LITERACY/SCHOOLING, DEVELOPMENTAL DIFFERENCES, SOCIOECONOMIC STATUS: FACTORS AFFECTING COGNITIVE DEVELOPMENT OF BILINGUAL CHILDREN

Ifigeneia Dosi
Democritus University of Thrace, **GREECE**
idosi@helit.duth.gr

ABSTRACT

The present study aims to investigate the factors that affect the cognitive development (i.e. non-verbal intelligence, verbal and non-verbal working memory and executive functions) of bilingual children. Previous studies suggest that bilinguals often show a 'cognitive advantage' over monolingual speakers, conceivably, because they move from one language to the other. In addition, other studies have noticed the role of developmental factors (i.e. chronological age, socioeconomic status and maternal education) as important factors that affect cognitive development. More recent studies claim that the language dominance, literacy practices and schooling also have a positive impact on the cognitive abilities (i.e. working memory and executive functions) of bilingual speakers. In the present study participated sixty-five monolingual children and one hundred forty-five bilingual children coming from different linguistic and educational backgrounds and they were tested by means of a large battery of cognitive tests (on non-verbal/fluid intelligence, (non-)verbal working memory and executive functions, i.e. updating). The results revealed that in most of the tasks the bilingual 'cognitive advantage' was not confirmed. Only in the updating task bilinguals outperformed monolinguals.; possibly the cognitive advantage is more evident in more complex and demanding tasks. The main factors that seem to affect bilingual cognitive development are literacy and schooling; age and socioeconomic status found also to affect and predict their cognitive abilities. Finally, language dominance found not to have a considerable impact on bilinguals' cognitive skills. The present findings confirm previous studies that indicate the role of literacy and schooling as the most important factors in bilingual cognitive and language development.

Keywords: Bilingualism, cognitive abilities, literacy/schooling, complex working memory, bilingual cognitive advantage.

INTRODUCTION

Studies on bilingualism and cognitive advantage have found that bilingual speakers have an advantage over monolingual speakers on cognitive tasks; thus one of the major benefits of bilingualism is their advanced cognitive skills (Bialystok 2006; Costa, Hernández and Sebastián-Gallés 2008) and the faster reaction times in online tests. This is probably due to the fact that bilinguals have to manage two languages, which are often antagonistic; therefore, their executive functions, such as cognitive updating or inhibitory control, are more developed in bilinguals compared to monolinguals (Green 1998; Bialystok 1999, 2001, 2010; Costa et al. 2009, Poarch & van Hell 2012). Also, Bialystok (2001) reports that bilingual children develop their cognitive abilities faster than their monolingual peers. In a series of studies (Bialystok 1999, 2001, 2010), she observed that bilingual children performed better at inhibitory control and shifting/switching than their monolingual peers. Nevertheless, the findings of the aforementioned studies were disputed by Carlson and Meltzoff (2008) who report that these differences were likely to be cultural differences, as monolingual Chinese children performed better than monolingual English speakers. Hence, the cultural context may affect cognitive development if children come into contact with related activities - such as problem solving, puzzles - from an early age may exhibit more developed cognitive abilities compared to other cultures. Socioeconomic status also found to play an important role in cognitive development (Carlson and Meltzoff 2008). In bilingualism, literacy and schooling have found to play a crucial role in cognitive development (Leikin et al. 2009; Dosi et 2016; Dosi and Papadopoulou 2019). Nonetheless, there are studies that do not confirm this bilingual advantage (Morton and Harper 2007; Namazi and Thordardottir 2010; Engel de Abreu 2011). From the above we may deduce that we should consider carefully this 'bilingual cognitive advantage' and test other factors that may affect the performance of bilingual speakers on cognitive tasks, such as literacy/schooling, input, language dominance, socioeconomic status, among others.

LITERATURE REVIEW

Cognitive development is the development of abilities that allow us to be flexible, to retain information in our memory for a short or longer period and to retrieve it in order to further process it, to learn, to think, to develop reasoning and to solve problems. The development of these abilities is also related to the linguistic development and experiences of the individual, often in the context of two-way relationships (for a review see Bialystok 2001). For example, a key question that has concerned the recent research is whether one's bilingual linguistic experience influences linguistic as well as cognitive development (Bialystok 2001; Hoff 2009). The first findings showed significant differences between the bilingual and monolingual; bilingual children performing lower than monolinguals on verbal and non-verbal intelligence measures (for a review see Hoff 2009). However, it is worth mentioning that the two groups differed in their socioeconomic status; monolinguals predominating over bilingual children who came from immigrant families. On the contrary, when later, Peal and Lambert (1962), simultaneously comparing bilingual and monolingual children of the corresponding socio-economic level, the bilingual group appeared to excel in the cognitive tests. This cognitive "advantage" was attributed to the contact of bilingual children with two languages and cultures, which was thought to contribute to cognitive development in general and to cognitive flexibility in particular (Palij and Homel 1987).

In recent years, a significant number of studies on cognitive development, as well as its relation to bilingualism, has focused on the development of Short-Term Memory (STM) and especially on the development of Working Memory (WM). - Working Memory (Alloway, Gathercole and Pickering 2006; Baddeley 2000; Baddeley and Hitch, 1974; Messer 2010; Messer et al. 2010). WM is a system of limited capacity that is responsible for the STM retention and processing of information we receive from the environment in relation to what information is stored in our long-term memory (i.e. general knowledge, facts, our experiences, etc.). A second area that has greatly concerned the studies on cognitive development is executive functions; i.e. high-level cognitive functions that contribute to the cognitive regulation of our behavior. In their model, Miyake et al. (2000) refer to three interrelated but largely independent functions: *Updating*, *Inhibition*, and *Shifting/Switching*. *Updating* refers to the ability of an individual to monitor the flow of information to the WM and to update its content, replacing information that is not considered useful with what may contribute to the performance of the current task. Inhibition refers to the ability to drive your attention, focus on your task and suppress disruptive stimuli or behavioral tendencies.

Finally, *Shifting/Switching* pertains to the ability to adapt to change between tasks, functions, or mental sequences.

Among the factors that may influence the development of these basic cognitive functions, researchers have also turned their attention to bilingualism in recent years. Languages spoken by a bilingual are considered to be simultaneously activated even when only one of them is used (Hernandez, Bates and Avila 1996; Dijkstra, Grainger and van Heuven 1999; Kroll, Bobb and Wodniecka 2006). This simultaneous activation of the two linguistic systems is significantly demanding for bilingual speakers in producing and understanding on a daily basis. These requirements mainly concern the control of their attention and, in particular, the focus on one of the two languages and the inhibition of interference by the competing language system. Also, in their daily lives, bilinguals are often asked to move simultaneously from one language to the other (Bialystok 2010) considering environmental requirements (e.g. when a bilingual child discusses with his parents, using however, with each parent their native language). This daily cognitive exercise of bilinguals also attributes the disadvantages of bilinguals to monolinguals in developing linguistic proficiency and verbal fluency (Bialystok 2009). By contrast, studies have found advantages when language is not involved, especially in terms of executive functions (Miyake et al. 2000) and their performance in non-verbal inhibition evaluation projects, as well as alternation between tasks, functions, or mental sequences (shifting between or switching tasks; for an overview see Adesope et al. 2010). There are also findings that show bilinguals have an advantage over monolinguals in terms of abstract symbolic representation and metacognitive awareness. However, there are studies that fail to identify 'bilingual cognitive advantage' (Engel de Abreu 2011; Morton and Harper 2007; Namazi and Thordardottir 2010).

The cognitive advantage of bilinguals was not verified by recent studies where homogeneous bilingual groups (in terms of age, pair of languages spoken, socioeconomic status, type of bilingualism, e.g. simultaneous, early successive or late successive bilingualism, and language dominance, e.g. balanced or dominant bilingualism, etc.) were matched with groups of monolinguals on socio-economic level and non-verbal intelligence (Duñabeitia et al. 2014; Vivas et al. 2017; von Bastian, Souza, and Gade 2016). In a study of Namazi and Thordardottir (2010) study English-speaking and French-speaking monolingual children, as well as bilingual English-French children, were examined in a series of WM and STM tests. The results showed no bilingual superiority across all cognitive tests. Similarly, a study by Tsimpli et al. (2015) bilinguals and monolingual children did not differ on a verbal WM task. In contrast, in a nonverbal WM task, bilinguals who received literacy in both languages had higher performance than both monolinguals and bilingual participants who had literacy in one of their languages. The observed advantage was attributed to the non-mediation of language in the case of the latest WM task, along with the educational setting (bilingual school). In addition, there are studies that show cognitive abilities support bilinguals' linguistic abilities despite their lower levels of linguistic proficiency; because of the bilingual educational setting they attend, where both languages are equally supported (Dosi, Papadopoulou and Tsimpli 2016; Dosi and Papadopoulou 2019). Therefore, literacy and educational setting, along with other environmental factors should be taken into account in future studies. The present studies takes into consideration all of the aforementioned variables.

METHODOLOGY

Participants

In the present study, one hundred forty-five bilingual children (8-12 years old) participated. The bilingual speakers were either Greek-Albanian or Greek-German. The bilingual speakers attended different types of educational settings (bilingual, monolingual and Greek-dominant schools). Additionally, sixty-five age-matched monolingual children took part in the study.

Background information about the participants was collected by means of a child questionnaire (Mattheoudakis, Chatzidaki & Maligkoudi 2014), which included questions about: (a) language input (i.e. *home language history* – language input before the age of six – and; current language use – language input after the age of six) and (b) literacy practices (i.e. early literacy exposure before the age 6; and current literacy practices – literacy received after the age of six).

Material

A large battery of four tasks was administered to the participants, which tested their non-verbal fluid intelligence, the (non-)verbal working memory and their updating skills. The first three tasks were offline; while the last one was online.

Non-verbal fluid intelligence task

The *Raven's Coloured Progressive Matrices* task (Raven's et al., 2008) was used in order to test their non-verbal intelligence. The participants should complete three levels of twelve test items each, consisting of visuo-spatial conceptual matching items, which were increasing in difficulty. Each correct answer was scored as 1 point and there were no penalty points for wrong identifications. The maximum score was 36 points.

Verbal Working Memory Task

The backwards digit recall task was normed for Greek by Chrysohoou (2006). In this test the child is required to recall a sequence of spoken digits in reverse order. The items were presented with the distance between the offset of a digit and the onset of the next one to be 1 second. In this span task the number of digits to remember increases progressively over successive blocks containing 6 trials each. The criterion for moving on to the next block was the correct recall of 4 out of the 6 trials. Testing stopped if the child failed in 3 trials in one block. The task consisted of 6 blocks, starting with 2-digit sequences in the first block and increasing to 7-digit sequences in the last block. Each correct answer was given 1 point and the highest possible score was 36 points.

Non-verbal working memory task

Non-verbal working memory was assessed through the Rotating Figure task (Alloway 2007). This is a demanding task, since the participant must simultaneously process and temporarily store visuo-spatial information. The participant is shown a picture of two individuals on the screen and has to identify whether one of them is holding the ball in the same hand as the other figure. The figure may also be rotated. At the end of each trial the child has to recall the location of the ball in sequence, by pointing to a picture with eight compass points. The procedure is similar to the one of the verbal working memory task. The highest score for correct trial responses is 42, and for span is 7.

Updating task

The updating task was N-back digit task (introduced by Kirchner 1958), which was adapted to a two back digit version. This task measures updating, i.e. standard "executive" working memory (Kane et al., 2007). The task was adapted to an online version and it was designed in *E-prime II* (Psychology Software Tools, Inc., Pittsburgh, PA, USA). In terms of the procedure, the child sees a sequence of digits (2, 5, 7, 8), each presented one by one for 500 ms, followed by a blank 2,500 ms inter-stimulus interval and was instructed to press the "J" on the keyboard if the current digit displayed was identical to the one introduced two steps back or refrain from pressing any key if the digit presented was not identical. The main test block consisting of sixty stimuli was introduced. Twenty of them were the accurate responses (*correct hits*) and the other forty were the inaccurate responses (*false hits*). To score the participant's performance we transformed both correct and false hits into percentages. For instance, if a participant had thirteen out of twenty correct hits, he received a 65% score for the correct hits and if he had presses ten times the "J" in cases where he should not have pressed any key, in other words if he has ten out of forty false hits he received a 25% score. The final score resulted from subtracting false from correct hits. In the aforementioned example the final score was 40%.

RESULTS

The results have shown no differences in cognitive tasks (see Figure 1), apart from the updating task, where bilinguals outperformed monolinguals (see Figure 2). In the non-verbal intelligence task the absence of differences between the groups indicates that the cognitive differences are not due to differences in fluid intelligence ($t(206)= .001$, $p= 0.970$). No differences were observed in the working memory tasks (verbal WM task: $t(206)= .205$, $p= 0.652$; non-verbal WM task: $t(206)= .056$, $p= 0.813$).

Figure 1. Accuracy (in raw numbers) on the offline tasks.

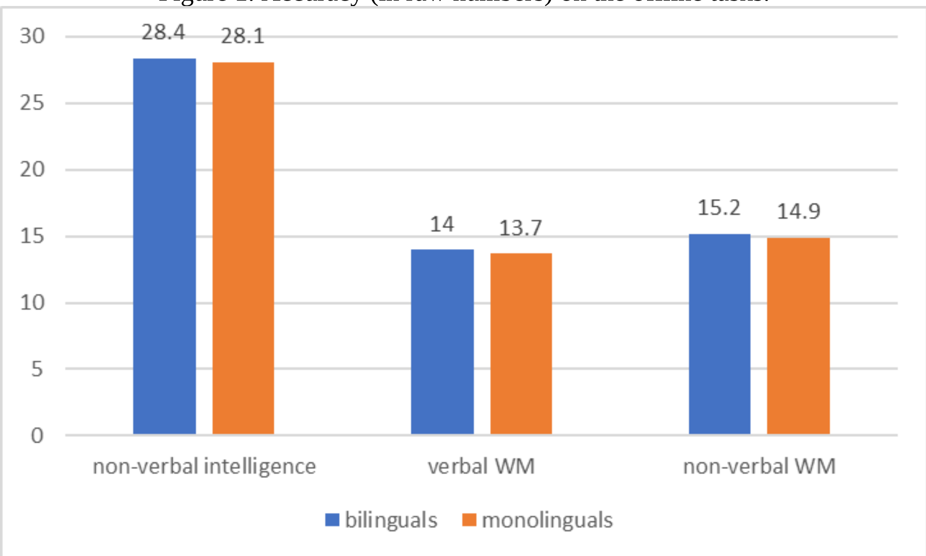
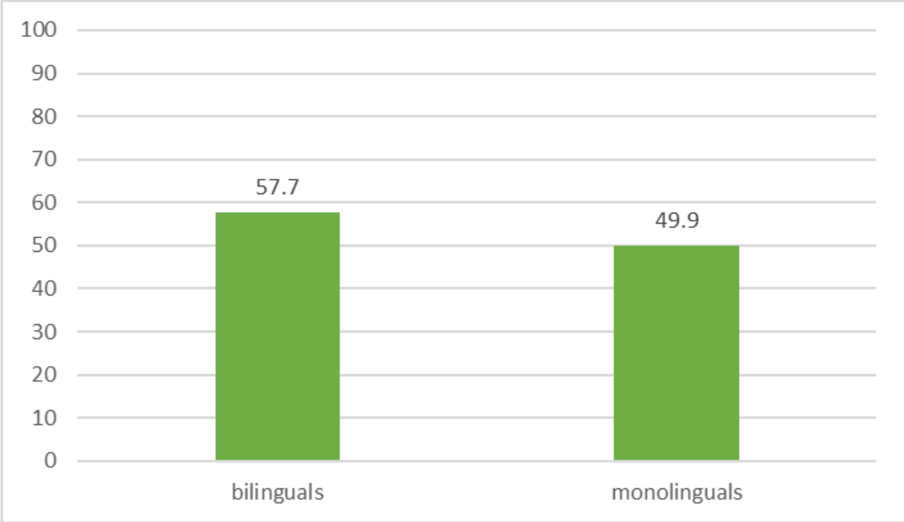


Figure 2. Accuracy (in %) on the online task (updating task).



In the updating task, differences were manifested between the two groups; thus bilinguals outperformed monolinguals ($t(206)= 3.340$, $p= 0.021$; see Figure 2).

Trying to further interpret the performance of the bilingual speakers on each cognitive task, stepwise regression analyses were performed (only for the bilinguals and not for monolinguals). The aim of these analyses was to identify any factors that can predict participants' performance on the cognitive tasks. The results have shown that for the non-verbal intelligence task, age, educational setting and SES predict participants' performance ($R^2= .226$, $F(1,141)= 6.221$, p= .014· age, $\beta= .331$, $p< .001$· educational setting, $\beta= .250$, $p= .001$· SES, $\beta= .186$, $p= .014$). Similarly, in the verbal WM task, biliteracy, SES and age predict 15.9% of participants' performance ($R^2= .159$, $F(1,141)= 5.827$, $p= .017$, biliteracy, $\beta= .224$, $p= .006$, SES, $\beta= .200$, $p= .013$; age, $\beta= .188$, $p= .017$). In the non-verbal WM task, age and SES predict 17.7% of participants' performance ($R^2= .177$, $F(1,142)= 5.932$, $p= .016$; age, $\beta= .365$, $p< .001$; SES, $\beta= .186$, $p= .016$). Finally, in the updating task, age, SES and schooling predict 26.6% of bilinguals' performance ($R^2=.266$, $F(1,141)= 8.337$, p= .004; age, $\beta= .342$, $p< .001$; SES, $\beta= .250$, $p= .001$; schooling, $\beta= .212$, $p= .004$).

DISCUSSION

The most important findings revealed that bilinguals outperformed monolinguals in (non-) verbal working memory tasks and in the updating task. These outcomes are in line with previous studies and do confirm the cognitive advantage of bilingual speakers. The absence of indicating difference in the non-verbal intelligence task depicts that the two groups are comparable and that the possible difference on the tasks are not driven by their differences in fluid intelligence. No differences were observed in the working memory tasks, confirming the findings of previous studies (Engel de Abreu 2011; Morton and Harper 2007; Namazi and Thordardottir 2010). Only in the updating task bilinguals scored higher than monolinguals (Green 1998; Bialystok 1999, 2001, 2010; Costa et al. 2009, Poarch & van Hell 2012); conceivably the finding suggests that the bilingual 'cognitive advantage' is more evident in more complex and demanding tasks (Bialystok 2001).

Regression analyses were performed in order to detect any variables/ factors that predict the performance of bilingual speakers. The results have shown that the non-verbal intelligence is

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affected by developmental differences, bilingual educational setting and socioeconomic status. The verbal working memory is predicted by biliteracy, socioeconomic status and developmental differences of the participants. The non-verbal working memory abilities are predicted by age and socioeconomic status. Finally, the updating skills are predicted by chronological age of the speakers, socioeconomic status and schooling. The present outcomes verify the findings of similar previous studies (Leikin et al. 2009; Dosi et 2016; Dosi and Papadopoulou 2019). In a nutshell, the findings indicate that bilingual participants who attend a bilingual education setting, where they receive literacy in both languages (biliteracy) and both languages are equally supported develop more successfully their cognitive skills. Similarly, our findings suggest that cognitive skills improve with age. Moreover, socioeconomic status, i.e. maternal education, plays a crucial role in the successful development of cognitive skills. Thus, the higher the SES, i.e. the years of education of the mother, the higher the cognitive skills of the bilinguals; conceivably, because these children have more chances to practice their problem-solving skills and their memory skills (Bialystok 2001, 2006, 2009). Finally, language dominance seemed not to affect and predict bilingual cognitive abilities.

CONCLUSIONS

To conclude, the present study investigated the factors that affect the development of bilingual cognitive abilities. For this purpose, one hundred forty-five bilingual and sixty-five monolingual children, aged 8-12, participated in the present study and were tested by means of a battery of cognitive tasks. The results exhibited that only in the updating task the bilingual 'cognitive advantage' was evident. In addition, biliteracy and bilingual schooling positively affect the bilingual cognitive development. In addition, age and socioeconomic status found also to affect and predict the cognitive abilities of the bilinguals. Language dominance does not to affect bilinguals' cognitive skills. The present findings suggest that biliteracy and bilingual educational setting, along with socioeconomic status and age, are the most important factors in bilingual cognitive development and the bilingual 'cognitive advantage' emerges when more complex cognitive abilities are involved.

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