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An experimental study on the impact of Wushu routine learning on executive functions of 7 - 8 years old female children

Abstract: - Executive function is one of the essential components of human cognitive function. Studies have found that improving executive function has a better impact on children's academic achievement, behavioral performance, and mental health. This study employed an experimental design to investigate the effects of different types of motor learning on the development of 7-8-year-old children's executive functions. The intervention was the Wushu routine learning; sample size was 37 female children (experimental group 23, control group14), mean age was 7.38 years. The study applied the psychological experimental research software E-prime 2.0 developed by Psychology Software Tools, Inc. to evaluate the experimental groups' inhibitory function, refreshing function, and conversion function level by completing the Flanker task, 1-back task, and more-odd shifting task. The results showed that the intervention effect of motor learning was mainly manifested in the conversion function, while it had no significant effect on the inhibitory function and refreshing function. Different intervention duration of motor learning did not have significantly different effects on executive function.

Keywords: Executive Function, Female children, Wushu routine learning

I. INTRODUCTION

Executive function is a collection of multiple cognitive functions of the brain, which mainly includes three sub-functions: inhibition, refresh and conversion. It can process, control and coordinate various cognitive processes, optimize human cognitive response patterns, and make the brain make appropriate responses[1-2]. Studies have found a positive correlation between physical activity in school-aged children and perceptual skills, intelligence quotient (IQ), academic achievement, verbal tasks, reading ability, and other abilities such as creativity, with higher physical activity predicting better cognitive performance[3-4]. Therefore, how to effectively improve executive function through physical activity has become a frontier and hot topic in multidisciplinary research. Although it has become a consensus that physical activity has a positive effect on improving cognition[5-6], there are often large inconsistencies in the results of studies on children at different ages and with different forms of exercise intervention.

Wushu is a traditional Chinese sport with the main content of fighting action, the form of routine and fighting, and the emphasis on both internal and external training[7]. Wushu routine has become one of the main forms of wushu sports and the main content of wushu teaching in schools because it is both competitive and ornamental. In the current research on executive function, it is very rare to use Wushu routine learning as an experimental exercise intervention, especially for the younger primary school children. Research on the development of children's executive function shows that primary school children are an important stage of rapid development of executive function. This study explores the effect of Wushu routine learning on the executive function of young children through experimental research methods, further analyzes the influence characteristics of different forms of physical activity on the executive function of children at different ages, and also provides scientific basis and reference for the development of physical and mental health of children promoted by school sports.

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II. METHODS

A. Participants

In this study, 37 female children aged 7-8 years (mean age 7.38 year) from Our Lady of Fatima Girls' School were selected as experimental subjects by convenient selection method. All subjects had normal vision, color vision, intelligence and hearing.

B. Experimental method

The subjects were divided into a training group (11 people) and received 1.5 hours of exercise intervention 3 times a week, the intervention method was Wushu routine learning, lasting 8 weeks, a total of 36 hours. The interest group (12 people) received 1.5 hours of exercise intervention once a week, the intervention method was Wushu routine learning, lasting for 8 weeks, a total of 12 hours; The control group (14 people) only took regular physical education course. Flanker task measurement suppression function, 1-back task measurement refresh function and More-odd shifting task measurement conversion function were used in the E-Prime system before and after the 8-week wushu routine learning intervention.

Executive function test

Flanker tested and assessed inhibition function. This experimental procedure was referred to Eriksen, B.A. The Eriksen Flanker Task paradigm proposed by et al and Hillmandi[8-9]and on this basis, the stimulus target was processed and the letter was changed to fish to make it more interesting to children and keep them focused. At the beginning of the test program, a fixation point of 500ms was first presented on the screen, and then the pictures of 5 small fish were presented 1500ms, the stimulation interval was 500ms, and the direction of the fish head would randomly appear in two shapes: Consistent condition and inconsistent condition, consistent condition means that the direction of the middle fish head is consistent with that of the two sides of the fish head or there is no interference from other fish, if it is consistent condition, press the "F" key on the keyboard, if it is inconsistent condition, press the "J" key, the pointer to evaluate the inhibition function is the average inconsistent reaction time minus the average consistent reaction time, the shorter the reaction time minus the average consistent reaction time. The better the inhibition ability.

1-Back test assessment refresh function. Referring to the n-back experimental paradigm of Smith and Jonides [10], this test adopts the number "1-9" as the stimulus subject. At the beginning of the test procedure, a fixation point of 500ms is presented on the screen. Then the number of "1-9" is presented for 2000ms, and the stimulation interval is 1000ms. The requirement of this test is that when the number appearing on the screen is the same as the previous number, press the "F" key on the keyboard. If the number appearing is different from the previous number, press the "J" key on the keyboard. The index of score is the average reaction time, and the shorter the reaction time, the better the refresh ability.

With reference to the paradigm of Salthouse et al.[11], this test adopts the numbers "1-9" as the main stimulus, but there is no 5. There are three parts in the test, and the three parts are presented in the same order. Then, one of the numbers of "1-9" is presented for 3000ms, and the stimulation interval is 1000ms. Part One (large/small judgment) : A black number "1-9" will randomly appear on the screen, requiring that when the number on the screen is less than 5, press the "F" key on the keyboard, such as the number is greater than 5, then press the "J" key. Part two (odd/even judgment) : A green number "1-9" will appear randomly on the screen, requiring that when the number appearing on the screen is odd, press the "F" key on the keyboard, such as the number is even, press the "J" key. Part three (mixed judgment) : A black or green number of "1-9" will randomly appear on the screen, requiring that when the number appearing on the screen is a black number, then make a large/small judgment, such as when the number appearing is a green number, then make an odd/even judgment. The score is evaluated by subtracting the average reaction time of part three (conversion) from the average reaction time of part one and two

(non-conversion). The shorter the remaining reaction time, the better the conversion ability.

C. Questionnaire survey method

In this study, the Physical Activity Rating Scale (PARS-3) was used to measure the daily exercise amount of the experimental subjects, and the students who exercised a lot were excluded before the experiment, so as to ensure that the daily exercise amount of the three groups of subjects was basically at the same level before the experiment. The scale was revised by Liang Deqing et al. according to the cultural background of our country, and the daily amount of exercise was calculated from three perspectives: intensity, time and frequency of participating in sports activities. Exercise amount = intensity × (time-1) × frequency, intensity, time and frequency from 1-5 grades, respectively recorded 1-5 points, the lowest score is 0, the highest score is 100 points, daily physical activity assessment score is ≤19 as small amount of exercise; 20-42 is divided into moderate exercise; ≥43 is classified as large exercise[12].

III. RESULTS

A. Three groups of homogeneity tests

The statistical results of the executive function tests of the three groups before the experiment (Table 1) showed the descriptive statistics of the response time (ms) in the suppression, refresh and conversion tests, and the differences of each executive function among the first three groups in the experiment were used by one-way analysis of variance. The results showed that there was homogeneity of executive functions among the first three groups.

Table 1. Descriptive statistics and analysis of executive function of each group before the experiment (M±SD)

	Control group	Interest group	Training group	F	P
Inhibitory ability	2.17 ±68.52	27.19 ±59.96	-5.67 ±45.37	0.97	0.39
Refreshing ability	1136.41±190.63	1038.98 ±204.40	1089.76±175.93	0.84	0.44
Conversion ability	409.53 ±326.88	375.84 ±401.28	577.25 ±328.80	1.07	0.35

Note: The inhibitory ability is the difference obtained when the inconsistent reaction is subtracted from the consistent reaction, and the conversion power is the difference obtained when the conversion reaction is subtracted from the non-conversion reaction.

B. Comparison of executive function between the three groups after the experiment

After the experiment, one-way analysis of variance was used for the differences of executive function among the three groups. The statistical results of the executive function test of the three groups after the experiment (Table 2) showed that the training group, the interest group and the control group had no significant difference in inhibitory function, $F(2,34)=0.09$, $P>0.05$. There was no significant difference in refresh function, $F(2,34)=0.37$, $P>0.05$; In the conversion function, there was a significant difference between the three groups $F(2,34)=4.35$, $P<0.05$.

Table 2. Descriptive statistics and analysis of executive function in each group after the experiment (M±SD)

	Control group	Interest group	Training group	F	*p*
Inhibitory ability	1.69 ±43.74	-3.61 ±56.35	4.44 ±38.08	0.09	0.91
Refreshing ability	1110.89±153.49	1068.02±181.34	1056.08±179.80	0.37	0.69
Conversion ability	471.10 ±220.27	244.18 ±249.94	248.75 ±199.68	4.35	0.02

Further multiple comparison test found that the conversion ability of the two groups who had learned Wushu routine for 8 weeks was significantly different from that of the control group. Compared with the control group, the conversion function of the interest group was significantly different P=0.01<0.05. There was a significant difference in conversion function between the training group and the control group (P=0.02<0.05). However, there was no significant difference in conversion function between the interest group and the training group, P=0.96>0.05, so there was no difference in conversion ability between the interest group and the training group after intervention.

Table 3. Multiple comparisons of conversion ability between three groups after the experiment

		Mean variance	Standard error	*p*
Control group	Interest group	226.92	88.40	0.01
	Training group	222.35	90.53	0.02
Interest group	Control group	-226.92	88.40	0.01
	Training group	-4.56	93.79	0.96
Training group	Control group	-222.35	90.53	0.02
	Interest group	4.56	93.79	0.96

C. Comparison of executive function tests before and after the three groups

Control group

The descriptive statistics of executive functions of the control group before and after the experiment are shown in Table 4. The T-test of the control sample is used to show that the ability indicators of the control group before and after the experiment in Flanker test, 1-Back test and More-odd-Shifting test all show P>0.05. There was no difference in the executive function of the control group before and after the test.

Table 4. Descriptive statistics and analysis of executive function before and after the control group (M±SD)

	before	after	t	*p*
Inhibitory ability	2.17 ±68.52	1.69 ±43.74	0.97	0.39
Refreshing	1136.41	1110.89	0.38	0.71

ability	±190.63	±153.49		
Conversion	409.53	471.10	-0.62	0.55
ability	±326.88	±220.27		

Interest group

The descriptive statistics of each executive function of the interest group before and after the experiment (Table 5) are shown by using the control sample T-test. The ability indicators of the interest group before and after the experiment in Flanker test, 1-Back test and More-odd-Shifting test all show P>0.05. It showed that there was no difference in the executive function ability of the interest groups before and after the test.

Table 5. Descriptive statistics and analysis of executive function before and after the interest group experiment

	before	after	t	*p*
Inhibitory	27.19	-3.61	1.59	0.14
ability	±59.96	±56.35		
Refreshing	1038.98	1068.02	-0.63	0.54
ability	±204.40	±181.34		
Conversion	375.84	244.18	1.23	0.24
ability	±401.28	±249.94		

Training group

The descriptive statistics of executive functions of the training group before and after the experiment are shown in Table 6. The t test of control samples is used to show that the ability indicators of the comparison training group before and after the experiment both show P>0.05 in Flanker test and 1-Back test, and there is no significant difference in inhibition function and refresh function before and after the intervention. In the More-odd-Shifting test (P=0.01<0.05), there is a significant difference in the conversion function after 8 weeks of Wushu routine learning.

Table 6. Descriptive statistics and analysis of executive function before and after the training group (M±SD)

	before	after	t	*p*
Inhibitory	-5.67	4.44	-0.83	0.43
ability	±45.37	±38.08		
Refreshing	1089.76	1056.08	0.49	0.63
ability	±175.93	±179.80		
Conversion	577.25	248.75	3.05	0.01
ability	±328.80	±199.68		

IV. DISCUSSION

Executive function is a collection of various cognitive functions in the brain, which is concentrated in the aspects of memory refresh, inhibitory dominance response and attention switching. Refresh is the ability to make continuous corrections to the contents of your working memory based on newly presented information. The impact of the actual refresh function is that the relevant information or part of the information in the working memory can be flexibly changed according to the requirements, rather than passively keeping the information in the memory to complete the task requirements[2]. The breadth and load of working memory are closely related to the refresh function, and the ability of working memory will directly affect the refresh function level[13]. The positive effects of physical activity on inhibitory function and refresh function have been confirmed by various studies, but different results have appeared under different research interventions for different research objects. From the perspective of wushu routine practice, the suppression function and refresh function can control the response caused by the information stimulus that has nothing to do with the goal and update and revise the basic movements

constantly. When students learn Wushu routine movements, they need to keep the information they have learned, such as the name of the movement, the composition of the movement, the order of connection between each movement, etc. in their minds, and constantly update and improve the quality of the routine through repeated exercises and combined with the teacher's explanation and demonstration. In this series of teaching process, the inhibition function and refresh function of executive function play an important role. Inhibitory function is the first function to develop among the sub-functions of executive function, and it develops rapidly in the preschool stage. Starting from the age of 8, the development space of inhibitory ability is very limited[14-16], so it is difficult for short physical activity intervention to have a significant impact on inhibitory function. In this study, through the 8-week intervention of Wushu routine learning, no significant intervention effect on the experimental group may be related to the age of the study object, and may also be related to the short intervention time and low frequency and intensity of intervention. Because the development of inhibition and refresh function in children is affected by many factors, it is still necessary to conduct in-depth research from many aspects and perspectives.

Conversion function is also regarded as cognitive flexibility, which refers to the process of flexible transformation of behavior or thinking according to the situational goals of different tasks when individuals perform complex tasks or work. The specific embodiment in the Wushu routine movement is that each action contains the coordination of body and eye technique step, and according to the offensive and defensive consciousness of each action, the combination of different actions makes the rhythm between the actions different, even the same action, because of the different connected actions, the rhythm between the actions has changed, requiring students to flexibly change the rhythm according to the combination of different actions and the offensive and defensive consciousness. Because the routine is not a simple action repetition and unchangeable rhythm connection, it also requires students to carry out flexible conversion in the practice of Wushu routine, reduce the mental set and inertial thinking, so as to exercise the conversion ability of students. The conversion function is undoubtedly the ability to process information at a higher level than the suppression function and refresh function. The data from this experiment show that after 8 weeks of Wushu routine learning, there is a significant difference in conversion ability between the interest group with 1 intervention a week and the training group with 3 interventions a week compared with the control group. However, there is no significant difference in conversion ability between the interest group and the training group. The results show that the conversion function of 7-8 years old children who have learned Wushu routines is better than that of the control group, and it is found that there may be no relevant effect difference on the improvement of conversion ability with the increase of intervention frequency in a fixed period of time. In addition, the 8-week learning of Wushu routine has the same effect on the improvement of the conversion function of the two experimental groups, which may be caused by the similar intervention content. This experiment deliberately uses the same routine learning intervention for the two experimental groups, and controls the influencing factors of the intervention content to a certain extent. The number of intervention times has an effect on executive function, while the results show that the number of intervention times has no significant difference on the effect of executive function in the same level of quality learning. In the longitudinal comparison of the groups, the conversion ability of the training group before and after the experimental intervention had a significant effect, and the improvement of the conversion function was statistically significant, while the interest group and the control group had no significant difference before and after the intervention. This study has a beneficial effect on conversion function after 8-week intervention of Wushu routines, which further confirms the positive effect of sports intervention on conversion function of children[17].

In summary, the three dimensions of executive function not only have different development characteristics, but also have close correlation and interactive influence, which may stimulate the functional work of the three dimensions at the same time when completing complex tasks. The learning and mastering of motor skills need the cooperation and timely transformation of various cognitive components, and need changeable executive control ability. The situation in exercise changes rapidly, which can exercise the function of refreshing and changing between different situations and actions, and also need to restrain the unwanted dominant response, so as to exercise and improve the executive function [18]. The results of this study found that at the age of 7 to 8 years old, the effect of 8 weeks of Wushu routine learning on the executive function of the experimental group was only manifested in the conversion function, and had no significant effect on the inhibition function and refresh function.

In the two experimental groups, different learning styles of Wushu routines did not have different effects on executive function. Obviously, although many experimental studies have shown that the level of executive function can be improved through exercise intervention, more studies have shown that the improvement of executive function by exercise is an extremely complex phenomenon, which is affected by multiple factors. Therefore, in order to fully reveal the mechanism of exercise to improve executive function, it is necessary to conduct integrated research from the perspectives of psychology, cognitive neuroscience, biology, sociology and other disciplines.

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