The Relationship between Parenting Style and Executive Function of Chinese Boys and Girls Aged 3-5 Years

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Abstract—The development of personal executive function is not only associated with the maturity of the related cerebrum region but also closely related to parenting style. As the first adopter of children, parents' parenting style influences children's cognition, socialization and personality development. This is a quantitative study which aims to investigate the development characteristics of the executive function (cool and hot) in boys and girls aged 3-5 years in China. Then, the relationship between the parenting style and executive function will be further explored. Through the analysis of data statistics by SPSS, the following research results are obtained: Firstly, There were significant age differences in the development of cool executive function in children aged 3-5 years, but not in hot executive function. Children have a better performance on the cool executive function as their age grows. Secondly, There was no significant gender difference in cool and hot executive functions in 3-5 years old children. Boys and girls do not differ significantly in performance on executive function tasks. Finally, The emotional warmth dimension in parenting style shows a tentative significant correlation with cool executive function, especially the hand games task. The other dimensions of parenting style are unrelated to cool and hot executive functions.

Index Terms—cool executive function, hot executive function, parenting style, *early* years

I. INTRODUCTION

The study will investigate the relationship between parenting styles and executive function in boys and girls aged three to five in China. Executive function helps children to control and adjust their behaviors and emotions, and is an important part of children's Personal, Social and Emotional Development (PSED) which is written in Early Years Foundation Stage. According to different brain mechanisms, Zelazo divides the executive function into the hot executive function (orbitofrontal cortex) and cool executive function (dorsolateral prefrontal cortex). [1] Close social relationships support abundant evidence that the interaction between parents and children in daily life influences the development of executive function. [2] Parenting style can predict and intervene the development of children's executive function to different degrees.

In this paper, appropriate methods were selected to measure them. Four adopted neuropsychological tests (hand games task, task of card classification, gift wrapping task and the window sticker task) are used to survey children's cool and hot executive function respectively in early years. Adapted EMBU Chinese version questionnaire is used to evaluate Chinese parents' parenting style. This questionnaire is divided into three dimensions: emotional warmth, rejection and overprotection. Descriptive statistics as well as the inferential statistics will be shown by SPSS. The study will be conducted at one local kindergarten in Shanghai (China).

II. LITERATURE REVIEW

A. Executive Function

Research on executive function started from the physiological brain system, and the damage of prefrontal cortex will result in decreased or damaged executive function, which is reflected in individual behavior. Because of that executive function was named "frontal lobe function" for a long period.[3] Attentional control, cognitive flexibility, and goal setting are the basic components of executive function. Anderson defined three concepts: attention control is the ability to selectively pay attention to specific stimuli and to focus attention for a long time. [4] Cognitive flexibility refers to the ability to switch between tasks, distract attention, and multitask. Inflexible people are considered ritualized, unable to adapt to new needs. The Goal setting area includes the ability to effectively develop and implement new plans. Many studies have shown that executive function has a positive impact on children's academic development. Some scholars believe that the regulation of children's emotions and behaviors is an important factor for them to prepare for school. [5] Willing to obey the emotional requirements of children show the classroom behavior is conducive to learning. Executive function determines the success of a child's transition from kindergarten to school. Executive function is generally regarded as a higher-order thought process for problem-solving. Promoting the development of children's executive function is conducive to improving academic performance in the future. [6]

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According to the different brain structure, the executive function can be divided into "cool executive function" and "hot executive function". Hot Executive Function and Cool Executive Function are related to the orbitofrontal cortex (OFC) and dorsolateral prefrontal cortex (DL-PFC). Different stimulus representations trigger them, and "Cool" executive functions are activated by related abstract, de-contextualized problems. "Hot" executive function requires high emotional involvement or involves evaluation of the emotional meaning of stimulation. Some scholars conducted direct comparative studies on cool/hot executive function and found that hot EF lagged behind cool EF. [7] Hot executive function and cool executive function follow different trajectories and develop independently, while the hot executive function is a delayed trajectory. The dorsolateral prefrontal cortex is a physiological mechanism of cool executive function, which is generally caused by abstract, context-free problems. The impaired cool executive function will lead to a series of cognitive defects, such as the inability to correctly perceive time and space, the performance of low self-control, and the inability to distinguish details in the surrounding environment. Cool executive function is considered purely cognitive. From its physiological basis, cool executive function is tended to be triggered by abstract, de-emotional problems. At present, most studies show that cold executive function starts to develop around the first year of birth, and in childhood 3-4 years old is the crucial age range for the development of cool executive function. Hot executive function, known as affective decision-making, is often highly emotional and requires flexible evaluation of the emotional meaning of a stimulus. The lateral prefrontal cortex, which determines the development of the hot executive function, is often associated with emotions. Zelazo argues that the hot execution function is a process for making emotional or emotional decisions about rewards or losses, which helps individuals deal with emotions and regulate motivation. The critical period of hot executive function development is also in the preschool stage.

B. Parenting Style

Baumrind was the first to put forward the concept of parenting style. Some researchers also call it parenting patterns and parental authority. About what is parenting style, the researchers also have different opinions. Maccoby summarized the parenting style as a behavioral tendency of parents in their daily life of education and raising children. [8] Integrating different kinds of literature, it can be seen that although different theories have different definitions of parenting style, they all show similar characteristics. Family upbringing is a relatively stable state. And then it is a behavioral tendency during the interaction between parents and children. Finally, family upbringing can convey and reflect parents' educational ideas and attitudes. [9]

Previous research confirmed that parenting style has a substantial impact on children's cognitive development, socialization, and personality development. First, the development of individual cognition depends on the way of parenting. Children's cognitive performance (such as academic performance, language development, and intelligence level) is negatively correlated with parents' punishment behavior. [10] Second, parenting style will have an impact on individual socialization. Children learn basic social cognition and moral norms in family life. Father, mother and child interaction between child's prosocial behavior are related. The family is the epitome and component of society. Parents' actions and ways of dealing with things, such as the way parents speak, permeate their children's life knowledge and have a permanent and continuous impact on their socialization and mental health. [11] Finally, there is a positive relationship between proper family upbringing and children's personality development. Kooraneh pointed out that parenting style has a deep-rooted influence on children in preschool education stage, and this behavior habit and pattern will accompany children for a lifetime and is not easy to change. [12] To sum up, family style, as an important factor in children's acquired environment, has a profound impact on individual development in all aspects.

C. The Relationship between Parenting Style and Executive Function

The development of executive function in children is related to two factors: the maturity of the relevant physiological areas of the brain and the living environment of the individual. [13] Rothbart & Bates considers executive function as a effortful control as a factor of temperament. Poor executive function may increase the disadvantage of parenting whereas good executive function may buffer or reduce the disadvantage of parenting. Parents' attitudes, sensitivities, and managing their children's needs and behaviors and thoughts can cause problems with their children's performance. Bernier points out that high-quality interaction promotes the development of executive function in children. From birth, infants' brains grow in the communication and response relationship with primary caregivers. Under individual parenting styles, children are consciously controlled to do certain things, which will affect the development of their executive function. The formation of secure attachment is related to children's executive function. In addition, Bernier points out that maternal sensitivity, autonomy, support, and thinking patterns are correlated with children's EF. As the first and most intimate caregiver, the characteristics of parenting style have an essential impact on the development of executive function.

III. METHODOLOGY

Two hundred children were selected from one classroom, which belongs to one setting in Shanghai, China. These children's ages are between 3 to 5 years old. Their parents also participated in this study. This study divided executive function into cool executive function and hot executive function. Using two adaptation of tasks (hand games task * task of card classification) to evaluate cool executive function. Hand games task mainly measures children's ability to restrain dominant responses. The children were first required to simulate the researchers' hand gestures (flat hands or fists) to see if they understood instructions and could make gestures accordingly. Then adapt the rules and let children change accordingly. Task of card classification test children's transformation ability in different dimensions. In this experiment, the children were asked to categorize a series of test cards, first on one dimension (color) and then on another (shape). Hot executive function is tested by the gift wrapping task and the window sticker task adapted. The ability of children to delay gratification and suppress poor behavior is evaluated by the gift wrapping task. The window sticker task investigated the ability of children to suppress dominant reactions and form rules under the involvement of emotions. EMBU Chinese version is used to measure parenting style. The questionnaire was divided into a five-point Likert scale (1=Strongly Disagree, 2=Disagree, 3=No opinion, 4=Agree, 5=Strongly Agree). This questionnaire consisted of 60 items in three dimensions: Rejection, Emotional Warmth, and Overprotection.

IV. FINDING

A. Executive Function Tasks

1) Descriptive statistics of children's executive function task results

According to the Table I, the full mark for the hand games task is 10 as well as the task of card classification. The means of them are 8.20 and 8.50 respectively. However, the lowest score in hand games task is sharply lower than that in card classification (4<7). The window sticker does nine times task, each task record one score. And the mean of it is 7.1. The max score (9) is more than twice the min (4). As for the standard deviation, the score is shown in the table. SD (0.66) is the lowest in gift wrapping; children's behaviors have little difference. In hand games task, SD is 1.78, the most significant number, the most prominent fluctuation, the biggest difference in children's performance.

TABLE I. DESCRIPTIVE STATISTICS OF EXECUTIVE FUNCTION TAS	KS
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	Hand games task	Task of card classification	Gift wrapping task	The window sticker task
М	8.20	8.50	1.4	7.1
SD	1.78	1.40	0.66	1.18
Max	10	10	2	9
Min	4	7	0	4

TABLE II. THE CORRELATION OF EXECUTIVE FUNCTION TASKS

	Hand games	Task of card	Gift wrapping	The window
	task	classification	task	sticker task
Hand games	1			
task				
Task of card	0.403*	1		
classification				
Gift wrapping	0.271	0.054	1	
task				
The window	0.110	0.091	0.013	1
sticker task				

Note: *P<0.1, **P<0.05, ***P<0.01

From the Table II, In cool executive function, scores of hand games task and the task of card classification were not correlated, which suggests these are independent measures. In the ho executive function, the scores for gift wrapping and the window task were also not correlated and so were separate tests.

2) Characteristics of executive function among children

According to the Table III, there is no difference in the performance of hot and cool executive function between boys and girls (p>0.1). Meanwhile, in the four separate tasks, the gender of the child did not affect the test scores (p>0.1). In the hand games task (M=8.6>7.8) and gift wrapping task (M=1.5>1.3), the means of girls are higher than that of boys. On the contrary, girl's means are lower than the boy's in the task of card classification (M=8.4<8.6) and the window sticker task (M=7.0<7.2). In general, the means of cool and hot executive function are higher in girls than in boys, although it did not reach a significant level. From the cool and hot executive function perspective, there was no difference between mean performance between boys' and girls' score. The means for both genders was the same (M=8.5).

TABLE III. GENDER DIFFERENCES IN CHILDREN'S EXECUTIVE FUNCTION

	Male (n=10)		Female (n=10)		
	М	SD	М	SD	F
Hand games task	7.8	2.32	8.6	0.80	0.960
Task of card classification	8.6	1.36	8.4	1.42	0.093
Gift wrapping task	1.3	0.64	1.5	0.67	0.419
The window sticker task	7.2	1.17	7.0	1.18	0.130
Cool Executive Function	16.4	3.44	17.0	1.94	0.231
Hot Executive Function	8.5	1.30	8.5	1.58	0.00

Note: *P<0.1, **P<0.05, ***P<0.01

TABLE IV. AGE DIFFERENCES IN CHILDREN'S EXECUTIVE FUNCTION

		3years old	4years old	5years old	F
Hand games task	Μ	6.6	8.6	9	3.281*
	SD	1.50	1.74	0.89	
Task of card	М	6.8	8.9	9.4	9.040***
classification	SD	0.75	1.22	0.49	
Gift wrapping task	М	0.8	1.5	1.8	3.762**
	SD	0.75	0.5	0.4	
The window sticker task	М	7.0	6.9	7.6	0.554
	SD	0.63	1.37	1.02	
Cool Executive Function	М	13.4	17.5	18.4	9.57**
	SD	1.52	2.41	1.14	
Hot Executive	М	7.8	8.4	9.4	1.85
Function	SD	0.84	1.58	1.14	

*P<0.1, **P<0.05, ***P<0.01

According to the Table IV, Children of different ages the scores of card classification show extremely difference (F = 9.040, p < 0.01), with the increase of age, the mean of score increased gradually (6.8 < 8.9, < 9.4). In the gift wrapping task, the scores presented significant differences (F=3.762, p<0.05). With the increase of 3-5 years old, the score of hand games task is affected (F=3.281, p<0.1). However, there is no significant difference in the age score of the window sticker task (F=0.554, p>0.1), and the average score doesn't increase with age. But five years old children still scored significantly higher than 3 and 4 years old, with little difference between 3 and 4 years old children. In general, scores of Cool executive function (Hand games task + task of card classification) at different ages present noticeable significant differences (F=9.57, p<0.02). Hot executive function (Gift wrapping task + The window sticker task) did not reach significance with increased age (F=1.85, p=0.188).

B. Parenting Style

According to the Table V, the figures show that Overprotection (76) has the highest mean, while the second highest is Rejection (67). The average score of Emotional Warmth (59) is nearly 20 lower than the Overprotection. Nevertheless, the standard deviation of Emotional Warmth and Overprotection are almost equal (SD=6.48 \approx 6.34), which indicates that the dispersion degree of the two sets of data is similar. Compared to the former, Rejection data has little fluctuation (SD=4.93).

 TABLE V.
 Descriptive Statistics of Parenting Style

 QUESTIONNAIRE'S THREE DIMENSIONS

	Rejection	Emotional Warmth	Overprotection
М	67	59	76
SD	4.93	6.48	6.34

C. The Relationship between Parenting Style and Executive Function in Children Aged 3-5 Years

According to the Table VI, one dimension of parenting style is related to the cool executive function task. According to the statistics, the Emotional Warmth and hand games task show an extremely significant positive correlation (r = -0.492, p<0.05). Hand games task belongs to cool executive function. The other cool executive function task, card classification was not correlated with emotional warmth. The other two dimensions of parenting style (Rejection and Overprotection) have no prominent correlation with Cool and Hot executive function tasks.

 TABLE VI. THE CORRELATION ANALYSIS OF INDIVIDUAL EXECUTIVE

 FUNCTION TASKS AND PARENTING STYLE

	Rejection	Emotional Warmth	Overprotection
Hand games task	-0.240	0.492**	0.081
Task of card classification	-0.127	0.008	0.046
Gift wrapping task	-0.078	-0.241	-0.090
The window sticker task	0.106	0.213	-0.073

*P<0.1, **P<0.05, ***P<0.01

According to the Table VII, emotional warmth showed a significant positive correlation with the hand games task, there was no correlation with the card classification task. Therefore, overall, the correlation between parenting style and cool executive function show a significant correlation (r=-0.324, p>0.1). Furthermore, the relationship overall is negatively correlated. Parenting style had no prominent correlation with Hot executive function. The percentage variance between the three domains of parenting style and cool/hot executive functions was determined by calculated by squaring the correlation coefficients. This shows that 10.4% of cool executive function shared variance with emotional warmth. 5.1% with rejection and 0.6% with overprotection. The variance shared for hot executive functions and parenting was below 1.1%. Whilst this suggests 10.4% variance in cool executive function may be accounted for by emotional warmth, 89.6% would be accounted for by other variables be that parenting style variables or other variables not researched here such as eg parents' economic status.

TABLE VII. THE CORRELATION ANALYSIS OF COOL AND HOT EXECUTIVE FUNCTIONS AND PARENTING STYLE

	Rejection	Emotional Warmth	Overprotection
Cool executive	-0.226	-0.324	0.078
function	(R2 = 0.051)	(R2 = 0.105)	(R2 = 0.006)
Hot executive	0.054	0.067	-0.107
function	(R2 = 0.003)	(R2 = 0.004)	(R2 = 0.011)

*P<0.1, **P<0.05, ***P<0.01, R2 = square of correlation coefficient

V. DISCUSSION

A. Developmental Characteristics of Executive Function in Children Aged 3-5 Years (Age/Gender)

1) Age-related change in executive function

The results of this study show that for children aged 3-5 years, cool executive function develops with age. The cool EF task performance of 3 to 4 years old increased slowly, and the task score of 4 to 5 years old increased significantly. This result is consistent with previous studies. According to the study of Luria, four years old is a crucial age for the perfection of individual prefrontal lobe. Four years old is a turning point in the development of the cool executive function. [14] The research results of brain neural mechanism also prove this point. The frontal lobe is a famous region involved in executive function execution, and the damage of the frontal lobe in children will lead to the stagnation of executive function development. [15] From the perspective of individual brain development, the development of the prefrontal cortex is relatively late, and its critical period of development is between 3 and 5 years old. Cool and hot executive function have different trajectories. According to the development trend of cool and hot executive function in this study, cool executive function develops more rapidly at ages 3 to 5 than hot executive function. Differences in cool and hot executive function development are influenced by both internal and brain mechanisms. Firstly, the internal part is the difference of cool/hot executive function itself. For example, hot executive function adds strong emotion, motivation and other factors. Planning, flexibility, working memory, inhibition, and monitoring are cool executive functions

that are goal-oriented and future-oriented skills. Hot executive function is a goal-oriented, future-oriented cognitive process that is triggered in the context of emotion, motivation and tension between immediate gratification and long-term return. Compared with cool executive function, hot executive function is defined as a more complex executive function requiring emotional and social abilities. Studies have shown that cool executive function first appears at the age of 1 years old, but emotional decision-making in children begins to develop at the age of 3-5 years old. This may be the reason why cool executive function development is earlier than hot executive function at ages 3-5.

2) Gender-related change in executive function

According to the test of gender differences in cool and hot executive functions, it can be seen that gender differences in cool and hot executive functions are not significant. This indicates that boys and girls aged 3-5 years old basically have the same level of cool and hot executive function development, which contradicts the research hypotheses. Although the gender difference did not reach a significant level, the average score of girls was slightly higher than that of boys in terms of cold and hot executive function. Looking at four separate tasks, boys and girls each had an advantage in scores in specific tasks. Among the Hand games task and Gift wrapping task which mainly involve suppression control, the average score of girls is higher than that of boys. In the classification of card and the window sticker task, boys performed better than girls on average score. Even though boys and girls have different dominant tasks, gender has no significant impact on executive function. Combining The four regions, The United States, Taiwan, South Korea, and China, no effect of gender on executive function performance was found.[16] Studies have shown that the measurement in the study of executive function, 3 to 6 years old children's gender differences are not obvious. These results showed no gender differences in inhibition, cognitive/conversion, and/or working memory tasks among children aged 3, 4, and 5 years. It can be speculated that gender of young children has no significant influence on executive function, and age is the main influencing factor. In the key period of development, gender influence will be highlighted when executive function becomes mature and enters the academic stage. In future studies, the same group of preschool children can be tracked to see if gender correlation is significant once they enter elementary school.

B. Characteristics of Chinese Parenting Style

Culture, as an important macro background factor in the ecological environment of children, has an impact on parental education. Influenced by traditional Confucian culture and Chinese customs, Chinese parents form a relatively collective parenting style. In this research, among three dimensions of parenting style the score of overprotection is the highest, emotional warmth is the lowest. This partly reflects the extent to which Chinese parents are physically protective of their children. This phenomenon is also reflected in the questionnaire question. For example, Chinese parents generally do not accept their children's participation in risky play, fearing that their children will be hurt. When a child is 3-6 years old, there is more emphasis on child care than education. Parents of overprotection are defined as: high supervision and vigilance, difficult to separate from children, do not encourage independent behavior, and high control.[17] This seems to fit with the traditional definition of Chinese parenting. Similar to 'Tiger parents', Chinese parents are often defined as strict and highly controlling. Influenced by China's family planning policy, parents overprotect and indulge their children. Such doting parents lack the ability to discipline and supervise children's behaviors, and children are prone to behavioral problems such as aggression. Chinese culture has a tradition of emphasizing the authority of parents and the obedience of children. Under this unique cultural background, parents tend to teach their children more harshly than western parents. However, it is worth noting that what Chinese culture encourages is parents' strict requirements on the basis of full warmth for children, parents' emphasizing attention, guidance and encouragement for children to make achievements. Therefore, in the dimension of emotional warmth, even if the score is low, Chinese parents will provide a lot of emotional support to their children, which is reflected in encouraging them to do what they want.

C. The Relationship between Parenting Style and Children's Executive Function

Parenting style could be an influencing factor in preschool children's acquired environment. This study examined the relationship between children's executive function and parenting style, and found that some dimensions of parenting style and children's executive function reached a significant level. Findings showed that Hand games task for cool executive function is correlated with emotional significantly warmth dimension of parenting style. Emotional warmth refers to parents' positive, positive and patient attitude towards children. [18] The more positive emotional support parents provide to children aged 3-5, the better their hand games task. In hot executive function, different dimensions of parenting style have no correlation with each task of hot executive function. The significant interaction between some dimensions of children's executive function and parenting style shows that improving emotional support of family interaction is beneficial to hand games task of cool executive function. Parental discipline and control patterns, responses to children, and support for children trying to solve problems predicted the development of executive function in children. [19] This is similar to the results of this study, parents' emotional warmth dimension can have an effect on cool executive function to different degrees. Many research results show that the support and high-quality communication provided by parents contribute to the development of children's executive function. [20] For example, mother's high warmth and independent support are positively correlated with children's good executive function performance.

Improper parenting behaviors are not conducive to children's executive function development. High-quality parenting style having high-quality interaction between parents and children will provide their children with a more intellectually stimulating environment.

VI. CONCLUSION

The gender difference between cool and hot executive function in children aged 3-5 years was not significant, and the overall score of female students was slightly higher than that of male students. This suggests that gender does not affect children's development of executive function during the early years. The effect of age on cool executive function was more significant than that on hot executive function. Although hot executive function task scores also increased with age, they did not reach a significant level. From three dimension (Rejection, Emotional Warmth and Overprotection) in parenting style questionnaire, Chinese parents have a high degree of Overprotection, followed by Rejection, emotional warmth is the lowest dimension. Only emotional warmth dimension in parenting style was correlated with cool executive function in children, and extremely significantly correlated with Hand games task in cool executive function. There was no correlation between the other dimensions and cool/hot executive functions. In the future, Families should pay attention to age-related trends in executive function. Implications should be provided to support recommendations or implications on how family parenting practices can better promote the development of executive function in children.

CONFLICT OF INTEREST

The author declares no conflict of interest.

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