

The Exploration of the Differences in Working Memory Ability Between Monolingual and Bilingual Children

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ABSTRACT

The purpose of this study is to explore whether bilingual children perform better in working memory tasks than monolingual children. A total of 60 Chinese monolingual and Chinese-English bilingual children from a kindergarten in Huainan participated in this experiment. The results indicated that monolingual children were better at processing information and suppressing cognitive interference than bilingual children, contrary to our hypothesis. However, differences in school levels and errors in assessing children's family economic status in the study still need to be controlled for more carefully. In addition, further implications of this study and the shortcomings of bilingual education were also discussed.

Keywords: Bilingual children, Monolingual children, Chinese, English, Working memory, Simon task

1. INTRODUCTION

In language education for children, teachers in many schools require children to read aloud and repeat the texts. It is not difficult to find that children's memory is closely related to their language ability, if their language ability is relatively strong, they can describe their memories with language, so that the memory is more solid. With the prevalence of early childhood education, there is a growing interest in the relationship between bilingualism and memory. Filipović [1] recently suggested that bilingual systems may have an advantage over having monolingual systems because speakers of different languages differ in their lexical and syntactic levels, which may be critical to the performance of events in language and memory, and bilinguals may be in a favorable position due to multiple encoding modes and multiple conceptual features being active at the same time. Based on this, we planned to further explore whether bilingual children have an advantage over monolingual children in terms of working memory ability so that in the future children can be trained to improve memory

through language at an early age.

According to Baddeley [2], working memory refers to one or more systems necessary to remember things when performing complex tasks such as reasoning, comprehension, and learning. Bilingual children exhibit enhanced working memory (WM) skills relative to monolingual children, which could have implications for early mathematics development [3]. Many studies have demonstrated that bilingual children showed stronger memory skills on the task than monolingual children. A meta-analysis found that bilinguals typically outperformed monolinguals on working memory across tasks. However, the socioeconomic and intellectual factors of the subjects were not discussed in the previous studies, which may affect the interpretation of the results. Furthermore, the working memory tasks included in the study were not clearly defined as "verbal" or "nonverbal" in the analysis, and this obscures any between-group differences one might expect [4]. As an improvement, we controlled for family economic factors in our study. Furthermore, Morales et al. [5] conducted two studies comparing the performance of monolingual and bilingual children on tasks requiring different levels of working

memory and found a greater advantage for bilingual children under more difficult conditions and incongruent trials. In both studies, children were administered two tests in a quiet room at school: the Peabody Picture Vocabulary Test (PPVT-III) to assess English receptive vocabulary and the Kaufman Brief Intelligence Test (K-BIT) to assess fluid intelligence, differing in that Study 1 used a picture task also known as the Simon-type task, while Study 2 used the frogs matrices task to measure visuospatial memory. The researchers considered socioeconomic factors, with all subjects being middle class and having parents with at least a college-level degree. However, in this home environment, children may have had different resources to support them such as extracurricular tutoring resulting in different levels of language proficiency. Moreover, in the study by Morales and her colleagues [5], bilingual children's second language was not controlled for, potentially affecting the results due to language family issues. This is because bilingual children who use the same language family and those who use different languages may have different degrees of language acceptance and language proficiency. The Russian, French, Portuguese, and Spanish in this study belong to the same Indo-European languages. Using this framework, we measured children's ability regarding working memory using the Simon task and manipulated the two languages of bilingual children, i.e., Chinese-English (Chinese belongs to the Sino-Tibetan languages and English belongs to the Indo-European languages), because few working memory-related studies have been conducted in the past on Chinese-English bilinguals. Also, we controlled for subjects in low socioeconomic situations, similar to the study by Blom and her colleague [6]. In this way, we can find out whether bilingualism counteracts the negative effects of low socioeconomic status backgrounds and whether bilingual advantages are found when differences in socioeconomic status backgrounds between the two languages are offset [6]. In their study, the home language use of the subjects' parents was not controlled for. We believed that children would have inconsistent proficiency in their second language if their parents would use two languages or a second language at home, so children whose parents did not speak English were selected.

Nevertheless, a study by Engel de Abreu [7] showed that bilingual experience did not convey any advantage in working memory capacity. In his study, bilingual children were exposed to both languages from birth, yet he proposed that there is no evidence that bilingual effects may occur through long-term exposure to a second language [7]. To know the effects of classroom bilingualism on task-shifting, verbal memory, and word learning in children, scientists got the result that while exposure to a second language in a classroom setting may not be sufficient to engender changes in cognitive control, it can facilitate verbal memory and verbal learning [8].

An empirical study also examined emergent bilingualism and working memory development in school-aged children [9]. The evidence showed that emergent bilingualism may modulate WM development in school-aged children at the sub-component level, but detecting this modulation is contingent on task selection. For these reasons, we were interested in exploring whether bilinguals who acquired a second language at a later age would show better working memory capacity, so in our study, we chose children who had not been exposed to English before kindergarten.

1.1. The present study

Our experiment was conducted mainly through Simon task to assess children's ability to suppress cognitive interference. The main purpose of our experiment is to explore the working memory performance of the children who speak Chinese and English and the children who only speak Chinese. The previous study mainly focused on children who can speak one or two languages in the West Germany branch. Our study compared bilingual children who can speak Chinese and English, Chinese belong to Sino-Tibetan. We can further investigate are their differences in working memory between children who speak languages in a different language family.

Based on Baddeley and Hitch's [10] multi-component model of working memory, this experiment examined the relationship between different components of working memory and children's arithmetic cognition. Our hypothesis 1 is that unit memory does not affect bilingual ability, but the ability to process information and suppress interference is related to bilingual ability.

Bilingualism is combined with the enhancement of multiple executive functions, including cognitive flexibility, efficiency, task switching, and conflict resolution. Many studies have evidence that bilinguals are stronger and more effective than monolinguals in controlling working memory. Similarly, bilingual children can allocate visual working memory resources more effectively than monolingual children. To be more specific, they have general executive control advantages to maximize their visual working memory. Our hypothesis 2 is that bilinguals have stronger working memory ability than monolinguals.

2. METHOD

2.1. Participants

In this experiment, we selected subjects based on the principles that their native language was Chinese Mandarin, that none had been exposed to any second language before kindergarten, that neither parent (or surrogate) knew a foreign language, and that to more effectively study the facilitative effects of bilingual

education (Chinese & English) on disadvantaged children, the subjects were all ordinary working-class people with low socioeconomic status (SES). This led to the selection of Wan Xin Ying He kindergarten in Hefei, Anhui Province, China (monolingual education, no foreign language). A total of 60 children were selected, with 30 taking English classes outside school and 30 children who had never been taught in any other language.

2.2. Materials and Procedure

In this study, the independent variables are children in a monolingual environment and children in a bilingual environment, and the dependent variable is the children's capacity for working memory.

Simon Test tests the effect of spatial compatibility. Children who are more spatially compatible also have better working memory. Thus we used the Simon task to assess children's ability to suppress cognitive interference in working memory, which is the difference in accuracy or response time between trials where the stimulus and response are on the same side and trials where they are on opposite sides, with responses generally being slower and less accurate when the stimulus and response are on opposite sides [11]. This measures the individual's ability to suppress cognitive interference and make judgments. The rules of the Simon Tasks are explained to the child before the test. The computer will present three colored dots (red, white, and green), two at a time, with the green dots on the right and the red dots on the left. The whole test is not related to the position of the red and green dots themselves, only to the position corresponding to the color. The final time (ms) is recorded; the smaller the value, the better the ability to suppress cognitive interference.

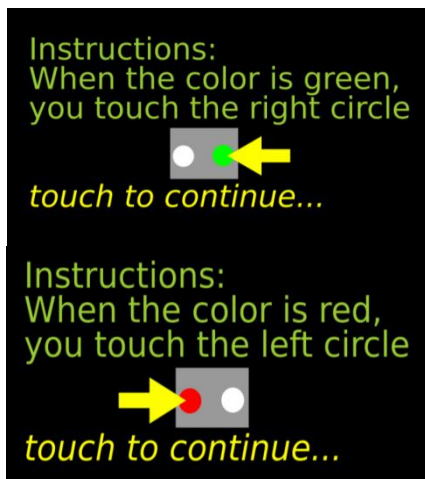


Figure 1 the Guidance of Simon Task

We did this test in a monolingual kindergarten, the children who have learning learn English mainly rely on after-school tutoring classes. Of the 57 children, 29 are learning English outside the home, the other 28 had not studied English. We gave each of the 57 children a Simon

test and recorded the children's test results. Then the parents of the 57 children were then given questionnaires to Obtain informed consent and let us know these parents' income, education, etc. The goal was to compare them with the children's test results. The Simon effect is the Spatial compatibility effect, congruence effect of stimulus-response Spatial congruence between stimulus and response is one of the important factors affecting cognitive operation. In general, when the features of the target stimulus (such as arrows positioned left or left) do not match the desired response (such as the right hand), the response time is generally longer than when the features of the stimulus (such as arrows positioned left or left) match the response (such as the left hand), and the response error rate is higher. The difference in response time or error rate between inconsistent and congruent conditions is the conflict effect, also known as the stimulus-response compatibility effect. In consideration of the children's young age, we used different colored circles for the test, the test screen will appear with two circles and possibly three colors: red, green, and white. We asked the children who were tested when they saw two circles in the skin and some circles were red, so we clicked the left circle. If one of the two circles was green, we clicked on the one on the right. By studying the correlation between stimulus task location and task, the congruent value represents when the response rate of the child at the same location of the stimulus task, incongruent represent the response rate at a different location. The difference in response between congruent and incongruent conditions is called the Simon effect, the test results are measured in milliseconds.

3. RESULTS

3.1. Descriptive statistics

Sixty-one kindergarten children participated in the test, and 57 remained after excluding the sample with incomplete information, including 28 monolingual children (16 males and 12 females) and 29 bilingual children (13 males and 16 females). We selected monolingual ($M = 5.57$, $SD = .57$) and bilingual children ($M = 5.03$, $SD = .73$) in the age range of 4 to 7 years. Standardization of the data showed the socioeconomic status of bilingual ($M = .12$, $SD = .69$) and monolingual children's families ($M = -.12$; $SD = .72$).

The results of Simon test reported a lower congruent time on average for monolingual children ($M = 2345.39$, $SD = 778.75$) than for bilingual children ($M = 2403.62$, $SD = 467.68$). Similarly, the bilingual children ($M = 2626.93$, $SD = 607.18$) were inferior to monolingual children's incongruent ($M = 2260.61$, $SD = 802.04$). The figures of Simon effect illustrated that the difference between positive and negative response rates was greater in bilingual children ($M = 190.41$; $SD = 580.62$) than in monolingual children ($M = -84.14$, $SD = 357.58$). For

Simon task, the smaller the experimental data, the better the anti-interference ability.

3.2. Correlates of main variables

According to Pearson's correlation analysis (Table 1),

being monolingual or bilingual was moderately correlated with the Simon effect ($r = .277, p = .037 < .05$). In addition, family socioeconomic status also had a moderate positive correlation with the Simon effect ($r = .28, p = .035 < .05$

Table 1. Pearson correlations of the main variables

	Age	Monolingual or bilingual	SES	Congruent	Incongruent	Simon effect
Age	-					
Monolingual or bilingual	-.383**	-				
SES	-.225	.170	-			
Congruent	-.115	.046	-.002	-		
Incongruent	-.098	.254	.205	.712**	-	
Simon effect	-.031	.277*	.280*	-.225	.515**	-

Note: * $p < .05$; ** $p < .01$

3.3. Difference tests

There were no significant differences between monolingual and bilingual children's results in terms of congruent and incongruent, but bilingual children had a significantly larger Simon effect than monolingual children, $t(55) = -.34, p = .037 < .05$.

4. DISCUSSION

This experiment analyzes the ability of bilingual children and monolingual children to suppress cognitive interference. The hypothesis is that bilingual children perform better than monolingual children in Simon Task, and second language acquisition has a positive effect on working memory [1]. But the results show that: Bilingual children's working memory and anti-interference ability are inferior to monolingual children, which is inconsistent with the results of previous comparative studies on monolingual and bilingual children. We analyze the reasons that influence the results: the bilingual children we studied are not those who have been exposed to two languages since birth. The main way for these bilingual children to study English is extra-curriculum tutorials, and their parents and teachers are generally unable to communicate with them in English. Therefore, bilingual children do not use English in real life, so most of them can't use the second language skillfully. Therefore, the bilingual children we tested are not a real sense of bilingual, and Chinese is their mother tongue. In addition, at present, English teaching in some Chinese extra-curriculum tutorials mainly focuses on reciting words and sentences. This kind of teaching method is like elementary school, which is not in line with the game-centered education method in kindergartens. The disadvantages of this kind of primary

education method are obvious. Teaching children specific language knowledge in a short time, but does not well combine language with other domains, which is not conducive to the development of children's working memory.

The significance of this experiment is also worth discussing. Previous studies tend to focus on the advantages of bilingual education, but seldom mention the defects. Therefore, we discuss the disadvantages of bilingual learning: Language is result-oriented to a certain extent, so it is easy to bring pressure to children when the results are not satisfactory. In some critical periods of brain development, stress will hinder the development of cells and the formation of synapses. Excessive stress may also cause a large amount of cortisol, which will be harmful to children's physical and mental development. In addition, the difficulties in learning the second language have negative impacts on children's enthusiasm for language learning in the future.

At present, bilingual education in China has not been standardized, and some kindergartens separate language learning from children's games, and simply let children read and memorize words and sentences repeatedly. To solve these problems, China needs to further promote the standardization and teaching methods of bilingual education. The method of education should conform to the children's physical and mental development and cognitive level and take the form of games. Try to make children have a happy and positive state in the process of second language learning.

5. CONCLUSION

From the process of The Simon Task, we can conclude that: First, the length of time it takes for the color and position to be consistent is most consistent with

the thinking habit of the brain, thus children react speed is relatively fast, and the error rate is low. Secondly, inconsistent colors and positions are not in line with brain thinking habits, this interferes with children's reaction times. Thirdly, the time of inconsistent minus consistent represents the ability of the subject to suppress interference.

From the results, we can know that: Firstly, monolingual children's thinking habits are better than bilingualism. Secondly, monolingual children's reaction time is quicker than bilingual children's. Thirdly, monolingual children have better abilities to suppress cognitive interference in working memory.

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