings have a great ability to imitate complex movements, the underlying mechanism of this successful imitation is largely unknown (Wohlschläger, Gattis, & Bekkering, 2003). Meltzoff and Moore (Meltzoff & Moore, 1994) presented a theory which proposes an overexposure representation system that combines the perception and action systems. This theory is well known as active intermodal mapping theory. The intermodal mapping theory is consistent with the current conventional view, which believes that imitation, perception, and action are combined with a direct perceptual motor mapping (Gray, Neisser, Shapiro, & Kouns, 1991). This direct perceptual motor mapping is also supported by the neurophysiological findings. The presence of mirror neurons in the F5 region somehow reflects the system of perception and action pairing, since these neurons are activated by actual observing and implementing the movement.

Direct mapping theories, including intermodal mapping theory, cannot justify certain findings. For

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example, in 18-month-old babies, it has been shown that not only these children react to the actions of the adults, but also they can infer the action that the adult has intended to do but failed to achieve it (Meltzoff, 1995). Although, these results are explainable using this direct mapping, there are some results that are no longer explained by this theory. It has been shown that, in some cases, imitation systematically diverges from the pattern of model movement (Wohlschläger et al., 2003). Accordingly, the goal-directed imitation theory was presented (Wohlschläger et al., 2003). According to this theory, imitation is cognitively guided by a specified goal, ie, the person does not imitate the movement during the imitation, but turns the observed movement into several distinct aspects, each of which is a goal. These aspects of movement are arranged in a hierarchical manner, and the highest aspect of this hierarchy becomes the main goal of the imitator (Wohlschläger et al., 2003). Other sub-aspects become the sub-goals. This theory somehow contrasts with the early work of observational learning. Researchers who have done the initial work on observational learning believe that successful learning is that the observer can accurately imitate the movement that had been shown (Bandura, 1977). However, this theory believes that in some cases the observer may not imitate the path of the individual's movement and instead, another goal (for example, achieving a result) would be placed in higher order in his hierarchy of goals, which leads to the deviation of the movement pattern (Wohlschläger et al., 2003). A lot of research has been done on this theory most of which have used point-light as a means of manipulating external goal of the task. The researchers believe that the kinematic information would be highlighted in point-light displays and extra structural information would be removed from the screen (Johansson, 1973). This method is used because the information about the object (ball or projectile) is not available in the point-light and the researcher can add or remove the role of the task constrains using the instruction. Using this method, it has been shown that in a ball-kicking task, there is no difference between the group receiving verbal information and the group receiving the videotape. The researchers argued that the achievement of the goal was probably the first priority of the participants and that is why no difference was observed between the groups (Horn, Williams, & Scott, 2002). In another study, the role of the constraint on learning the pattern of the movement was studied (Wild, Poliakoff, Jerrison, & Gowen, 2010). The results of this study showed that when there is an external goal in movement, the pattern of the movement would not be well understood, and a movement pattern will be well understood when it does not require the achievement of an external goal (Wild et al., 2010).

In other studies, the eye movement of individuals was investigated and it was shown that individuals in the non-target state tended to follow kinematic data more than when there was an external target (Wild, Poliakoff, Jerrison, & Gowen, 2012). Recently, in a research on an innovative movement, it has been shown that the existence of an external goal in the task leads to the destruction of learning the movement pattern (Fazeli & Moradi, 2017). In other studies, it has been shown that the existence of an external goal may not be the main constraint for observational learning (Cole, Atkinson, D'Souza, Welsh, & Skarratt, 2017; Cracco et al., 2018; Forbes & Hamilton, 2017).

Contrary to these evidences, the results of some studies show that there is a better coordination pattern when there is an external goal for accessing the movement. For example, in a research on a football kick, the results showed that the existence of an external goal in the task would lead to a pattern more closely resembling a skilled pattern than a non-external goal (without goal) (Hodges, Hayes, Breslin, & Williams, 2005). In parallel with the results of this research, another study on bowling showed that the existence of a goal in the task would lead to more similar movements of the participants with the model (Hayes, Hodges, Huys, & Williams, 2007). These results were also repeated in a further study of ballistic performances (Hayes, Ashford, & Bennett, 2008).

Considering the contradiction between the researches, in which some support the idea that the existence of an external goal in the task would result in neglecting the pattern of movement and others believe that the existence of an external goal in the task leads to better learning of the movement pattern, more research would be needed. One of the factors that can be attributed to these various findings is the use of adults and simple tasks in the research. Research has shown that the movements that have been previously learned and are meaningful to the individual (with goal) are better imitated than the novel movements without meaning (without goal) (Rumiati & Tessari, 2002). The goal-directed theory of imitation (Bekkering, Wohlschläger, & Gattis, 2000) may be applicable to cases in which the intended movement requires the acquisition of a new coordination pattern, and possibly when the movement is novel, the existence of an external object causes the individual to be discarded from the movement pattern, and the person cannot achieve the same coordination pattern as there were no external goal (Bekkering et al., 2000; Wohlschlager et al., 2003). Accordingly, the possible reason is that adults, who have participated in previous research and have been trained in simple tasks, probably had these movements in their movement memory and their task has been meaningful for them. For this reason, children from 10 to 12 years old were used as a participant in this research to help further clarify the ambiguity of this research field.

Method

Participants

The participants included 20 children (aged 10 to 12 years old and mean of 11.6±1.7) who took part voluntarily in this study. The participants in this study were randomly divided into two groups of 10 individuals, with and without ball, so that the mean age of both groups would not be significantly different. Written consent was obtained from parents of children before participating in the research.

Instruments

Balls (Size 4) were used to perform the chip shot task. Also, in order to perform a chip shot, a string was placed on two rods, with the height of 40 centimeters from the ground. A metal cube with a square meter of two meters in two meters and height of 5 centimeters were placed on the ground, which was filled with soft sand to determine the location of the ball when it landed on the ground. In the middle of container, there was a red circle with a diameter of 10 centimeters, and participants should have kicked the ball so that it would pass the string and hit the red target. Maximum error was considered for the ball that did not pass or fell out of the container. The distance from the starting point to the string was one meter and it was two meters up to the edge of the container. In a preliminary study, the ability to perform this task was reviewed with children of the same age range. Participants in this preliminary study included 10 people, none of whom participated in the main study.

The projector was also used to display the film, which flashed a pattern on a two-meter in two-meter display.

Procedure

First, in order to prepare a film, a person (18 years old) was asked to practice the task for five days and 100 attempts each day. The model was created when stability was seen in the performance graph of the person. Model's film was created in a process. Then, in order to provide the point-light film, the 18 light reflecting markers were placed on the body of the person that were arranged as follows: the distal of fifth metatarsal (toe), tarsus (ankle), external condyle (Knee), greater trochanter (thigh), clavicle (shoulder), epicondyle (elbow), ulna (wrist) and distal of the first metacarpal (finger) and forehead (head) (Fazeli & Moradi, 2017). Then, the model was asked to execute the desired task. The film was taken from one of the model's moves that passed the string and landed exactly in the middle of the target, and then, the film was used as the model's film. The movement was filmed by six Qualysis cameras, and then, the point-light film was created with QTM software.

Participants were then assigned to the task based on their grouping. The group with the task constraint should do the task the same as the model. This group, like the model film, should have kicked the ball and the ball should have hit the target. Participants were told to do the movement as similar as possible to the model, and the ball should land exactly in the middle of the target. They were told that reaching the goal and imitating the movement of the model have equal scores. However, for the group without task constraint, the film was shown and nothing was said about kicking the ball, and nothing was said about the purpose of the movement, and they were only told to watch the moves, and imitate it. It should be noted that there were no information about the context in the point-light film, and there were only information about the markers placed on the body, so participants had no information about receiving and kicking the ball. On the body of the participants, markers were placed similar to the model to record their movement kinematic and then, compare them with the model.

At the acquisition stage, individuals performed 30 attempts (three blocks of 10 attempts with two minutes rest between each block). Before the first performance, the film was displayed five times and in next attempts, the film was displayed before each attempt.

Twenty-four hours later, the participants came to the lab to test the retention and performed ten attempts as retention test. At this stage, similar to the acquisition stage, light reflective markers were placed on their bodies and their performances were filmed by Qualysis cameras. No film was displayed to participants at this stage.

Data Analysis

In order to compare the similarity of movement coordination of participants with the model, a form of coordination measurement between the body parts was used, which is known as the Normalized Root Mean Squared Difference (NORMS-D). This modified formulation is based on the formula developed by

(Sidaway, Heise, & SchoenfelderZohdi, 1995) (Hayes et al., 2007). This formula provides an indicator of similarity to the model, in which smaller indicator means the greater similarity of the movements between the participants and the model (Hodges et al., 2005). Since all the subjects were right-handed and the desired movement was done with the right leg, the kinematics of the right side of the body was used in compare to the model. These kinematics include hip-knee coordination, knee-ankle coordination, and the maximum difference between the ankle speed of the participants and the model. Before any calculation, the start and end of the movement were determined. The first flexion of the knee was considered as the start of the move, and the maximum knee opening after kicking the ball was considered as the end of the movement. Then, the data were calculated and transmitted from a Fourth-Order Filter of the 7-Hertz Butterworth, and then, the data was transmitted to 100 data (Winter, 1990). The kinematic data in the acquisition stage, from the first three attempts of the first block (attempts 1 to 3), the three final attempts of the second block (attempts 18 to 20), and the three final attempts of the third block (attempts 28 to 30), were used to calculate the NORMS-D (Fazeli & Moradi, 2017; Hayes et al., 2007). These three attempts were called the first to third acquisition blocks.

In the retention phase, the first three attempts (attempts of 1 to 3) and three final attempts (attempts 8 to 10) were used to calculate NORMS-D. Also, in order to calculate the maximum difference between the wrist speeds of the participants and the pattern, the wrist speed of individuals were reduced from the patterns in each attempt and the difference was calculated.

To analyze the data at the acquisition stage, a variance analysis scheme 2 (groups) × (3 categories of acquisition attempts) was used that has repeated measures in their last factor. In the retention phase, a variance analysis scheme 2 (groups) × (2 sets of retention attempts) was used, which has repeated measures in their last factor.

Findings

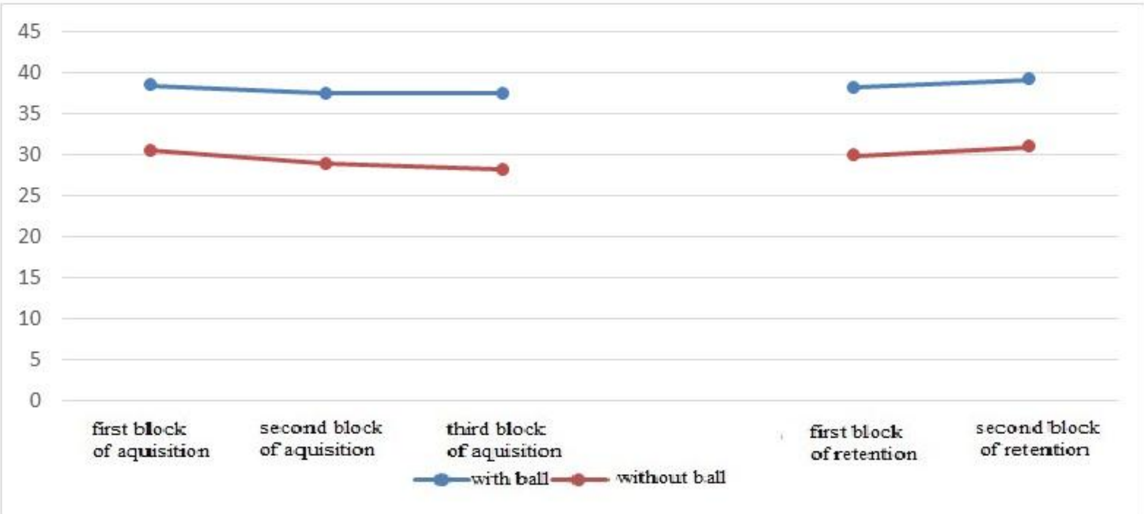

Figure 1.
NORMS-D diagram for hip-knee

The results of ANOVA test showed that the main effect of the group was significant (η^2_p= 0.32, p= 0.008, F (1 & 18) = 8.75). However, the main effect of the block not significant (η^2_p = 0.05, p= 0.34, F (2 & 36) = 1.09), and interaction of group in block, (η^2_p=0.01, p= 0.82, F (2 & 36) = 0.19). For the main effect of the group, the mean comparison showed that the non-ball group performed more like the model than the group that imitated the movement with the ball (means, without ball = 29.2, with ball = 37.8).

Table 1.
Results of ANOVA test for hip-knee coordination during acquisition.

source	Sum of squares	df	Mean square	F	sig	Partial Eta squared
Group	11.1	1	11.1	8.75	0.008	0.32
block	0.3	2	0.1	1.09	0.33	0.05
Group× block	0.1	2	0.0001	0.19	0.82	0.01

The results of analysis of variance for the retention stage showed that the main effect of the group is significant (η^2_p= 0.40, p=0.003, F (1&18) =12.01). However, the main effect of the block and its interaction with the group was not significant, all F<1. For the main effect of the group, mean comparison showed that the non-ball groups performed more similar to the model than the group with balls (means without ball = 30.3, means with ball = 38.6). Figure 1 shows a performance diagram of the groups at different stages in the NORMS-D variable for the hip-knee.

Table 2.
Results of ANOVA test for hip-knee coordination during retention.

source	Sum of squares	df	Mean square	F	sig	Partial Eta squared
Group	6.8	1	6.8	12.01	0.003	0.40
block	0.1	1	0.1	0.72	0.40	0.03
Group×block	0.0001	1	0.0001	0.0001	1.0	0.0001

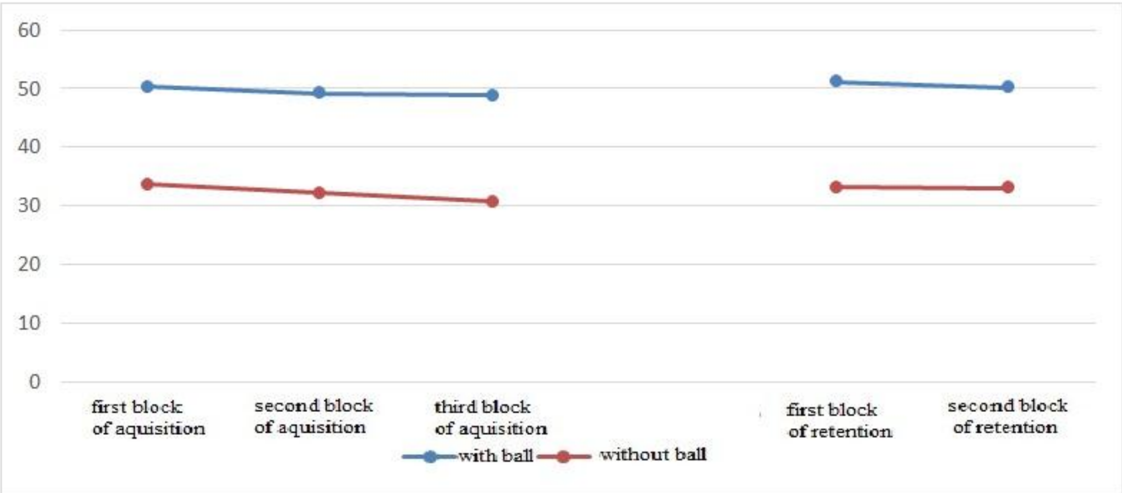

Figure 2.
Performance of the groups in the coordination of the knee and ankle.

The results of ANOVA test showed that the main effect of the group was significant (η^2_p= 0.79, p= 0.0001, F (1 & 18) = 71.06). Also, the results showed that the main effect of the block was also significant (η^2_p = 0.25, p=0.005, F (2 &36) =6.07). However, the interactive effect of the group in the block was not significant (η^2_p = 0.03, p= 0.57, F (2 & 36) = 0.57). The comparison of the means of the main effect of the group showed that the non-ball groups performed better than those with balls (means, without balls = 32.2, with balls = 49.5). For the main effect of the block, Bonferroni's post hoc test was used, which results showed a significant difference between the first and third block of acquisition (P <0.05). The comparison of the means showed that the groups in the third block of acquisition performed more similar to the model than the first block (means, first attempt group=42, third attempt group=39.8).

Table 3.
Results of ANOVA test for knee- ankle coordination during acquisition.

source	Sum of squares	df	Mean square	F	sig	Partial Eta squared
Group	44.9	1	44.9	71.06	0.0001	0.79
block	0.5	2	0.003	6.07	0.005	0.25
Group× block	0.0001	2	0.0001	0.57	0.57	0.03

The results of the analysis of variance for the retention stage showed that the main effect of the group was significant (η^2_p= 0.71, p=0.0001, F (1&18) = 44.52). However, the main effect of the block (η^2_p= 0.03, p=0.44, F (1 & 36) =0.60), and group interaction of group in block was not significant (η^2_p= 0.01, p=0.61, F (1&36) =0.27). The mean comparison of the main effect of the group showed that the non-ball group performed more similar to the model than the group that imitate the movement by kicking the ball (means, without ball = 33.2, with ball = 50.7). Figure 2 shows the performance of the groups in coordination for knee-ankle.

Table 4.
Results of ANOVA test for knee- ankle coordination during retention.

source	Sum of squares	df	Mean square	F	sig	Partial Eta squared
Group	30.5	1	30.5	44.52	0.0001	0.71
block	0.0001	1	0.0001	0.67	0.44	0.03
Group×block	0.0001	1	0.0001	0.27	0.61	0.01

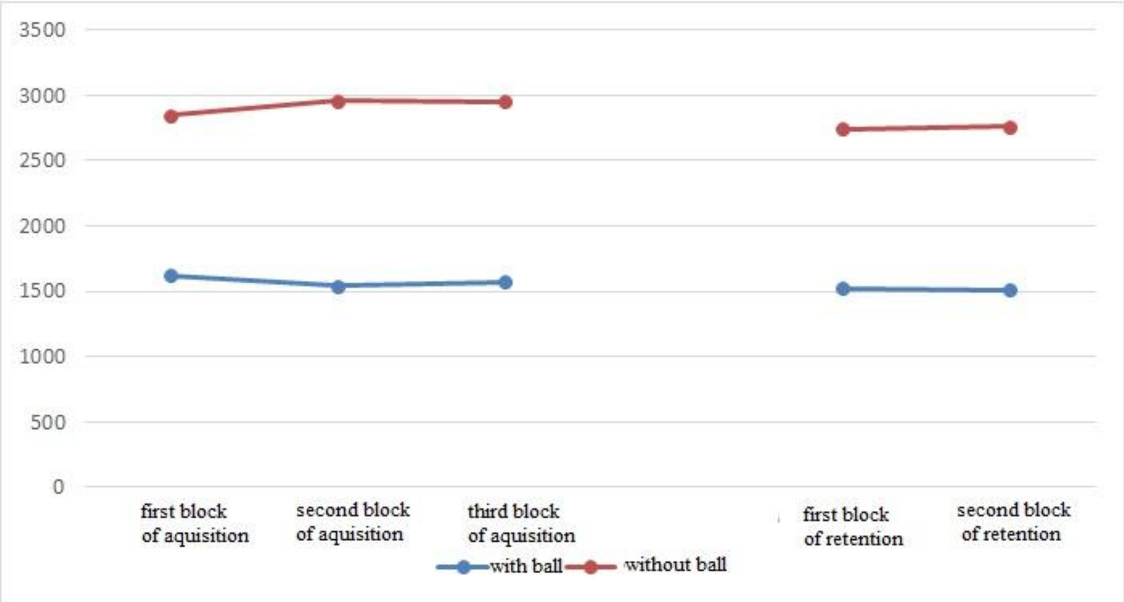

Figure 3.
The performance of the groups at the maximum difference between the leg speed of the participants and the pattern

For the maximum speed difference, the results of the analysis of variance for the acquisition stage showed that the main effect of the group was significant (η^2_p=0.58, p=0.0001, F (1&18) =25.73). However, the main effect of the block (η^2_p=0.004, p=0.93, F (2 &36) = 0.06), and group interaction in the block (η^2_p= 0.03, p=0.53, F (2 &36) = 0.63), were not significant. For the main effect of the group, the mean comparison showed that the group with ball had less differences with the model in comparison to the non-ball group (means: without ball = 2914, with ball = 1575).

Table 5.
Results of ANOVA test for maximum speed difference during acquisition.

source	Sum of squares	df	Mean square	F	sig	Partial Eta squared
Group	2.686E7	1	2.686E7	25.73	0.0001	0.58
block	9504.99	2	4752.499	0.06	0.93	0.004
Group× block	88885.56	2	44442.78	0.63	0.53	0.03

For the retention stage, the results of ANOVA test showed that the main effect of the group was significant (η^2_p= 0.55, p= 0.0001, F (1&18) =22.57). However, the main effect of the block (η^2_p= 0.01, p= 0.89, F (1 &18) =0.01), and group interaction in the block (η^2_p=0.006, p=0.74, F (1 &18) =0.11) were not significant. The mean comparison of the main effect of the group showed that the group with ball had less differences with the model than the non-ball group (means, without ball= 2747, with balls = 1512). Figure 3 shows the performance of the groups in terms of maximum difference between the speed of the participants' and the model's leg.

Table 6.
Results of ANOVA test for maximum speed difference during retention.

source	Sum of squares	df	Mean square	F	sig	Partial Eta squared
Group	1.524E7	1	1.524E7	22.57	0.0001	0.55
block	490	1	490	0.017	0.89	0.001
Group× block	3240	1	3240	0.11	0.74	0.006

Discussion and Conclusion

The purpose of this study was to investigate the role of the task constraints on learning football chip shot through observation. The results of this study showed that in the changeability of the variable of coordination between body parts in relation to the model, the non-ball groups performed more similar to the model. These results were true for both acquisition stage and the retention stage. These results were also consistent with the results of some previous studies (Chiavarino, Bugiani, Grandi, & Colle, 2013; Cole et al., 2017; Cracco et al., 2018; Fazeli & Moradi, 2017; Horn et al., 2002; Wild et al., 2010). Also, these results contradict with some previous research (Hayes et al., 2007; Hodges et al., 2005). Possible reasons for such a contradiction can be related to a different movement memory of participants involved in this research and previous research (Hayes et al., 2008).

It is believed that, when the desired movement is in participants' memory, information representation will not play a role in improving their movement pattern (Scully & Newell, 1985), and more observational information at the beginning of the learning the movements pattern plays an important role in the observation learning process (Scully & Newell, 1985). For this reason, in the researches, which showed that the existence of a task constraint can be the cause of the similarity of the participants movement with the model, the reason would be that the movements were already existed in the participants' movement memory, and despite the existence of task constraint in the movements, the necessity of achieving the common goal caused the similarity of their movement with the model, and generally, imitation of the movement was not their main goal in the observation process (Wohlschläger et al., 2003). However, in this research, children were used as participants. Less movement memory of children in this study may lead to different outcomes in comparison to some previous research. It is likely that when there was a task in movement, the main goal of the participants was to reach the external goal, which caused participants to neglect the information displayed by the pattern (Chiavarino et al., 2013; Fazeli & Moradi, 2017; Wild et al., 2010; Wohlschläger et al., 2003).

However, when there was no task, it was likely that the pattern displayed was the main goal of the participants, which is why their movement was more similar to the model than the group with the ball (Wild et al., 2010, 2012). In the variable of leg movement speed, the results were opposite of the findings in the movement coordination variable. In this variable, it was shown that the speed of leg movement of those who imitate the movement with a ball was more similar to the model than the non-ball group. These results, at first glance, contradict with the findings of vision perception (Scully & Newell 1985). According to this view, the parameters of the movement variable are not achievable through observation, but in this study, the group that performed the movement with a ball had the same speed as the model person. It should be noted that if the speed parameter was achieved through observation in this study, then the speed of the non-ball group should be similar to the model and also similar to the group with the ball, but this was not the case. One possible reason is that the achievement of an external goal at a given distance for the group with a ball (similar to the pattern) has led to such a similarity (Fazeli & Moradi, 2017; Hayes et al., 2007). When we look at the results of the non-ball group, the validity of this argument is more confirmed. In the non-ball group, since there was no external goal to achieve, their first priority was to achieve a similar movement pattern as the displayed information, which is why their speed was less similar to the model than the group with ball. (Fazeli & Moradi, 2017; Hayes et al., 2007).

In general, the results of this study showed that, where there is a task constraint and the movement requires an external goal, in comparison to the condition with no task and no need for the external goal, the movement coordination of the individuals is less similar to the displayed model. The probable cause based on the goal-oriented imitation hypothesis can be that in the presence of an external goal, the first priority of observing individuals is not the imitation of the model of movements and the achievement of the external goal would be the higher priority (Cole et al., 2017; Cracco et al., 2018; Wild et al., 2010; Wohlschläger et al., 2003). Also, the results of this study showed that although the existence of an external goal negatively impacts the movement pattern, it would be helpful to achieve the movement parameter, and the movement speed of the individuals' body parts will be more similar to the model in comparison to the non-goal condition.

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