DOI: 10.22122/jrrs.v16i1.3554 Published by Vesnu Publications

The Effect of Verbal and Analogical Learning on the Accuracy and Angular Velocity of Dart-Throwing in Children

Natalie Gedayloo[1], Shahzad Tahmasebi-Boroujeni[2], Masoumeh Shojaei[3]

Original Article

Abstract

Introduction: The importance of implicit learning and ways to achieve it in learning motor skills is increasing. However, little research has been carried out on children and the effects of analogy on children's compressive performance are unclear. This study is performed aiming to compare analogy and verbal learning on accuracy and angular velocity of dart-throwing skills in children.

Materials and Methods: This experimental study was performed using a semi-experimental design in 24 children with a mean age of 11.06 ± 2.2 years. The subjects were selected by the convenience sampling method and randomly divided into three groups: verbal training, analogy, and control. After the dart throw test (10 attempts), the participants underwent 8 rehearsal sessions (including 50 attempts per session). Retention and transfer tests were taken 3 weeks after the last session and 10 attempts were made on the variables of radial error and angular velocity. Data were analyzed using mixed-design analysis of variance (ANOVA) (3 × 4 in performance and 3 × 3 in angular velocity). $\alpha = 0.05$ was considered as the significance level.

Results: The results showed that the verbal group had a significant decrease in radial error in the acquisition ($P < 0.001$), retention ($P \leq 0.003$), and transfer ($P \leq 0.025$). However, an increase in error was observed in the learning ($P \leq 0.001$) and transfer stages ($P < 0.001$) in the control group, and in the transfer stage in the analogy group ($P \leq 0.038$). Moreover, the verbal group had a significant increase in elbow angular velocity ($P \leq 0.005$), while in other groups there was no significant difference between the test phases ($P < 0.05$).

Conclusion: It seems that verbal instruction increases the angular velocity, improves accuracy and performance compared to analogy, and is more effective in children's performance.

Keywords: Analogy instruction; Explicit learning; Implicit learning; Angular velocity; Dart-throwing; Children

Citation: Gedayloo N, Tahmasebi-Boroujeni S, Shojaei M. **The Effect of Verbal and Analogical Learning on the Accuracy and Angular Velocity of Dart-Throwing in Children.** J Res Rehabil Sci 2020; 16: 103-9.

Received: 18.05.2020 Accepted: 01.07.2020 Published: 05.07.2020

Introduction

All specialists, researchers, and coaches in sports science and other related fields are trying to find efficient methods and identify the factors affecting the acquisition and learning of motor skills. Implicit and explicit learning are among types of learning. The process by which individuals become specialized at performing skills without being aware of what they are performing is called implicit learning. In this type of learning, information is processed at an unconscious level and cannot be presented verbally (1). Different strategies have been proposed for implicit learning, including chain situations (2), skill learning with simultaneous secondary task (3), learning without feedback (4), low-error learning (1), analogy learning (5), exploratory learning (6), and guided exploratory learning (7).

A quick look at the research on motor learning shows that in the past, instruction in skill training was given verbally and step by step, and the person began to practice the skill with full knowledge of the obvious knowledge of the basic principles of movement. However, the findings of subsequent studies have suggested that lack of presenting the skill implementation instruction to individuals and lacking explicit knowledge not only do not have a negative impact on skill learning, but also improves performance

1- PhD Student, Department of Motor Behavior, Faculty of Physical Education and Sport Sciences, University of Tehran, Alborz Campus, Tehran, Iran
2- Associate Professor, Department of Motor Behavior and Sport Psychology, Faculty of Physical Education and Sport Sciences, University of Tehran, Tehran, Iran
3- Associate Professor. Department of Motor Behavior, Faculty of Sport Sciences, Alzahra University, Tehran, Iran
Corresponding Author: Shahzad Tahmasebi-Boroujeni, Email: shahzadtahmaseb@ut.ac.ir

under certain conditions (8,9). Skills that are learned explicitly and without accumulation of task-related rules and knowledge are better performed over long periods of time under stressful conditions, fatigue, and multiple tasks (10). The purpose of learning a skill is to apply it in real life. Therefore, many researchers believe that implicit learning processes enhance resistance to disorders due to cognitive overload, psychological stress, and physical fatigue; while in explicit learning, under similar conditions, the overall performance may be severely impaired (11).

The results of investigations in this area are contradictory, with some reporting no significant difference in the accuracy of throws in basketball shots and joint kinematics between the two groups of explicit and analogy training in young people (12,13). However, some other studies have demonstrated the superiority of analogy learning over verbal learning in the young people over the elderly in the Top Spin stroke in table tennis (a stroke in which the racket is applied onto the ball) (14), and improved badminton learning in the elderly (15). Analogy instructions seem to reduce confidence in verbal information processes during motor programming compared to traditional forms of training (explicit rules of how to move). Although the study of two groups of novice basketball players with high or low preference for receiving verbal instructions showed a significant decrease in the activity of verbal areas of the brain in the high preference group after analogy learning, their function remained constant. However, the low preference group did not show a significant decrease in verbal areas of the brain after the analogy learning, but their performance declined significantly. In other words, cognitive and functional changes after analogy training may depend on personal aspects of information processing such as verbal preference (16).

The childhood level is one of the levels of maturation of individuals. This period of the individual is different from adulthood in terms of psychological skills and perceptual-cognitive-motor processes are not refined like the adulthood period (17). Thus, children may respond to the effects of psychological skills with difficulty or differently than learners who have gone through developmental stages. Given these different cognitive and motor abilities, different learning strategies that are useful for adults may not be necessarily optimal for children (18). Perhaps one of the reasons for this is the challenges and limitations involved in attracting children to participate in research. However, in order to gain more knowledge and insight, it is necessary to conduct more extensive studies on this group. Additionally, given the few studies accomplished in the field of implicit learning, more evidence is needed to confirm the acquisition of the pattern and its persistence in the implicit method. Therefore, the present study is carried out with the aim to apply the effects of implicit learning and its application in everyday situations. Some studies have found the verbal method to be effective (13,16,19) and others have advocated explicit learning (14,15,20). Accordingly, the present study examines the question of whether there is a difference between explicit and implicit learning in accuracy and acquiring a dart-throwing skill pattern and whether these guidelines can lead to the acquisition and learning of darts?

Materials and Methods

This study was a quasi-experimental study that was designed in an intra-group and inter-group form and was conducted every other day evenings from 4 to 6 in the gym of the Malaek Welfare Center. G*Power software was employed to estimate the sample size based on the study by Oppici et al. (21) and Van Dyck et al. (22). Based on the statistical method of mixed-design analysis of variance (ANOVA) factor analysis, 3 groups, 4 repetitions, power of 0.95, and η^2 related to interactions of 0.35, the minimum sample size was estimated to be 24 people. The participants were randomly selected from 50 students aged 7 to 13 from the Malaek Welfare Center and were divided into three learning groups: verbal, analogy, and control. The study inclusion criteria included physical health and immaturity. In addition, dissatisfaction with the continuation of the training process and absence of more than one training session were also considered as the exclusion criteria. In order to ensure the musculoskeletal immaturity of the participants, the relevant person and then the participants themselves were asked about their start of menstruation period. The participants participated in the project voluntarily and an informed consent form was obtained from them. The study process was approved by the Institute of Physical Education and Sports Sciences affiliated to the Ministry of Science, Research and Technology of Iran with the code IR.SSRC.REC.1398.027.

To perform the movement task, a standard Unicorn dartboard with a diameter of 45 cm was used, which was hung at a height of 122 cm from the ground and at a distance of 2 m from the subject (23). The camera used in the present study was a Casio digital camera (EX-ZR1000, China) with a frequency of 240 frames per second, which was placed 6 meters away from the person at an angle of 90 degrees to him (24). Light-

reflecting markers were affixed to the superior hand and to the anatomical sites of the internal styloid process of the wrist, the outer epicondyle of the arm, and the acromion of the shoulder (25).

In the exercise room, the subjects first performed 10 attempts without any training, using kinematic data and throw accuracy as pre-test information. Then, they were randomly divided into three groups of verbal, analogy, and control learning (8 subjects in each group). Each person in each group performed 400 training attempts in the form of 10 sets of 5 attempts in each of the 8 training sessions with the relevant instructions. The next day, exercises for each group began. Before starting the first attempt set, the subjects were given three test throws to warm up and get acquainted with the exercise. In the group of verbal training, verbal instructions such as how to stand, hold a dart, and how to throw it were presented to each subject. In the analogy group, likening of throwing a stone into the hole was used and the control group was asked to shoot a dart at the center of the plate. Three weeks after the last training session, each subject performed two sets of 5 attempts without instructions as a retention and transfer test. In the transfer test, a competition was held to create high-pressure conditions and the subjects were informed that the first three people would be awarded (26).

To analyze the data, the images were first processed in Kinovea software version 8.27 (Kinovea 0.8.27-October 2018) and the angular velocity was obtained from the angular difference between the maximum elbow flexion and the elbow angle at the moment of release divided by the throw time (27). Information about the elbow flexion and extension and dart flight time were extracted and analyzed in Excel software version 2013 (Microsoft Corp. Released 2013. Microsoft Office for Windows, Redmond, WA, USA). Accuracy was also measured using radial error (RE) (Equation 1) and in RE, which showed the mean deviation of the dart from the center of the target and a lower number indicated a better performance. In each throw, the coordinates of the dart landing point on the horizontal and vertical axes were recorded in terms of distance from the center in centimeters. The landing point of each dart had coordinates x, y.

Equation 1: How to calculate the radial error M (Median) RE = RE = $\sqrt{(x^2/Y^2)}$

Since the radius of the dartboard was 22.5 cm, the coordinates of the darts outside the dartboard range for x and y were considered as 23 and 23, respectively (24). The throwing time from the moment the dart was released from the subject's hand until it hit the dart plate was calculated in the Kinovea software and its angular velocity was obtained from the angular difference between the maximum elbow flexion and the elbow angle at the moment of release divided by the throwing time (27).

The normality of data distribution was checked and confirmed using Shapiro-Wilk test. Mean and standard deviation (SD) central tendency measures were applied for descriptive statistics and mixed-design ANOVA of 3 (groups) in 4 (tests) for analysis of performance variables (radial error and variable) as well as for the variable of elbow joint velocity analysis. Paire-wise comparisons were performed by least significant difference (LSD) post hoc test. Finally, the data were analyzed in SPSS software (version 24, IBM Corporation, Armonk, NY, USA). $P < 0.05$ was considered as the significance level.

Results

The demographic information of the participants of the three groups is given in table 1. Despite the random division of the subjects into three groups, age and demographic characteristics in the control group were higher compared to the other two groups; however, this difference was not significant ($P < 0.05$).

Table 1. Demographic characteristics of the participants (8 subjects in each group)

Groups	Age (Year)	Weight (kg)	Height (cm)
Verbal	10.75 ± 2.77	43.00 ± 16.89	142.25 ± 12.26
Analogy	10.62 ± 1.73	40.27 ± 15.95	141.00 ± 13.47
Control	12.00 ± 1.77	49.85 ± 15.90	145.16 ± 9.95

Data are reported as mean ± standard deviation (SD).

The results of descriptive statistics of the radial error and elbow joint velocity variables are presented in table 2. It should be noted that the speed of movement of the elbow joint was not evaluated in the dart throwing skill acquisition stage.

Table 2. Mean of variables in different conditions

Variable	Radial error (cm)			Elbow joint speed (degrees per second)		
	Control	Verbal	Analogy	Control	Verbal	Analogy
Pre-test	20.35 ± 3.89	22.15 ± 2.76	18.53 ± 3.66	-0.64 ± 0.22	-0.62 ± 0.18	-0.75 ± 0.17
Acquisition	12.64 ± 3.69	14.26 ± 4.18	16.08 ± 4.01	-	-	-
Delayed retention	20.42 ± 2.81	16.00 ± 5.34	19.39 ± 3.27	-0.56 ± 0.19	-0.78 ± 0.19	-0.67 ± 0.20
Delayed transfer	20.71 ± 1.63	18.26 ± 2.62	19.99 ± 1.95	-0.57 ± 0.21	-0.37 ± 0.16	-0.59 ± 0.09

Data are reported as mean ± standard deviation (SD).

The descriptive statistics of performance accuracy of the three groups are shown in figure 1.

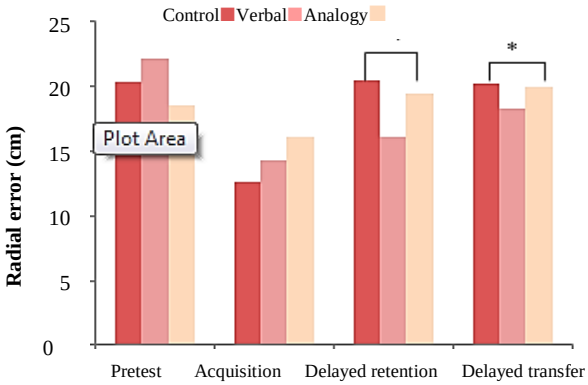

Figure 1. Mean radial error at different stages
* Significant differences between groups in the test phase at the level of P < 0.05

Descriptive statistics of angular velocity of the three groups are also presented in figure 2.

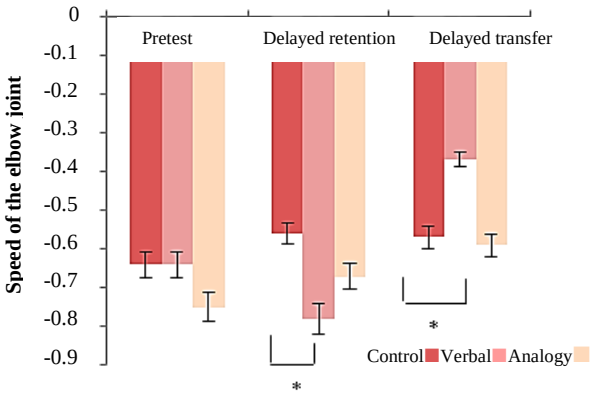

Figure 2. Mean speed of the elbow joint in different stages (a larger negative number indicates a lower speed and vice versa)
* Significant differences between groups in the test phase at the level of P < 0.05

Based on the data of figure 1, the results of 3 by 4 mixed-design ANOVA in RE showed that the main effect of the test (η^2 = 0.421, P < 0.001, $F_{(3,63)}$ = 27.23) and the interactive effect of the test and the group (η^2 = 0.213, P < 0.016, $F_{(6,63)}$ = 2.64) was significant, but the main effect of the group was not significant (η^2 = 0.051, P = 0.580, $F_{(2,21)}$ = 0.56). Given the LSD post hoc test results, the verbal group showed a significant decrease in RE in all three stages of acquisition (P < 0.001), retention (P = 0.003), and transfer (P = 0.025) compared to the pretest. The control group also showed a decrease in error (P < 0.001) from pre-test to acquisition, but an increase in error in the stages of retention (P = 0.001) and transfer (P < 0.001); while in the analogy group, an increase in error was observed only in the transfer compared to the acquisition (P = 0.038) (Table 2). Moreover, there was no difference between the groups in the findings of radial error of pre-test and acquisition stages, but the RE of the verbal group in retention test (P = 0.037) and transfer (P = 0.031) was less than the control group and there was not a significant difference between the other groups.

The results of 3-by-3 mixed-design ANOVA in elbow joint speed indicated that the main effect of the test (η^2 = 0.266, P = 0.002, $F_{(2,42)}$ = 7.59) and the interactive effect of the test and the group (η^2 = 0.266, P = 0.010, $F_{(2,42)}$ = 3.80) were significant, however the main effect of the group was not significant (η^2 = 0.09, P = 0.373, $F_{(2,21)}$ = 1.03). Given the results of pairwise comparisons of the main effects of the test, the speed in transfer increased significantly compared to the pre-test (P = 0.002) and retention (P = 0.001) stages (Table 2). Furthermore, the findings revealed that the speed of the verbal group in the retention stage was lower than the control group (P = 0.038), but in the transfer stage, it was higher than the control group (P = 0.025). Based on the results of the intra-group comparisons, only the verbal group showed a significant increase in speed from pre-test to transfer (P = 0.005), but in other groups, no significant difference was observed between the test stages (P < 0.050) (Figure 2).

Discussion

The aim of this study was to determine the effect of verbal and analogy learning on the accuracy and kinematics of dart throwing skills in children. The findings suggested that dart throwing skills training, both verbally and analogically, led to a significant decrease in RE, but in the verbal group this decrease was significantly higher than that in the analogy and control groups. In the throw angular velocity variable, the verbal group showed a significant increase in speed from the pre-test to the transfer, and no significant difference was observed between the test stages in the other groups. The speed of the verbal group was lower compared to the control group in the retention stage, but increased in the transition to the control group. These results confirm the principle of the power law of practice (28) that at the beginning of training, a significant improvement in overall performance is observed. According to this law, most physical skills performance curves have a negative acceleration curve.

In other words, as practice continues, progress is significantly reduced. Thus, in the early stages of practice and when there are more items to learn, progress is much faster than in the final sessions of practice where there is not much left to learn (29). The results of the present study confirm the above. In the analogy learning, no explicit instructions were given to the learner regarding the dart throwing movement, and only throwing darts was likened to throwing a stone into a hole. Therefore, in the learning process of this group, working memory (WM) was not active and the learners, regardless of the details of the task execution method, learned the connection between the components of the task unconsciously and were not aware of what they learned.

According to Schmidt and Lee's three-step model for motor learning, the performance of individuals in the early stages is associated with numerous and large errors and also, is very variable and shows its inequality from one effort to another (29). In the early stages of learning, movement pattern is acquired during practice and gradually. Therefore, from the pre-test to the transfer test stage, a difference could be observed in increasing the mean angular velocity of the verbal group. If motor learning is examined from Gentile's point of view, who introduces it as a progression between the first and second stages (30), it is clear that the participants in the present study sought to understand the concept of movement as the appropriate pattern required to achieve the goal of the desired movement.

It is believed that the analogy acquisition of skill takes place through the transition from declarative knowledge to procedural knowledge: that is, the first stage of skill acquisition (cognitive stage), is fulfilled through the testing of hypotheses and the acquisition of explicit knowledge about skill based on the skill implementation rules. The rules of this stage are obvious and verbalizable, but as a result of practice, the person gradually enters the automatic stage. At this stage, skill-related knowledge is implicit and non-verbal. This explanation is the basis of many recent theories about skill acquisition (31).

In a study of 45 female students aged 8 to 12 years with developmental dysfunction, although both verbal and explicit teaching methods improved performance in these children, verbal education was superior (18); this finding was consistent with the present study. The results of another study revealed that children's motor learning in the analogy method may be influenced by their desire for conscious control of movements, which suggests that educators should adapt instructions to individual differences between learners (32). Considering the results of the present study, in explicit training, the effect of age is observed whenever an explicit intervention is carried out in the test, which casts doubt on the view of Witt et al. regarding the independence of implicit learning of age (19).

The results of the present study indicated that in the implementation phase, verbal learning was more effective than analogy learning, which was in line with the results of previous studies (1,14-16).

If the effect of implicit learning is in the same level of the effect of explicit learning, it still does not diminish in importance; because, as mentioned, it is a good way to avoid a large and confusing amount of information that should be presented to the learner when teaching a type of movement task (33,34). In the present study, the advantage of using analogy was not confirmed. The word used may not have been expressive to the children or different interpretations of the word stoning may have been conceived by the participants. To use the analogy method, age, status, culture, and position of individuals should be considered. The usefulness of the analogy method is achieved when the number of instructions is reduced and only the important points are stated (25). In this approach, even one cue is enough to perform the movement properly (35,36). Hence, it seems that a wide field is open to researchers; so they can examine the impact of this type of learning in all the implicit learning situations explored so far.

Limitations

Rest, mental state, and other physical, mental, and perceptual activities could not be controlled during the study.

Recommendations

It seems that the failure to achieve the desired results in using the analogy due to the type of explanation used for children was not clear or has caused different perceptions of throwing stones for participants. Therefore, it is suggested to use another word in dart throwing. Moreover, according to a latest study, the subjects' preference for receiving verbal instructions can also be examined before starting the study and have different effects (16).

Conclusion

Verbal training seems to increase the angular speed of throwing and improve accuracy compared to analogy, and is more effective in children's performance.

Acknowledgments

The present study was taken from a PhD dissertation No. 2615, approved by the University of Tehran, Alborz Campus, Tehran, Iran. The authors would like to appreciate the Malaek Welfare Center and all individuals who participated in the implementation of this research project.

Authors' Contribution

Natalie Gedayloo: study design and ideation, attracting financial resources for the study, study support, executive, and scientific services, data collection, analysis and interpretation of the results, specialized statistical services, manuscript preparation, specialized manuscript evaluation in terms of scientific concepts, final manuscript approval for submission to the journal office, responsibility of maintaining the integrity of the study process from the beginning to the publication, and responding to the referees' comments; Shahzad Tahmasebi-Boroujeni: study design and ideation, study support, executive, and scientific services, data collection, analysis and interpretation of the results, manuscript preparation, specialized manuscript evaluation in terms of scientific concepts, final manuscript approval for submission to the journal office, responsibility of maintaining the integrity of the study process from the beginning to the publication, and responding to the referees' comments; Masoumeh Shojaei: study design and ideation, study support, executive, and scientific services, data collection, analysis and interpretation of the results, manuscript preparation, specialized manuscript evaluation in terms of scientific concepts, final manuscript approval for submission to the journal office, responsibility of maintaining the integrity of the study process from the beginning to the publication, and responding to the referees' comments.

Funding

The present study had no financial resources and was conducted based on a PhD dissertation No. 2615, approved by the University of Tehran, Alborz Campus, Tehran, Iran. The study with the code of ethics IR.SSRC.REC.1398.027, was approved by the Institute of Physical Education and Sports Sciences affiliated to the Ministry of Science, Research and Technology of Iran.

Conflict of Interest

The authors had no conflict of interest. Natalie Gedayloo is a PhD student in Motor Behavior at University of Tehran, Alborz Campus. Dr. Shahzad Tahmasebi-Boroujeni is an Associate Professor of Motor Behavior and Sports Psychology at the University of Tehran and the dissertation supervisor and Dr. Masoumeh Shojaei was an Associate Professor of Motor Behavior at Al-Zahra University, Tehran, Iran and the dissertation consultant.

References

1. Masters RSW, Maxwell JP. Implicit motor learning, reinvestment and movement disruption: What you don't know won't hurt you. In: Williams AM, Hodges NJ, editors. Skill acquisition in sport: research, theory, and practice. London, UK: Routledge; 2004. p. 207-28.
2. Maxwell JP, Masters RS, Eves FF. From novice to no know-how: a longitudinal study of implicit motor learning. J Sports Sci 2000; 18(2): 111-20.
3. Liao CM, Masters RS. Analogy learning: A means to implicit motor learning. J Sports Sci 2001; 19(5): 307-19.
4. Maxwell JP, Masters RS, Eves FF. The role of working memory in motor learning and performance. Conscious Cogn 2003; 12(3): 376-402.
5. Lam WK, Maxwell JP, Masters R. Analogy learning and the performance of motor skills under pressure. J Sport Exerc Psychol 2009; 31(3): 337-57.
6. Wulf G, Weigelt C. Instructions about physical principles in learning a complex motor skill: To tell or not to tell.... Res Q Exerc Sport 1997; 68(4): 362-7.
7. Capio CM, Uiga L, Lee MH, Masters RSW. Application of analogy learning in softball batting: Comparing novice and intermediate players. Sport Exerc Perform Psychol 2020; 9(3): 357-70.
8. Masters RS, Poolton JM, Maxwell JP. Stable implicit motor processes despite aerobic locomotor fatigue. Conscious Cogn 2008; 17(1): 335-8.
9. Green TD, Flowers JH. Implicit versus explicit learning processes in a probabilistic, continuous fine-motor catching task. J Mot Behav 1991; 23(4): 293-300.
10. Gabbett T, Masters R. Challenges and solutions when applying implicit motor learning theory in a high performance sport environment: Examples from rugby league. Int J Sports Sci Coach 2011; 6(4): 567-75.
11. Masters RS, Lo CY, Maxwell JP, Patil NG. Implicit motor learning in surgery: Implications for multi-tasking. Surgery 2008; 143(1): 140-5.

12. Abdoli B, Farsi A, Ariafar M. The effect of variability of practice on the basketball free-throw learning under implicit and explicit conditions. Journal of Motor Learning and Movement 2017; 9(3): 335-52. [In Persian].
13. Bobrownicki R, MacPherson AC, Coleman SG, Collins D, Sproule J. Re-examining the effects of verbal instructional type on early stage motor learning. Hum Mov Sci 2015; 44: 168-81.
14. Tse AC, Fong SS, Wong TW, Masters R. Analogy motor learning by young children: A study of rope skipping. Eur J Sport Sci 2017; 17(2): 152-9.
15. Lee RWL, Tse ACY, Wong TWL. Application of analogy in learning badminton among older adults: Implications for rehabilitation. Motor Control 2019; 23(3): 384-97.
16. van Duijn T, Crocket H, Masters RSW. The role of instruction preference in analogy learning: Brain activity and motor performance. Psychol Sport Exerc 2020; 47: 101615.
17. Takizadeh K, Farsi A, Baghernia R, Abdoli B, Asle Mohammadizadeh M. Validity and reliability of a Persian version of Developmental Coordination Disorder Questionnaire in 3-5 aged children. J Res Rehabil Sci 2013; 9(3): 502-14. [In Persian].
18. Mohammadi N, Tahmasebi Boroujeni S. An essential role of explicit educational instruction in children's learning in children developmental coordination disorder [PhD Thesis]. Tehran, Iran: University of Tehran; 2019. [In Persian].
19. Witt A, Puspitawati I, Vinter A. How explicit and implicit test instructions in an implicit learning task affect performance. PLoS One 2013; 8(1): e53296.
20. Veraksa AN, Gorovaya AE. The possibility of using sign and symbolic tools in the development of motor skills by beginning soccer players. Procedia Soc Behav Sci 2013; 78: 285-9.
21. Oppici L, Panchuk D, Serpiello F, Farrow D. The influence of a modified ball on transfer of passing skill in soccer. Psychol Sport Exerc 2018; 39: 63–71.
22. Van Dyck E, Moens B, Buhmann J, Demey M, Coorevits E, Dalla Bella S, et al. Spontaneous entrainment of running cadence to music tempo. Sports Med Open 2015; 1(1): 15.
23. Emanuel M, Jarus T, Bart O. Effect of focus of attention and age on motor acquisition, retention, and transfer: A randomized trial. Phys Ther 2008; 88(2): 251-60.
24. Hejazidinan P, Aslankhani MA, Farrokhi A, Shojaei M. The effect of attentional focus instructions on kinematic and accuracy of dart during learning of the skill in novices. Motor Behavior 2012; 3(9): 45-65. [In Persian].
25. Bobrownicki RK. Impact of verbal instruction type on movement learning and performance: A multidisciplinary investigation of analogy and explicit instruction [PhD Thesis]. Edinburgh, UK: The University of Edinburgh; 2016.
26. Koedijker JM, Oudejans RRD, Beek PJ. Table tennis performance following explicit and analogy learning over 10,000 repetitions. Int J Sport Psychol 2008; 39(3): 237-56.
27. Lohse KR, Sherwood DE, Healy AF. How changing the focus of attention affects performance, kinematics, and electromyography in dart throwing. Hum Mov Sci 2010; 29(4): 542-55.
28. Snoddy GS. Learning and stability: A psychophysiological analysis of a case of motor learning with clinical applications. J Appl Psychol 1926; 10(1): 1-36.
29. Schmidt RA, Lee TD. Motor control and learning: A behavioral emphasis. 5th ed. Champaign, IL: Human Kinetics; 2011.
30. Gentile AM. A working model of skill acquisition with application to teaching. Quest 1972; 17(1): 3-23.
31. Baddeley A. Exploring the central executive. Q J Exp Psychol [A] 1996; 49(1): 5-28.
32. Duijn Tv, Thomas S, Masters RS. Chipping in on the role of conscious processing during children's motor learning by analogy. Int J Sports Sci Coach 2019; 14(3): 383-92.
33. Orrell AJ, Eves FF, Masters RS. Implicit motor learning of a balancing task. Gait Posture 2006; 23(1): 9-16.
34. Jamie MP, Richard SWM, Jon PM. The development of a culturally appropriate analogy for implicit motor learning in a Chinese population. Sport Psychol 2007; 21(4): 375-82.
35. Lam WK, Maxwell JP, Masters RS. Analogy versus explicit learning of a modified basketball shooting task: performance and kinematic outcomes. J Sports Sci 2009; 27(2): 179-91.
36. Koedijker JM, Poolton JM, Maxwell JP, Oudejans RR, Beek PJ, Masters RS. Attention and time constraints in perceptual-motor learning and performance: Instruction, analogy, and skill level. Conscious Cogn 2011; 20(2): 245-56.