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Effects of Linear and Non-linear Pedagogy on Motor and Cognitive Creativity

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ABSTRACT

Background: The aim of this study was to determine the effect of linear and non-linear pedagogy on motor and cognitive creativity with respect to the role of high and low memory inhibition. **Methods:** 40 students (age mean 7 ± 0.51 years) were divided into four groups (high inhibition and nonlinear training, low inhibition and nonlinear training, high inhibition and linear training, low inhibition and linear training). The training sessions included 6 weeks, 3 sessions per week, and 60 minutes each session. In the pretest, Torrance's cognitive thinking test and Bertsch's motor creativity test were performed on them and fundamental movements were performed in both linear and nonlinear methods**.**

Results: The results of the 2 (type of training) × 2 (memory inhibition) analysis of covariance showed that in all components (fluency, originality and flexibility) of motor creativity and cognitive thinking, the nonlinear training group performed better than linear training ($p \leq 0.05$). In fluency and originality of cognitive thinking, high memory inhibition groups were better than low memory inhibition groups ($p \leq 0.05$). In the fluency of cognitive thinking, the nonlinear group had the highest score and the linear group had the lowest score.

Conclusion: The results showed that the use of nonlinear training is more effective than linear training in improving motor creativity and cognitive thinking.

1. Introduction

In a complex and fast-changing world the development of cognitive thinking skills is paramount – it allows individuals to be more adaptable and flexible to the opportunities and constant challenges that they faced in social, professional and individual (Ritter and Mostert 2017). In fact, creativity is the emergence of new methods and the creation of behaviors that have not been used before (Bournelli 2009). Creativity include measures of fluency, flexibility, and originality. Fluency refers to the ability to produce many cognitive or motor solutions; flexibility denotes the capacity to generate solutions that pertains to different ideas or movement categories; and originality represents the capacity to generate novel and unique solutions (Russ and Dillon 2011). A new model for training creativity in cognitive problems is the so-called dual model of creativity (Nijstad 2010).

The dual path creativity model states that there are two types of thinking to find new solutions: flexible thinking and sustainable thinking. Flexible thinking, which is based on traditional approaches to creativity (Friedman 2003). If a goal is to train cognitive thinking skills, effective creativity training programs need to be developed and successfully implemented. The study Ritter et al, provided further evidence that creative potential is inherent to cognitive functioning and can be facilitated with training (Ritter and Mostert 2017). In this traditional teaching model, teachers give priority to prescriptive feedback, aimed at improving technical execution, and not cognitively involving students (Crotti 2021). In contrast, sustainable thinking demonstrates the idea that innovative solutions can arise from limited structured and focused ideas and concepts (DeDreuCK 2008). For example, in divergent thinking tasks, participants find different solutions they can find and use to the problem, and finally a number of new solutions and innovations of solutions to evaluate motor creativity in solving. In fact, more that recognize the importance of creativity in the domain of sciences and the arts (Feist and Gorman 1998), creativity should also be considered in other perspectives such as the development of creative movement patterns for movement, for dancing, or even for playing. Because children are in the motor sensory stage and usually show creativity through movement, they examine motor creativity to study creativity. For example, (Bournelli Makri and Mylonas, 2009). So finding new solutions to cognitive and motor problems is probably no different. However, there is little research that shows that limiting factors in solving cognitive problems also limit motor problems in addition to motor creativity, cognitive creativity has also been discussed.

The development of creative movement behavior is related with the production of a novel motor pattern to solve any challenge (Bournelli, Makri, and Mylonas 2009). It means finding a new solution that does not already exist and the person expresses it freely. This idea is similar to the proposal of nonlinear pedagogy approach that considered that practice tasks should guide players to discover individual and functional solutions to the problems based on the identification of possibilities for action in the environment of play. In a study by Richard et al, he changed the traditional program to a creative program and examined the effect of a nonlinear program on cognitive and motor creativity (Richard 2018). Memmert et al have also studied the effect of

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proprietary and non-proprietary methods on tactical creativity; both studies improved motor creativity in the nonlinear and non-specific groups (Memmert and Roth 2007).

On the other hand, motor activities provide opportunities for the development of the child's motor creativity. Therefore, the development of children's motor creativity and movement through education is also important (Richard 2018). Several techniques have been used to foster movement creativity in children. Many studies in this field have used traditional exercise programs (Crotti 2021). Linear pedagogy (LP) or traditional programs are based on the fact that the child is not active and curious and only instructions are given to the child through the instructor. In fact, this method is structured and emphasizes the repetition of skills (Chow 2007). Traditional programs limiting children chances to play in game play. The emphasis of this technical model is on acquiring technical skills for game play, while the cognitive skills essential and participation in games are often undermined (Turner and Martinek 1999).

This method, which focuses more on learning the technique, usually has difficulty transferring skills in real situations and fails (Blomqvist, Luhtanen, and Laakso 2000). Because in the linear method, people have less chance to participate in the game and be in a situation similar to the main field. As a result, the necessary and effective movement and cognitive skills in the game are often not considered (Prxedes 2018). However, some research supports this traditional approach. Analysis some research findings using the linear training program indicated this method improved general skills and fitness level in games (Blomqvist 2000). In the meantime, Due to the limitations of the linear training method, sports scientists have created a new and different educational approach called non-linear training (Davids 2012). According to the view of dynamic human systems, a complex being with a nonlinear system is considered, and nonlinear teaching methods also consider learners as nonlinear dynamic systems (Davids 2012). In fact, nonlinear change means that each person behaves differently in response to change and will respond differently when interacting with constraints (Davids 2012). These actions emerge from the nonlinear interaction between the intrinsic dynamics of the creator and environmental constraints (Torrents 2021). Findings from Nathan et al, showed that performance in nonlinear education improved over linear education, and suggested that nonlinear education should be practiced in schools (Nathan, Salimin, and Shahril 2017). According to active scientists in the field of nonlinear methods, this type of training will be more suitable for increasing the child's motor creativity. The findings revealed that introducing elements of the nonlinear pedagogy into a conventional exercise program can increase children's cognitive and motor creativity (Pogana and Costas 2008). But because there is so little research, it is not possible to conclude with certainty which training method is more suitable for motor creativity (Richard et al, 2018).

Overall, linear pedagogy is based on traditional theory (such as Adams' closed-loop theory) in motor learning motor and should, therefore, lead to more beneficial outcomes than a theoretical approaches currently employed (Metzler 2017). With teacher-led, linear approaches, the development of motor proficiency in one optimal technique may result in fast learning, leading to early feelings of success that should increase perceptions of competence, contributing to higher levels of motivation (Schmidt 1975). Linear pedagogy can be characterized by a teacher-centered approach, as (a) children should learn the optimal movement patterns for each movement skill and all children should conform to these idealistic movement patterns; (b) movement skills should be broken down into basic and simpler movements to facilitate learning; (c) movement variability within a task is seen as detrimental for learning and therefore should be reduced; (d) teachers in early learning should encourage an internal focus of attention in children who are performing skills to reduce cognitive load, while, as children become proficient in the skill, teachers would encourage an external attention of focus (Beilock 2002). In contrast, the nonlinear learning perspective is justified based on the dynamic systems perspective. In the dynamic motion control systems approach, which also seeks to respond to degrees of freedom, motion coordination is seen as an emerging feature of self-regulation (Davids 2012). In human movement systems, the interaction between the performer and his environment contributes to the formation of self-regulatory and self-organizing behaviors. The emergence of self-organizing motor solutions in a search process is facilitated by the interaction between performer constraints, task, and environment, which actually act as boundaries to shape purposeful behaviors (Renshaw and Holder 2010). In such a case, it seems that human complexity and skill acquisition are taken into account more. Certainly if the number of ways to reach a goal includes a domain, there will be mobility opportunities to create coordination patterns for a wider range of people than there is a boundary that would lead to greater results. Especially when direct perception underlies this performance of movement (Warren 2006)

Cognitive components are one of the factors that can affect children's creativity (Runco and Chand 1995). The dual path model shows that both flexible and sustainable thinking can lead to new solutions in individuals, but are differently affected by factors such as attention span, working memory capacity (De Dreu 2012). Friedman et al, have argued that increasing working memory leads to an increase in innovative solutions within the group (sustainable thinking), while increasing working memory has no effect on flexible thinking (Friedman 2003). Working memory keeps new information in a high state of access and ensures that information is relevant to the task at hand (Spencer 2020). When people acquire new information in the long run, working memory is retrieved from long-term memory to deal with the use of permanent and available information solutions. Therefore, working memory is one of the important cognitive components that supports creativity. As a result, the main goal is to find out whether working memory, a factor that affects creativity (Moorman and Miner 1997). De Dreu et al, states that superior working memory and creativity are intertwined (Dietrich 2012), which has received some empirical support for example see (Feist and Gorman 1998). In contrast, some studies such as Dietrich, have argued relationship between working memory and creativity unclear. Thus, the paradox supports the fact that one of the variables that modulates creativity is working memory (Dietrich 2004).

In summary, because most of the research done in the field of creativity is language education (Vass 2007), music (Memmert and Roth 2007) and imagination and less attention to creativity as a public activity. Therefore, due to the importance of motor creativity in primary school students, it is necessary to include this factor in the educational categories. Also, its importance and learning in the field of cognitive and motor creativity has been less discussed. In turn, possibly achieving adequate motor skills during the early ages will substantially impact the creativity. It seems necessary to do more research in this area. On the other hand, cognitive creativity interacts and improves in the direction of motor creativity, therefore, researchers are looking for educational methods that improve children's cognitive and motor creativity.

Thinking and motor creativity are considered to be two distinct, but related, both of which are influenced by cognitive factors such as working memory. By reviewing the research findings, it was determined that the role of cognitive factors in the underlying processes of creativity is still unclear. Therefore, the aim of this study was effects of linear and non-linear pedagogy programs on motor creativity and cognitive thinking.

2. Materials and Methods

2.1. Subjects

The study was approved by the Ethics Committee of the Sport Sciences Research Institute (IR.SSRI.REC.1399.817).

The Goodenough-Harris Drawing was taken from student. The Goodenough-Harris Drawing test was a projective personality test used for clinical purposes and intelligence testing. The validity and reliability of this test was confirmed by Rajabi et al

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(1999). Children participating were asked to draw three pictures, one of a man, a woman, and of themselves. The drawings were then evaluated using 64 scoring items. Once identified, all students are normal in terms of IQ, then Random Number Generator test (RNG) taken from student. We used the version that Towse (Towse and Mclachlan 1999) .used because it was possible to do RNG with children. The students were placed individually in a quiet environment and were given a homework game with numbers. They were then asked to say a sequence of 70 numbers from 1 to 10 with any desired rhythm (Moraru et al, 2016).

Forty students agreed to participate in the present study. The first group: high inhibition and nonlinear training (M age = 7.51; M height =127.48; M weight = 28.46), The second group: low inhibition and nonlinear training (M age =7.55; M height =125.73; M weight = 26.99), The third group: high inhibition and linear training (M age =7.57; M height =126.61; M weight =27.5), The fourth group: low inhibition and linear training (M age=7.53; M height =126.43; M weight =28.20). All subjects had all the characteristics of the inclusion criteria. Inclusion criteria for students include a) no physical injury or specific illness b) participation in all training sessions c) no sports background d) all female students. Students were divided into four groups of ten based on the type of memory training and memory inhibition.

2.2 Apparatus and Task

Children`s motor creativity was performed using version B of the Bertsch test designed for students (Scibinetti, Tocci, and Pesce 2011) .The validity and reliability of this test in the present study were confirmed by using the methods of internal consistency, retest, inter-tester and intra-tester reliability. The validity of this test in the present study was evaluated and confirmed by face validity, content validity, differential validity and structural validity. The test consists of four main steps that the students completed in 30 minutes. During the test, students were encouraged to continue the test so that they could continue and not give up. They were told to try to find different ways to do each step. Ways that you think other students have not found. Scoring was done once as a direct observation of behaviors and once after watching the film.

Two parallel lines, 3.50m (11.48 ft.) apart, were set on the floor. Students were asked to use a 36-inch loop and go from line to line as they wished, trying different methods.

2.2.1. Throw

Because of the study was done at the time of the Covid-19 pandemic and the test was no performed in the gym, minor changes were made to the test. Bean bags were used instead of balls, and targets were placed on the ground instead of on the wall. The students stood in the middle of a 36-inch ring. Four targets were identified outside the ring and told that your task is to hit the targets using these bean bags. Students were free to use bean bags and had to try to hit them in different ways.

2.2.2 Floor

Two parallel lines were placed 2.50m (8.2 ft) apart on the floor. Students had to move from one line to another using different methods and were free to do anything between the two lines.

2.2.3. Bench

A bench was located in the middle of a room and two hoops were positioned at the two ends of the bench representing the starting and arrival point, respectively.

Students were told to move from one ring to the other and backwards so that they were always in contact with the bench along the way. Students had to try different methods.

To measure cognitive thinking, the Italian version of the Torrance (1989) test was used, the Cognitive Thinking Test (TTCT) (Form A), which is designed for children in kindergarten and into adulthood.

The validity and reliability of Cognitive Thinking Test (TTCT) was investigated in the present study. Face validity, as well as content validity, was accepted using experts' opinions and coefficients (CVI = 0.91). Cronbach's alpha coefficient ($\alpha = 0.92$) is greater than 90% and indicates very low variability of test structures. The results of intra-cluster correlation coefficient between the tester (ICC = 0.98), intra-tester (ICC = 0.99) and retest test (ICC = 0.92) showed that the creative thinking test set has acceptable reliability. Findings of the independent t-test showed that the set of creative thinking tests ($t = 6.48$, $p = 0.001$) has construct validity. The correlation coefficient between fluency, flexibility, and initiative items with Piaget's tests of convergent thinking, creativity in perception and action, and motor creativity is significant and indicates the validity of the test ($p < 0.05$).

The Torrance Cognitive Thinking Test (TTCT) scores are based on three subscales: Fluency, Flexibility, and Originality. Fluency: the number of different methods that each person used in each task. Flexibility: the total number of categorized categories used that include at least one movement and is based on body positions, direction and type. Originality: the number of new and unique solutions implemented by the student was determined by assigning a score from zero to three (Scibinetti 2011). Torrance theory of cognitive thinking consists of the following three activities, each of which takes ten minutes and one minute to breathe between each activity (a total of 30 minutes of test time) and requires amazing designs, which have standard shapes. And have certain commonalities as test components: A) Making an image: Drawing an image using a shape similar to a bean, pear, or jelly bean candy or teardrop (dark curve) B) Completing the image: Drawing a painting, an object or a complete image using 10 incomplete shapes C) Metaphorical lines: Create a different image or design using 30 lines. Quoted from (Patricia et al., 2011).

2.3. Procedure

Participants in each of the four groups perform a test related to motor creativity (Bertsch) and Cognitive Thinking Test (TTCT). Then, the nonlinear training group was trained in non-linear motor skills and the linear training group was trained in linear skills. In these two training models, the subjects will practice for 6 weeks, 3 sessions per week (18 sessions in total) and 60 minutes each session (Renshaw and Chow 2019).

The difference between the training protocol in the two models of linear and nonlinear education is the order of presenting the lesson content. In this way, in the nonlinear model, it has progressed from the simplest tactic to the tactical complexity. Simultaneously with the non-linear model experimental group exercises, the linear model experimental group will also perform their own exercises. The difference is that in the linear model, first all kinds of skills will be taught and then the subjects will gradually apply the skills in games.

2.3.1. Training Interventions for non-Linear groups

To design the exercises based on the nonlinear methods (Renshaw and Chow 2019) .Extensive skills taught to children include: It was skipping, jumping horizontally, receiving the ball with both hands, throwing the ball over the shoulder and throwing the ball below the shoulder. In nonlinear training, the points related to linear training were considered. For example: Manipulation of task constraints (change of instructions, equipment, new rules, change in size and length of equipment, etc.) was performed. The training took place without additional feedback. In this way, the student is not told exactly what to do, but in order to help the person discover better to do it. Tactical complexity was applied, and at first children with less complex skills were taught, and no instructions were given. The variability of the exercise, which is another point of nonlinear training, was

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applied, for example, the size of the target and the distances were changed (Alizadeh, Mohammadzadeh 2019).

2.3.2. *Training Interventions for Linear groups*

Linear group training focused more on learning the skill. The method used for this group was traditional. That is, the learning environment had its own structure and principles and included warm up activities. The skill components were repeated and emphasized as the main components, and the students had little chance to play. In this method cognitive skills such as decisions making were not emphasized and direct feedback and prescriptive and verbal instructions were formed.in this method, which is a common method among teachers, first the correct movement was shown to the students and they were told how to do each component of the task correctly and they were asked to imitate the movements exactly.

2.4. Data Analysis

Data were represented as Mean ± SD. Before using parametric tests, the assumption of normality was confirmed using the Shapirovilk test. Leven test was used to check the homogeneity of variances. Analysis of covariance (ANCOVA) 2 (linear and nonlinear training) * 2 (inhibition of high and low memory) by Covariate the pre-test variable was used to examine changes in the performance of experimental groups in the tests of cognitive thinking and motor creativity. paired t-test and Bonferroni post hoc test were used to identify and determine the location of differences between groups in different stages of the test. Finally, a significant level was considered for all statistical methods ($p \leq 0.05$) and Excel and SPSS version 21 software were used to perform statistical calculations.

3. Results

The results of the Shapiro-Wilk test confirmed the assumption that the data were normal for all groups ($p>0.05$). Before performing the analysis of covariance, the results of M-box test (for assuming uniformity of the covariance matrix) and Leven test (for identical variance) showed that the relevant assumptions were observed ($p> 0.05$).

The results of ANCOVA for motor creativity variables are given in the **Table 1.**

Table 1.
Analysis of covariance 2 (type of training) × 2 (memory inhibition) for variable of motor creativity

	Source of changes	sum of squares	Df	mean of square	F	P	Effect size
Fluency	Pre-test	0.24	1	0.24	0.315	0.57	0.009
	Type of training	11.11	1	11.11	14.52	0.001*	0.29
	memory inhibition	2.28	1	2.28	2.98	0.093	0.07
	Interaction effect	0.002	1	0.002	0.002	0.96	0.001
	Error		35	0.76	------		
Originality	Pre-test	0.02	1	0.02	0.27	0/60	0.008
	Type of training	1.17	1	1.17	16.34	0.001*	0.32
	Memory inhibition	0.22	1	0.22	3.08	0.08	0.081
	Interaction effect	0.03	1	0.03	0.42	0.52	0.012
	Error	2.51	35	0.075	------		
Flexibility	Pre-test	0.36	1	0.36	0.38	0.53	0.011
	Type of training	8.05	1	8.05	8.59	0.006*	0.197
	memory inhibition	1.74	1	1.74	1.86	0.181	0.05
	Interaction effect	0.119	1	0.119	0.126	0.72	0.004

*Significance at the level of $P \leq 0.05$.

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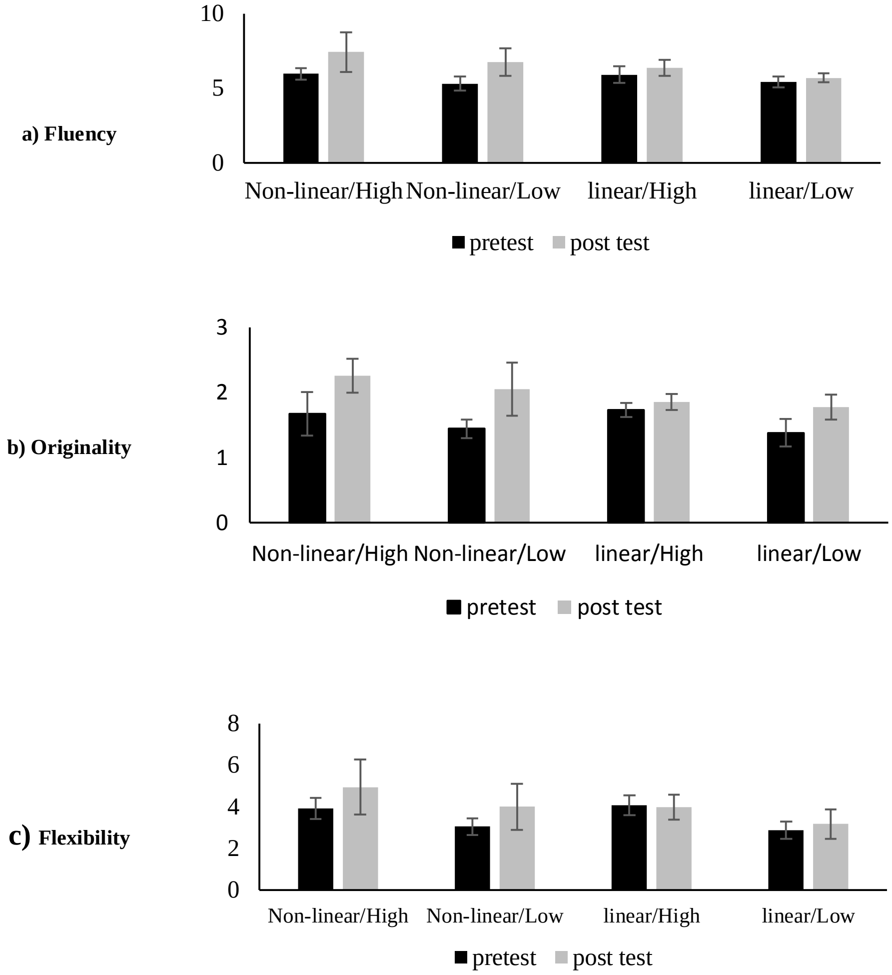

Figure 1. pre and posttest variables of motor creativity.

In the fluency, the results showed that the interaction effect of the type of training on memory retention was not significant. The memory inhibition effect was not significant. The effect of the type of training (linear and non-linear) was significant. The comparison of means showed that the mean of fluency component in non-linear training (M= 7.09) was better than linear training (M= 6.03). The results of pre- and post-test of the fluency variable of motor creativity showed that the fluency of all four experimental groups in the post-test was better than the pre-test. The mean of fluency was highest in the nonlinear training group and high memory inhibition and lowest in the linear training group and low memory inhibition (**Figure 1-a**).

About the flexibility, the results of 2 (type of training) × 2 (memory inhibition) ANCOVA showed that the interaction effect of training type on memory inhibition was not significant. The effect of memory inhibition was not significant. The effect of the type of training (linear and non-linear) was significant. The comparison of means showed that the mean of flexibility component in non-linear training (M= 4.47) was better than linear training (M= 3.58).

The results of pre- and post-test of the flexibility variable of motor creativity showed that the flexibility of all four experimental groups in the post-test was better than the pre-test. The mean of flexibility was highest in the nonlinear training group and high memory inhibition and lowest in the linear training group and low memory inhibition (**Figure 1-c**).

For total score of motor creativity, the results of covariance analysis showed that the interactive effect of training type in

In the originality, the results showed that the interaction effect of the type of training on memory retention was not significant. The effect of memory inhibition was not significant. The effect of the type of training (linear and non-linear) was significant. The comparison of means showed that the mean of the originality component in non-linear training (M= 2.15) was better than in linear training (M=1.81). The results of pre- and post-test of the originality variable of motor creativity showed that the originality of all four experimental groups in the post-test was better than the pre-test. The mean of originality was highest in the nonlinear training group and high memory inhibition and lowest in the linear training group and low memory inhibition (**Figure 1-b**).

memory inhibition was not significant. The effect of memory inhibition was significant. A comparison of means showed that the mean of motor creativity in high memory inhibition (M= 13.22) was higher than in low memory inhibition (M= 11.92). The effect of the type of training (linear and non-linear) was significant. The comparison of means showed that the mean of motor creativity in non-linear training (M= 13.71) was better than in linear training (M= 11.42). The results of 2 (type of training) × 2 (memory inhibition) covariance analysis test in cognitive creativity variables are given in the **Table 2.**

In fluency of cognitive creative, the results of covariance analysis showed that the effect of memory inhibition was significant. The comparison of means showed that the mean of the fluency component of creative thinking in high memory inhibition (M= 21.10) was higher than in low memory inhibition (M=18.09). The effect of the type of training (linear and non-linear) was significant. The comparison of means showed that the

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mean of the fluency component of creative thinking in non-linear training (M= 20.73) was better than linear training (M= 18.46).

The findings presented in **Figures 2-a** showed that the performance of all four experimental groups in the posttest in fluency variable of cognitive thinking was better than the pre-test. The mean of fluency variable of cognitive thinking was the highest in the nonlinear training group and high memory inhibition and the lowest in the linear training group and low memory inhibition.

In fluency of originality of cognitive creative, the results of covariance analysis showed that the effect of memory inhibition was significant. The comparison of means showed that the mean of the originality variable of cognitive creative in high memory inhibition group (M= 8.06) was higher than low memory inhibition group (M= 6.23). The effect of the type of training (linear and non-linear) was significant. The comparison of means showed that the mean of the originality variable in non-linear training (M= 9.17) was better than in linear training group (M= 5.12). The interactive effect of training type in memory inhibition was not significant the comparison of the performance of the four experimental groups in the originality variable before and after the test. The comparison of the means showed that all four experimental groups improved in the post-test compared to the pre-test, and the non-linear training groups with high and low memory inhibition showed the most progress in the initiative

The interactive effect of training type in memory inhibition was significant.

component, and the linear training group with low memory inhibition showed the least progress. The initiative performance of the non-linear learning group with high memory inhibition was better than the other groups **(Figure 2-b).**

The flexibility of cognitive creative results showed that the effect of memory inhibition was not significant. The effect of the type of training (linear and non-linear) was significant. The comparison of means showed that the mean of the flexibility component of cognitive creative in non-linear training (M= 7.19) was better than linear training (M=6.03). The interaction effect of training type in memory inhibition was not significant.

Figure 2-c shows the comparison of the performance of the four experimental groups in the flexibility component of the cognitive creative before and after the test. The comparison of the means showed that all four experimental groups have improved in the post-test compared to the pre-test (P= 0.001), and the non-linear training groups with high and low memory inhibition have the most progress in the flexibility component, and the linear training group with low memory inhibition have the least progress. The flexibility performance of the non-linear training group with high memory inhibition was better than the other groups.

Table 2.
Analysis of covariance (type of training) 2 × 2 (memory inhibition) to compare variables of cognitive creative

	Source of changes	Sum of the squares	Df	Mean of square	F	P	Effect size
Fluency	Pre-test	0.511	1	0.511	0.157	0.69	0.004
	Type of training	46.96	1	46.96	14.45	0.001*	0.3
	memory inhibition	74.96	1	74.96	23.07	0.001*	0.39
	Interaction effect	12.68	1	12.68	3.91	0.05*	0.10
originality	Pre-test	3.77	1	3.77	2.17	0.14	0.05
	Type of training	156.17	1	156.17	89.86	0.001*	0.72
	memory inhibition	28.08	1	28.08	16.62	0.001*	0.316
	Interaction effect	0.023	1	0.023	0.013	0.91	0.001
Flexibility	Pre-test	3.59	1	3.59	1.34	0.25	0.03
	Type of training	13.83	1	13.83	5.16	0.029*	0.12
	memory inhibition	8.25	1	8.25	3.08	0.08	0.081
	Interaction effect	0.319	1	0.319	0.119	0.73	0.003

*Significance at the level of $P \leq 0.05$.

For the total score of creative thinking, the results of covariance analysis showed that the effect of memory inhibition was significant ($F_{(1,35)} = 22.57$, $p = 0.001$, $\eta2 = 0.12$). The comparison of means showed that the mean of creative thinking in high memory inhibition (M=36.18) was higher than in low memory inhibition (M= 30.5). The effect of the type of training (linear and non-linear) was significant ($F_{(1,35)} = 69.60$, $p = 0.001$, $\eta2 = 0.081$). The comparison of means showed that the mean of creative thinking in non-linear training (M= 37.19) was better than in linear training (M= 29.50). The interaction effect of training type in memory inhibition ($F_{(1,35)} = 2.56$, $p = 0.11$, $\eta2 = 0.003$) was not significant. The comparison of the means showed that all four experimental groups have improved in the post-test compared to the pre-test, and the non-linear training groups with high and low memory inhibition have the most progress in the variable of creative thinking, and the linear training group with low memory inhibition have the least progress.

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a) Fluency

b) Originality

c) Flexibility

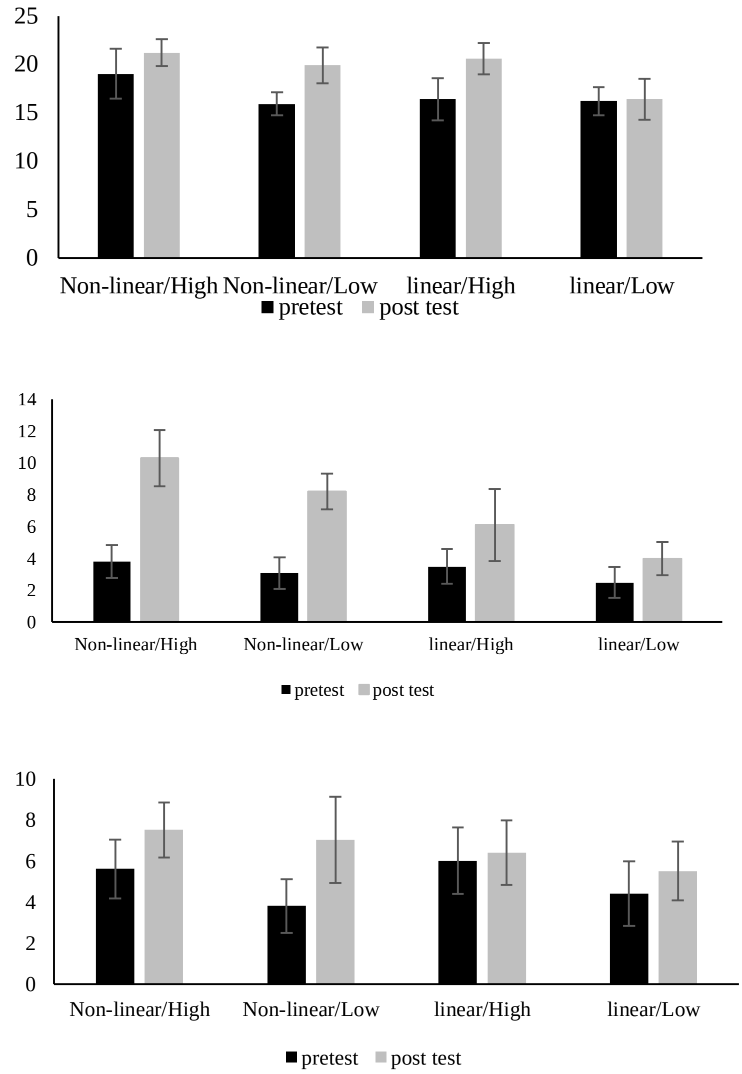

Figure 2. Pre and posttest of the variables of cognitive creative

4. Discussion and conclusion

The aim of this study was to compare linear and nonlinear training methods on motor creativity and cognitive thinking with respect to high and low memory inhibition. The results showed that both linear and non-linear training have a positive effect on motor and cognitive creativity. It was also found that the use of nonlinear training is more effective than linear training in improving motor and cognitive creativity.

The results showed that linear and nonlinear training methods have a significant effect on motor creativity in children aged 7-8 years with high and low memory inhibition. Comparison of means showed that the mean of motor creativity in high memory inhibition was higher than low memory inhibition. The effect of the type of education (linear and non-linear) was significant. Comparison of means showed that the mean of motor creativity in nonlinear training was better than linear training.

Also, all four experimental groups had improved in post-test compared to pre-test, and nonlinear training groups with high and low memory inhibition had the most improvement in motor creativity and linear training group with low memory inhibition had the least improvement. The motor creativity performance of the nonlinear training group with high memory inhibition was better than other groups. The results of this study are in line with the results of research (Furley and Memmert 2015), entitled Creativity and working memory capacity in sports: Working memory capacity is not a limiting factor in creative decision making among performers who state that the results model provided evidence. The general scope of working memory capacity is not related to creativity in the specific creative task of football. In explaining these results, it should be noted that nonlinear training is more effective than linear training and memory size and high and low memory inhibition can't be a limiting factor for progress and promotion in nonlinear learning. However, having a high memory inhibition power helps the effectiveness of nonlinear learning and also helps children to avoid stereotyped and repetitive behaviors.

The results showed that linear and nonlinear teaching methods have a significant effect on cognitive thinking in children aged 7-8 years with high and low memory retardation. Comparison of

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means showed that the mean of cognitive thinking in high memory inhibition was higher than low memory inhibition. The effect of the type of education (linear and non-linear) was significant. Comparison of means showed that the mean of cognitive thinking in nonlinear education was better than linear education. Comparison of means showed that all four experimental groups improved in post-test compared to pre-test and nonlinear training groups with high and low memory inhibition had the most improvement in cognitive thinking variable and linear training group with low memory inhibition had the least improvement. The mean score of cognitive thinking in the nonlinear training group with high memory inhibition was better than other groups. The results of this study showed that according to nonlinear approaches, this type of training method has a greater effect on the motor and cognitive creative than traditional training. What emerges from these results is that one is a sports skill and learning it is a complex process that can be influenced by many components, and these components are interrelated and interact that can be component He pointed out such things as the nature of the task, experiences and motor intelligence of individuals, physical structure and psychological conditions.

The results of the present research were in line with studies such as (Richard 2018) which stated that introducing elements of nonlinear education to a linear training program can increase children's cognitive and motor creativity and understanding of the difficulty and adaptation questionnaire in the nonlinear group. They were better than the traditional (linear) group, which could be one of the reasons for the more effective nonlinear training in the present study. According to the research (Alizadeh, Mohammadzadeh 2019), that both nonlinear education and linear education have a positive effect on participation motivation, it was also found that the use of nonlinear education is more effective than participatory education on participation motivation. Nonlinear is due to the increase in motivation to participate in the nonlinear group. Also, Memmert et al, study entitled The effects of non-specific and specific concepts on tactical creativity in ball sports teams by comparing two specific and non-specific models on creativity They used a tactic where the results showed that the dedicated group improved in the game-centric creativity they had been trained in and the non-specific group improved in general creativity, which could be a reason for the results of the present study (Memmert and Roth 2007)

Zetou et al, also stated that tactical games affect the learning of tennis skills and the development of self-efficacy in primary school students (Zetou 2014). According to a recent study entitled "Comparison of the effect of nonlinear training on the emergence of coordination patterns in short badminton service", the nonlinear training approach is effective in achieving homework results and creating diverse movement patterns tailored to learners' characteristics. But the emergence of specific patterns depends on factors such as the nature of the task, the goal and the motivation of the learner. As a result, accurate design of providers can provide better results that are more suitable for the learner and the task. This research can also be a reason for the results of the present research (Mousavi, Seyed Kazem, Yaali 2020). Also, the results of the present study are in line with the results of the study Alizadeh and Mohammadzadeh entitled The role of task constraint manipulation on learning basketball skills and strategies by nonlinear training method, which states the effect of basketball training TGFU (Teaching Games for understanding) by manipulating task constraints And TGFU differed on learning basketball skills and strategies without tampering with homework, and confirmed the positive role of tampering with homework (Alizadeh, Mohammadzadeh 2019) .As in the present study, nonlinear instruction used constraint manipulation, it can be concluded that nonlinear instruction with task manipulation instruction is very effective in instruction and helps learners to form information-movement pairs. The purpose of manipulating constraints, which is temporary and especially at the beginning of the learning process, is to increase special performance in the mind and encourage special adaptation in learners' behavior (Handford 1997). From this perspective, skill acquisition is the process of gradually changing the coordination dynamics in each person to meet a set of new task constraints.

Gibson's view supports the idea that integrating learner perception and practice subsystems is important for organizing effective practice. In the sense that the practice must have dynamic conditions, have all the key resources and create for the learner. This approach is contrary to traditional education and its rules because traditional education emphasizes fixed environments and not dynamic environments and believes that with fixed environments the learner's information load should be reduced. Instead, this approach suggests that educators should use simplification strategies to reduce the information burden (Chow 2007). The challenge for educators is to design activities that help learners to form information-movement pairs while controlling the learner's information constraints. Simplification, that is, practice conditions, must simulate real conditions. But key performance variables such as the speed of objects and people, the distance between surfaces and objects, and the forces of motion of people and objects must be reduced to simplify the task. During practice, it is important to maintain important sources of information that should be converted into simple task forms. The results of this study are also in line with the results of research (Renshaw and Holder 2010), and (Machado 2016) .is consistent. The results of this study are inconsistent with the research (Mousavi, Seyed Kazem, Yaali 2020). entitled the effect of nonlinear training on the performance of badminton short backhand service. Because they state that according to the research results, both training groups (linear and non-linear) showed progress at the end of the training sessions, but neither of the two groups had superiority in service accuracy scores over the other. The results of this study showed that despite the claim of nonlinear approaches less than linear approach emphasizes accuracy in execution, but it should be noted that the nonlinear approach has been able to lead people in achieving results with people in the linear group. The cause of inequality can be considered as a difference in the age of the subjects who in the study Mousavi et al were 20 undergraduate students in the field of physical education or a difference in the type of homework (Mousavi and Yaali 2020, Mohammadi et al 2019). Also, the present study was inconsistent with some research, which states that the tactical model and the direct model can have an equal effect on improving the performance of basketball. These results indicate that the effect of linear and nonlinear training on progress in ball sports and learning basic skills is different and may have been the cause of homogeneity in the type of task (Harrison 1999).

As the results of this study showed, in general, both linear and nonlinear training have a positive effect on motor creativity and cognitive creativity. It was also found that the use of non-linear training is more effective than linear training in improving motor and cognitive creativity and will lead to the improvement of all components of motor creativity and cognitive thinking (fluency, flexibility and originality). It was also found that the mean of cognitive thinking and motor creativity in high memory inhibition was higher than low memory inhibition.

Authors' contribution

Conception and design of study: H.D; data collection: E.SH; Data analysis and/or interpretation: E.SH; Drafting of manuscript and/or critical revision: H.D; Approval of final version of manuscript: M. M.

Conflict of interest

The authors declare that there is no conflict of interest.

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