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The Differences in Executive Function according to the Experience of Full-time and Part-time Early English Education of Children

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Background/Objectives: The purpose of this study was to analyze the differences in the executive function (attention control, cognitive flexibility, information processing, and goal setting) between children with full-time early English education experience and children with part-time early English education experience. **Methods/Statistical analysis**: The subjects of this study were 40 7-year-old children who had full-time and part-time early English education experience during their early childhood. The measurement tools were Stroop task, card classification task (DCCST), pattern fluency, and maze. We conducted covariance analysis (ANCOVA) with total intelligence as a covariate in order to investigate the difference in executive function between children with full-time and part-time English education experience. **Findings**: First, attention control didn't show any difference in full-time or part-time early English education in early childhood. Second, children who experienced full-time early English education showed more favourable cognitive flexibility than children who experienced part-time early English education. Third, children with full-time early English education were found to have lower information processing scores than children with part-time early English education. Fourth, the goal setting was more favourable for children who experienced full-time early English education than those who experienced part-time early English education. **Improvements/Applications**: In conclusion, the experience of early English education in EFL situations, that is, learning both languages at the same time in early childhood, positively affects cognitive flexibility and goal setting, but negatively affects information processing.

Key words: *Executive Function, Early English Education, Early Childhood, Language and Cognition, Immersive English Education.*

Introduction

Looking at the position of affirmation for early English education, from the neurophysiological point of view, the younger the children, the more plastic the brain is, so it is easier to accept language (Lee et al., 2003). From the cognitive aspect based on Piaget's cognitive developmental stage, before going to formal manipulators with concrete manipulators, it is viewed as the optimum period of early English education before 11 years of age (Douglas, 2000). On the emotional side, it is said that when learning a second language, it is less influenced by the first language because of flexibility and plasticity before puberty in forming a language ego (Guiora, 1980). Therefore, it is necessary to investigate whether early English education is helpful in acquiring the mother tongue by enabling the language function of young children, and how it relates to higher cognitive development.

Early English education means bilingual education, second language education, and foreign language learning. It refers to teaching foreign languages to young children before the age of 12 years (Lee, 2002). In this study, we defined early English education as the case of using EFL (English as a foreign language) education, that is, when all the lessons were received in English by the language school based on the definition of (Lee, 2002).

Recently, it became clear that executive function was related to the development of the frontal lobe in addition to psychological development in the mind, and researchers began to be interested in the development of early childhood executive function, whose brain development was vigorous. (Bialystok, 1986) suggested four domains: attention control, cognitive flexibility, information processing, and goal setting based on factor analysis research and neuropsychological knowledge. Attention control includes selective attention, sustained attention, accuracy and speed of attention, and the elements of self-control. In this study, we analyze the suppression of attention control based on previous studies that have advantages in the fact that there is little difference between the two languages in selecting and using one proper language (Bialystok, 1988); (Bialystok, 2002); (Cummins, 1978); (Lee and Lee, 2006). The cognitive flexibility includes divisiveness, switching of attention, working memory, etc. It is considered that the young children using the two languages are superior in the ability to flexibly switch languages according to the situation and that the young children who are bilingual are superior in the control task requiring switching of the attention of the card classification task (Bialystok, 1999); (Anderson, 2002). Information processing consists of fluency, efficiency, and processing speed, reflecting the integration of

neuronal connections and functional integration of the frontal system, and can be assessed by the speed, quantity and quality of information processing (Kim, 2005). (Park and Song, 2009) stated that information processing fluency requires cognitive flexibility and creativity. Goal setting refers to initiative, conceptual reasoning, action plan, strategic organization (Bialystok and Codd, 1997). In other words, goal setting should be able to look into the future to plan, anticipate possible changes or problems, set up alternative action plans, and choose among alternatives (Park and Song, 2009).

According to several previous studies, bilingual children aged 3 to 9 years have more control over attention control ability than single language children (Bialystok, 2003); (Bialystok, 1999)**;** (Bialystok, 1986); (Bialystok, 1988). In addition, previous studies have shown that bilingual children are more likely to engage in attention switching than single language children (Bialystok, 1999); (Bialystok, 2003). (Bialystok, 2003) conducted a study on executive functions of English-Chinese bilingual children using Chinese at home and using English at kindergartens and in communities. In addition, (Bialystok, 1999) conducted a study on the execution function of Korean-Chinese bilingual children who use Korean at home, Korean or Chinese in kindergarten, and Chinese in the local community. Nevertheless, there are few studies in English-Korean bilingual children who use the Korean language in their homes and communities and have full-time English classes only at language schools.

This study needs to compare the development of executive function in children who are receiving early English education in Korea, where the bilingual environment is different, and the second language is not used as a competently to the native language. Therefore, the purpose of this study was to analyze the differences in the executive function between children with full-time early English education experience and children with part-time early English education experience.

In order to achieve this, research questions are set as follows.
Research question 1. Is there a difference in attention control between children with full-time early English education and children with part-time early English education?
Research question 2. Is there a difference in cognitive flexibility between children with full-time early English education and children with part-time early English education?
Research question 3. Is there a difference in information processing between children with full-time early English education and children with part-time early English education?
Research question 4. Is there a difference in goal setting between children with full-time early English education and children with part-time early English education?

Method

The Participants

The subjects of this study were 20 7-year-old children who had full-time early English education experience during their early childhood and 20 7-year-old children with part-time early English education experience, a total of 40 children in 3 English language schools(E-, S-, W-). Children with full-time English education experience refer to a 7-year-old child who has been taught in an American curriculum by a native speaker over two years in English schools during early childhood. On the other hand, children with part-time English education experience mean a 7-year-old child who has been taught English by a Korean teacher for 1 or 2 times a week for 2 years in a daycare center. They were all in English classes at the English Language schools in the first grade of elementary school, one or two hours each day after school.

The age and gender distribution of children with full-time English education experience and part-time English education experience is shown in Table 1.

Table 1: Age and gender distribution of children with full-time and part-time English education experience

Division		**Children with full-time English education experience**		**Children with part-time English education experience**	
		N	*%*	*N*	*%*
7-years old (Average 85 months)	boy	9	45.0	10	50.0
	girl	11	55.0	10	50.0
	total	20	100	20	100

Table 2 shows the age at which children begin full-time English education and the length of time they attend language schools.

Table 2: English language education background of children with full-time English education experience

Division		***N***	***%***
age of English starting	under 3 years old	3	15
	3 ~ 4 years old	9	45
	4 ~ 5 years old	8	40
study period	1 year 6 months ~ 2 years	4	20
	2 years ~ 2 years 6 months	7	35
	2 years 6 months ~ 3 years	9	45

Instrumentation

Attention Control: Stroop Task

Stroop task were performed using Perret's form, which was reconfigured to match the domestic situation. This test consists of 'simple execution' and 'interference execution'. Simple execution is a task with low dependency on execution function, and interference execution is a task with high dependency on execution function. In this study, the response time and the number of error responses were measured in all three tasks. The error number per task was 0 ~ 24. The total time required for the test was about 2 to 5 minutes. The results of the test-retest reliability coefficients in this study were fairly reliable, with time r=.95(p<.001) and error number r=.89(p <.001).

Cognitive flexibility: card classification task (DCCST)

Cognitive flexibility was used by adding numerical dimensions based on the Dimensional Change Card Sort Task (DCCST) used by (Bialystok, 2003). The control tasks were performed 10 times each in the shape task and number task. The score distribution was 0~10 points for each task, and the time taken for the test was about 20 minutes. The reliability of this study was r=.72 (p<.001) as a result of Pearson correlation analysis between shape task and numerical task. The internal consistency of yield was Cronbach's α coefficient of .81.

Information Processing: Pattern Fluency

The pattern fluency test was conducted using the modified Ruff Figural Test. The pattern fluency test was done with three subtests, and in a limited minute, we connected two or more points of 5 points and measured the frequency accurately drawn with lines and figures. We excluded duplicate drawings of the same shape and scored the number of designs drawn in different shapes. The time taken for the test took about 10 minutes. The correlation coefficient in this study was r=.70(p<.001).

Goal Setting: Maze

The maze was measured using the WISC-III maze test. This test is composed of 9 questions in total and gets the maximum score when it is resolved within the time limit without any error. The time limit for each question is from 30 seconds to 120 seconds. The half-confidence coefficient for WISC-III was .58.

Experimental Procedure

This test was conducted by two trained early childhood education teachers and was conducted in a separate room of the English language institute. Of the children selected through intelligence screening, except for the four children who were transferred during the test period or who were absent from the test day, the final analysis included 20 children with full-time English education experience, and 20 children with educational experience. In order to rule out the effect of the order, the test was carried out at the intersection of four tests.

Data Analysis

In this study, statistical processing was performed using SPSS 18.0, and the data processing method is as follows. First, to analyze the English background variables of children with full-time English education, frequency analysis was performed to calculate frequency and percentage. Second, correlation analysis and Cronbach's α coefficient were calculated to examine the reliability of test-retest reliability. Third, we conducted covariance analysis (ANCOVA) with total intelligence as a covariate in order to investigate the difference in executive function between children with full-time and part-time English education experience.

Results

The difference in attention control according to the experience of early English education

Table 3 and Table 4 show the results of comparing the difference of attention control between children with full-time early English education experience and those with experience of part-time early English education.

Table 3: Mean and standard deviation of attention control scores according to experience of early English education

Division		**Attention control scores**		**Adjusted attention control scores**	
		M	***SD***	***M***	***SD***
reaction time (second)	full-time children	37.45	10.42	37.27	2.23
	part-time children	39.55	11.47	39.73	2.23
number of errors(count)	full-time children	2.05	1.73	2.03	.39
	part-time children	2.95	1.79	2.97	.39

According to Table 3, the response time of children with full-time English education experience was relatively faster than the response time of 39.73(SD=2.23) seconds of children with 37.57 seconds(SD=2.23) The number of errors was lower in children with

full-time English education experience than those with 2.03(SD=.39) and part-time English education experience 2.97(SD=.39).

Table 4: Analysis of covariance of attention control scores according to experience of early English education

Division	A source of change	Sum of squares	Degree of freedom	Mean squared	*F*
reaction time (Second)	total intelligence (covetous)	870.96	1	870.96	8.74**
	group(main effect)	60.36	1	60.36	.61
	error	3688.94	37	99.70	
	sum	63894.00	40		
number of errors (count)	total intelligence (covetous)	6.99	1	6.99	2.33
	group(main effect)	8.68	1	8.68	2.89
	error	110.91	37	3.00	
	sum	376.00	40		

** $p<.01$

According to Table 4, there was no significant difference in attention control scores between the two groups in response time and errors.

The difference in cognitive flexibility according to the experience of early English education

[Table 5] and [Table 6] show the results of comparing the difference of cognitive flexibility between children with full-time early English education experience and those with experience of part-time early English education.

Table 5: Mean and standard deviation of cognitive flexibility scores according to experience of early English education

Division		Cognitive flexibility scores		Adjusted cognitive flexibility scores	
		M	***SD***	***M***	***SD***
shape task	full-time children	9.25	.72	9.26	.17
	part-time children	8.90	.79	8.90	.17
number task	full-time children	8.70	.66	8.70	.23
	part-time children	7.70	1.30	7.70	.23
total	full-time children	17.95	1.00	17.96	.35
	part-time children	16.60	1.93	16.59	.35

According to Table 5, the overall score of the card classification task was 17.96(SD=.35) for children with full-time English education experience and 16.59(SD=.35) for children with part-time English education. The scores of the form tasks were relatively high in children with full-time English education experience of 9.26(SD=.17) and 8.90 (SD=.17) with part-time English education experience. The scores for the number tasks were relatively high for children, 8.70(SD=.23), and 7.70(SD=.23) for those with full-time English education.

Table 6: Covariance analysis of cognitive flexibility scores according to early English education experience

Division	A source of change	Sum of squares	Degree of freedom	Mean squared	*F*
shape task	total intelligence (covetous)	.64	1	.64	1.13
	group(main effect)	1.29	1	1.29	2.29
	error	20.91	37	.57	
	sum	3317.00	40		
number task	total intelligence (covetous)	.09	1	.09	.08
	group(main effect)	10.06	1	10.06	9.23**
	error	40.31	37	1.09	
	sum	2740.00	40		
total	total intelligence (covetous)	1.21	1	1.21	.50
	group(main effect)	18.56	1	18.56	7.76**

	error	88.55	37	2.39	
	sum	12045.00	40		

** $p<.01$

Table 6 shows that there was a significant difference in cognitive flexibility scores between children with full-time early English education experience and children with part-time early English education experience(F=7.76, p<.01). There was no significant difference between the two groups in shape task. Number task showed significant differences between children with full-time early English education experience and children with part-time early English education experience(F= 9.23, p<.01).

The difference in information processing according to the experience of early English education

Table 7 and Table 8 show the results of comparing the difference of information processing scores between children with full-time early English education experience and those with experience of part-time early English education.

Table 7: Mean and standard deviation of information processing scores according to experience of early English education

Division	**Information processing score**		**Adjusted information processing score**	
	M	***SD***	***M***	***SD***
full-time children	22.55	6.58	22.56	1.97
part-time children	29.15	10.40	29.14	1.97

According to Table 7, 22.56(SD=1.97) children with full-time English education experience were relatively lower information processing scores than 29.14(SD=1.97) children with part-time English education experience.

Table 8: Analysis of covariance of information processing scores according to experience of early English education

A source of change	**Sum of squares**	**Degree of freedom**	**Mean squared**	***F***
total intelligence (covetous)	5.47	1	5.47	.07
group(main effect)	431.22	1	431.22	5.55*
error	2874.03	37	77.68	
sum	30044.00	40		

* $p<.05$

Table 8 shows that there is a significant difference in information processing scores between children with full-time early English education experience and children with part-time early English education experience(F=5.55, p<.05).

The difference in goal setting according to the experience of early English education

Table 9 and Table 10 show the results of comparing the difference of goal setting scores between children with full-time early English education experience and those with experience of part-time early English education.

Table 9: Mean and standard deviation of goal setting scores according to experience of early English education

Division	Goal setting scores		Adjusted goal setting scores	
	M	***SD***	***M***	***SD***
full-time children	12.33	2.88	12.26	.41
part-time children	11.06	2.83	11.10	.32

According to Table 9, 13.05(SD=3.12) children with full-time English education experience were higher goal setting scores than 12.20(SD=2.48) children with part-time English education experience.

Table 10: Analysis of covariance of goal setting scores according to experience of early English education

A source of change	Sum of squares	Degree of freedom	Mean squared	***F***
total intelligence (covetous)	105.80	1	105.80	14.60***
group(main effect)	36.34	1	36.34	5.02*
error	811.42	112	7.25	
sum	16250.00	115		

*** p<.001, * p<.05

Table 10 shows that there is a significant difference in goal setting scores between children with full-time early English education experience and children with part-time early English education experience (F=5.02, p<.05).

Conclusion

First, attention control didn't show any difference whether the children experienced full-time or part-time early English education in early childhood. These results differ from the results of previous studies in which bilingual children aged 3 to 9 years were superior, with regards to attention controls, over children with part-time early English education experience. The experience of early English education conducted by native speakers in English language schools does not affect the control of the state of the language in the light of the view that bilingual children use the appropriate language in two languages according to the language situation with little mistake.

Second, children who experienced full-time early English education showed more favorable cognitive flexibility than children who experienced part-time early English education. These results support previous studies that bilingual children have higher cognitive flexibility than single language children. In other words, children who have full-time English education need to acquire English and Korean at the same time, so they use a higher level of cognitive flexibility because he or she should use English and Korean depending on the conversation partner or language situation.

Third, children with full-time early English education were found to have lower information processing than children with part-time early English education. In other words, the experience of immersion in early English education in early childhood means that the fluency of children affects information processing negatively. These children in the language school are not only being taught all day in the closed space of the school building, but also have less linguistic interaction with the teacher than general daycare or kindergarten. In other words, teacher-centered education can be one-sided; listening to native English teachers who the children can't understand properly. In addition, when they learn English, they have to consciously perform in a structured environment, unlike acquiring their native language, and are exposed to a negative learning environment.

Fourth, the goal setting was more favorable for children who experienced full-time early English education than those who experienced part-time early English education. This result implies that the ability to properly use two languages and to represent two names in one thing is related to the ability to look ahead and plan and organize.

In conclusion, the experience of early English education in EFL situations, that is, learning both languages at the same time in early childhood positively affects cognitive flexibility and goal setting, but negatively affects information processing. In order to increase the effectiveness of early English education in early childhood, systematic English activities and program developments are required. In addition, it is necessary to develop and apply an

early English education program in early childhood, reflecting the content of the national level early childhood education course.

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