Cognitive Advantages in Children Enrolled in Early Immersive Bilingual Education in Dutch Primary Schools

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Date: 25 August 2016
Word count: 5395

Abstract

A bilingual upbringing has been generally considered to positively influence children in various ways. Several studies found that individuals who were raised bilingually experienced advantages in cognitive functioning. The current study set out to explore whether the advantages found in fully bilingual children could be generalised to children enrolled in immersive bilingual education (i.e. Dutch speaking children immersed in Dutch-English bilingual education). The experiment investigated possible cognitive advantages in verbal and non-verbal working memory, non-verbal switching, selective attention, and attentional inhibition. It was expected that the children in the bilingual group would outperform the children in the monolingual group on all cognitive tests. No significant effects were found that indicated overall cognitive advantages in the bilingual group over the monolingual group. However, slightly higher scores were visible on several tasks for the bilingual group. Future research will have to indicate whether an increase in sample size and a longer exposure to the second language result in indisputable differences.

Keywords: cognitive advantage, bilingual, education, attention control, inhibition, switching, working memory, children

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1. Introduction

Bilingually raised children have been generally considered to be positively influenced in various ways. One of the advantages is that bilingual children are cognitively more developed than children who have only learned one language. Several studies in the past found that individuals who were raised bilingually experienced advantages in cognitive functions such as working memory, attentional control, and executive functioning over monolingual individuals (Barac, Bialystok, Castro & Sanchez, 2014). The current study investigated whether these cognitive advantages could be generalised to a sequential bilingual setting, in which the second language has been offered in immersive bilingual primary education.

1.1 Advantages of a bilingual upbringing

The linguistic advantages of bilingualism have been a much-discussed topic in previous research (Barac et. al., 2014). The other possible advantages, such as cognitive advantages, have been examined more and more in recent research. The studies mentioned below include the most-discussed cognitive advantages of a bilingual upbringing.

Bialystok (2011) studied early bilinguals with a certain combination of languages. She investigated whether bilingual children are more superior in coordinating executive control tasks than monolingual children specifically with regard to memory, inhibition, and shifting. She compared monolingual eight-year-olds to bilingual eight-year-olds in their performance on a complex classification task in which they made semantic judgements on stimuli that were either presented visually or auditorily. The stimuli included pictures and sounds of 25 animals and 25 musical instruments. The children were required to classify every presented object as either an animal or an instrument. Bialystok found that bilingual children performed better than the monolingual children at complex tasks in which the two modalities were combined. The results were interpreted in terms of the enhanced ability bilingual children have to coordinate the executive control components that are required in performing this complex task.

Morales, Calvo, and Bialystok (2012) also examined early bilingual children with a certain combination of languages. Both executive functioning and working memory abilities were compared between bilingual and monolingual children. The bilingual group spoke English and the second language varied. They used a Simon-type task and a visuospatial span task to measure working memory. Working memory demands in the Simon-type task were operationalized as the difference between performing the task while holding in mind either two response rules or four response rules, or included conflict and so required inhibition and shifting. The visuospatial span task measured the number of items children could correctly recall, when presenting the stimuli either simultaneously or sequentially. For both tasks the stimulus presentations were manipulated to create conditions that varied in their demands for executive control. Overall the study showed that bilingual children have an advantage in working memory over monolingual children, especially when the task includes more challenging executive function demands. The bilingual children outperformed the monolingual children in the sense that they had shorter response times and were more accurate in the incongruent trials than the monolingual group.

Barac and Bialystok (2012) conducted research on potential similarities and differences between early bilinguals acquiring different sets of languages. The cognitive abilities of several groups of six-year old early bilinguals were compared to those of a group of English monolinguals. The bilingual groups consisted of Chinese-English, French-English, and Spanish-English children respectively. The aim of their study was to investigate whether the specific languages of the different bilingual groups were similar in their effects on cognitive functioning. The children were compared on 3 verbal language tasks and 1 non-verbal executive control task. The verbal language tasks included the Peabody Picture Vocabulary Test-III, the Wugs test, and Formulated Sentences from the Clinical Evaluation of Language Fundamentals Test. The executive control task was a computerised colour-shape switching task. Barac and Bialystok found that all bilingual groups exceeded the monolingual group on the non-verbal executive control task. The results varied between the bilingual groups on all three verbal language tasks due to cultural components, overlap between both languages, and educational aspects.

In 1992 Ricciardelli investigated the effect of proficiency in the languages early bilinguals have acquired on possible cognitive advantages they experience. She determined whether the level of linguistic proficiency children attain underlies whether or not they have cognitive advantages over monolingual children. Ricciardelli found that when children have a low level of proficiency in one of their two languages they have cognitive deficits rather than benefits. A high degree of proficiency in both languages is therefore needed for bilingualism to be cognitively beneficial.

Kapa and Colombo (2013) examined late bilinguals in comparison to earlier bilinguals. They compared school-aged English monolingual children, early English-Spanish bilingual children, and late English-Spanish bilingual children with regard to attentional control. With early bilinguals they referred to children who began speaking both languages at the age of three. With late bilinguals they meant all children who began speaking one of their two languages after the age of three. In their study they used the Attention Network Test (ANT) to compare attentional control between the three experimental groups. Their research resulted in faster response times on the ANT in the early bilingual group, which suggested a monitoring advantage for early bilinguals compared to late bilinguals and monolinguals. The response times of the late bilinguals did not differ significantly from those of the monolinguals. Kapa and Colombo indicated that their results were in agreement with the theory that children who start speaking a second language earlier in childhood have greater advantages. These effects could possibly be attributed to the fact that they started acquiring the second language earlier in life or to a longer duration of bilingual experience.

1.2 Advantages of bilingual education in primary school

Cognitive advantages of a fully bilingual upbringing have been frequently examined in recent research on psycholinguistics. Little research however, has been done on the possibility of experiencing cognitive advantages purely based on immersive bilingual education. The studies listed below have focussed on whether the advantages found in studies on a bilingual upbringing could be generalised to educational settings.

To examine whether children benefit from learning a second language not only in a full bilingual upbringing, but also in second language immersion education in primary school Nicolay and Poncelet (2012) compared French-speaking children that had been enrolled in English immersion classes since the age of five to French monolingual children. They used tests on alerting, selective attention, divided attention, mental flexibility, and response inhibition using the Test for Attentional Performance in Children (KITAP). They conducted these tests using a computerised standardised test battery. Interference inhibition was tested using the ANT. The immersion group scored higher on tasks that assessed alerting, divided attention, auditory selective attention, and mental flexibility than the monolingual group after having had only three years of second-language immersion classes.

De Graaff (2015) conducted research within Dutch primary schools. The study focused on language proficiency rather than cognitive development. He compared children that learned English as a second language from the age of four to children that were taught English from the age of eleven on overall language proficiency. He found that children that learned English at an early age performed slightly better than children that learned English at a later age on all tested areas: reading, listening, conversational abilities, spelling and use of English. According to De Graaff a possible explanation for the relatively small effect sizes could have been the difference in minutes of English lessons per week and teachers' didactical skills.

In continuation of De Graaff's study several Dutch universities (ITS, UU, RU & UM) worked together (Driessen et al., 2016) and started research on an immersive English-as-a-second-language educational pilot in twelve primary schools in the Netherlands. They reported results of the first measurement on language proficiency and pupil characteristics, but as De Graaff (2015) they focussed on language proficiency rather than cognitive development. The bilingual pilot in the primary schools was coordinated by the EarlyBird group. EarlyBird is a Dutch national centre for early foreign-language programmes in primary education in the Netherlands. They are based in Rotterdam and have become an institution that warrantees the quality of their education (earlybirdie.nl). In the current educational pilot their aim is to compare the level of linguistic proficiency children attain when enrolled in an immersive second language programme, in which they receive fifty per cent of all classes in English from the age of four, to the linguistic proficiency of children that are enrolled in the regular primary school programme in which they have not received any English yet.

1.3 Research context and hypothesis

The current study expanded De Graaff's study in accordance with the ongoing FoTo study (Flankerend onderzoek Tweetalig primair onderwijs) by Driessen and colleagues (2016) to examine whether there are differences in cognitive functioning besides the linguistic advantages the children may experience. The study set out to explore whether the advantages found in fully bilingual children, as reported in the above-mentioned studies, could be generalised to children enrolled in immersive bilingual education. The hypothesis of the current study was based on these studies and especially Nicolay and Poncelet's study on sequential bilingual children (2012). It was hypothesised that children that have received fifty per cent of all classes in a second language (English) would have a cognitive advantage over children that are monolingual in Dutch. To test this hypothesis, it was examined whether Dutch five-year-old primary school children that have been enrolled in an immersive English-as-a-second-language programme since the first year of primary school have a cognitive advantage over children that have not been taught any English yet. The previously discussed studies found advantages in certain cognitive functions. Based on these findings, the functions that were examined are verbal and non-verbal working memory, non-verbal switching, selective attention, and attentional inhibition.

2. Method

2.1 Participants

The participants were 47 native Dutch primary school students from the second grade of a primary school in Rotterdam, the Netherlands. The participants were either drawn from classes that offered immersive English-as-a-second-language education or from classes that offered monolingual Dutch education. The first group consisted of 26 second-grade TPO students (immersive second language programme) out of which 42.3 % were female and the average age was 5.00 years old. The second group consisted of 21 second-grade students (regular second grade without a second language) out of which 47.6% were female and the average age was 5.19 years old.

All participants' parents received an informed consent form consisting of an information letter and an approval slip on the details of the study. They all confirmed to have complete understanding of the experiment and gave permission for their children's participation in the study. All data were treated confidentially. None of the participants had any cognitive or language impairments.

2.2. Child and family background

As a baseline for equality between groups a questionnaire, derived from the FoTo study, filled out by the childrens' parents (Driessen et. al., 2016) was compared between both experimental groups. The questionnaire served to examine whether the monolingual and bilingual groups were comparable in the percentage of children that have been raised bilingually or have received extended exposure to a second language outside of school (table 1). In the monolingual group 93% of the mothers and 88.9% of the father had Dutch as their mother tongue. In the bilingual group 70% of the mothers and 68.4% of the fathers had Dutch as their mother tongue. This difference has proven to be non-significant (mothers: p = .076, fathers: p = .126). In addition, the parents' level of education was examined and served as an indication of the children's socioeconomic status and intelligence (table 1). General intelligence is an important human quantitative trait that accounts for much of the variation in diverse cognitive abilities (Davies et. al., 2011). Davies and colleagues (2011) found that a substantial proportion of individual differences in intelligence could be explained by genetic influences. Because of this, the parents' level of education is a good predictor for the children's intelligence.

Table 1. Means and standard deviations for parents' level of education and language exposure measures.

	Monolingual (n = 29)	Bilingual (n = 20)
English games / apps[a]	32.93(93.04)	35.79(41.58)
English tv-shows for English pre-schoolers[a]	13.45(27.03)*	64.75(130.72)*
English tv-show for Dutch pre-schoolers[a]	7.67(24.59)	4.00(9.40)
English tv-shows for older children / adults[a]	26.72(39.29)	15.75(23.58)
English songs and stories[a]	42.78(98.52)	43.95(57.19)
Mother's level of education[b]	7.23(0.63)	7.35(0.75)
Father's level of education[b]	7.04(0.96)	7.39(1.20)

Note. [a] Exposure to English outside of school in minutes per week.

[b] The statistic reported for parent education is the mean value: 1 = no education; 2 = primary school; 3 = lower secondary education (LBO/VBO/VMBO); 4 = intermediate secondary education (MAVO/VMBO); 5 = higher secondary education (HAVO/VWO); 6 = technical degree/associate's degree (MBO); 7 = bachelor's degree; 8 = master's degree or higher.

* $p < .05$

2.3 Materials and cognitive tests

An empty classroom was used as test location. Only one table and two chairs were set up in this classroom. All digital stimuli were presented using the computer program E-prime (Psychology Software Tools, 2012) on a laptop. The computer program IBM SPSS Statistics 20th edition (IBM corp., 2011) was used to conduct the statistical analyses of the data. All participants took part in five cognitive tests. Four out of the five tests were conducted digitally. This battery of cognitive tests was used to measure verbal and non-verbal working memory, attention inhibition, selective attention, and executive switching. Since the data files for the non-verbal executive switching test (CoDemBi, 2016) were corrupted, the test results were excluded from the analysis.

2.3.1 The Dot Matrix and Digit Span test

The Dot Matrix as well as the Digit Span (Alloway, 2007) both measured working memory capacity. The Dot Matrix measured non-verbal working memory whereas the Digit Span measured verbal working memory. Both tests started with an increasing sequence of items that the participant had to remember in the same order as they were offered. This part of the test is called forward sequences. The second part of both tests was the backward sequences. The task was similar, but the items in this part had to be remembered in the opposite order in which they were offered. The trials in the Digit Span included sequences of auditorily presented digits that started with 2 digits and extended with 1 digit after 4 correct verbal repetitions by the participant. The trial was terminated as soon as the participant made more than 2 mistakes in a row when repeating the given sequence. The Dot Matrix used a grid in which dots appeared consecutively (figure 1). As in the Digit Span the first trials started with a sequence of 2 dots that extended with 1 dot after 4 correctly answered trials. The trial was terminated as soon as the participant pointed at a wrong box when repeating the given sequence in more than 2 consecutive trials. For both the Dot Matrix and the Digit Span the number of correctly repeated sequences for the forward and backward part were recorded in a data file.

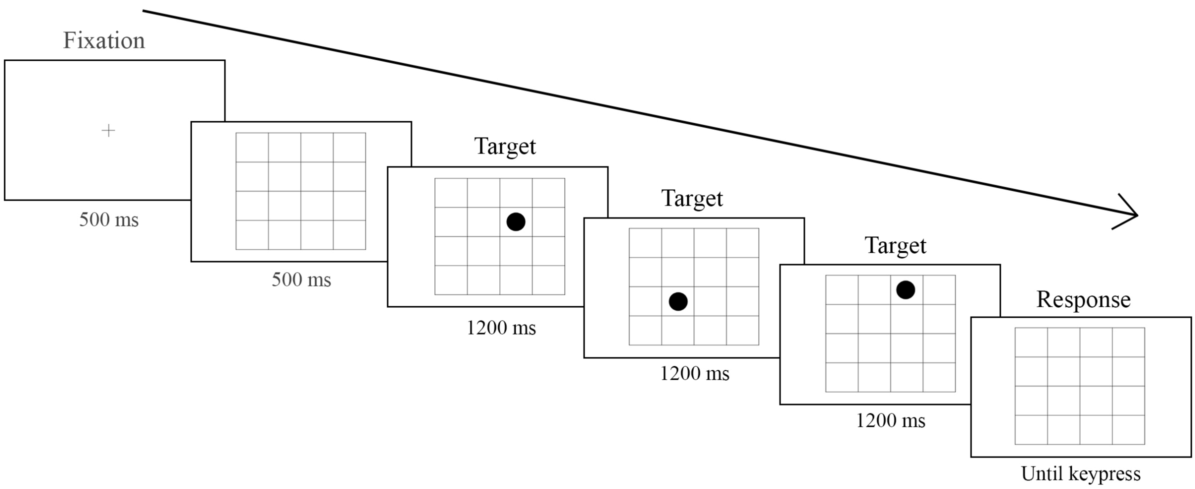

Figure 1. Order of screens in the Dot Matrix test for a sequence of three dots.

2.3.2 The Flanker test

The Flanker test for attention inhibition (Engel de Abreu et. al., 2012) is similar to the Attention Network Test used by Kapa and Colombo (2013) and consisted of a couple of test trials followed by two sets of experimental trials. In each trial a fixation cross and a cue of position were displayed after which 5 fish were presented on the screen (figure 2a). The child was instructed to only pay attention to the fish in the middle of the line (figure 2b). In each trial they had to indicate, by pressing a dedicated key, whether the fish in the middle swam towards the left or right. When the participant gave the correct response a cheering sound was played. When the participant responded incorrectly a buzzing sound was played. There were congruent trials in which all the fish swam in the same direction and incongruent trials in which the fish in the middle swam in the opposite direction of the other fish (figure 2b). For each trial the accuracy and reaction time were saved in a data file.

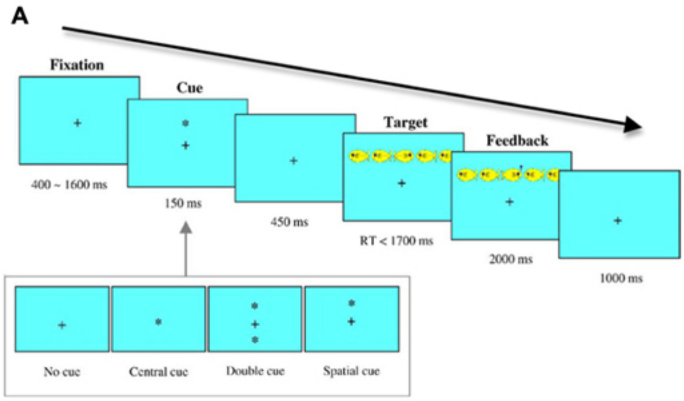

Figure 2a. Order of screens in a single trial

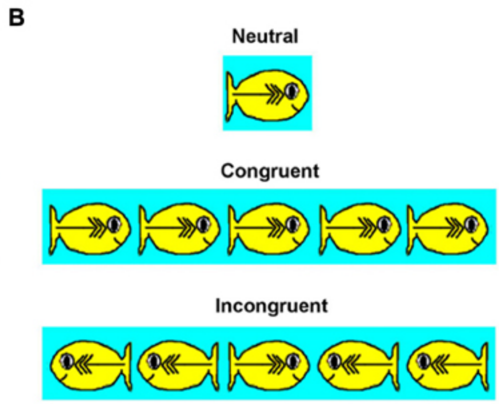

Figure 2b. Overview of the stimuli as presented in the Flanker test.

2.3.3 The Sky Search test

The Sky Search test for selective attention was derived from the Test for Everyday Attention for Children (TEA-CH, Manly et. al. 2004). The Sky Search test was the only manually conducted test. For this test three Sky Search maps (one for practice, and two test versions) were used along with a stopwatch, a score form, and a marker. The map included 20 matching pairs of abstract spaceships among 108 distractors (figure 3). The participant was required to review each pair and identify the matching pairs. When they found a matching pair they had to circle it with a marker. The total search time was administered with a stopwatch. The child indicated when he/she thought they had found all the matching pairs by drawing a cross in a box in bottom right corner. The search style was observed by the test examiner and could be any of the following 5 styles:

1. The child searched quickly and chaotically (criss-cross over the map)
2. The child searched quickly, but systematically
3. The child searched precisely and checked the map several times
4. The child searched precisely, but as quickly as possible
5. The child searched precisely, but chaotically (criss-cross over the map)

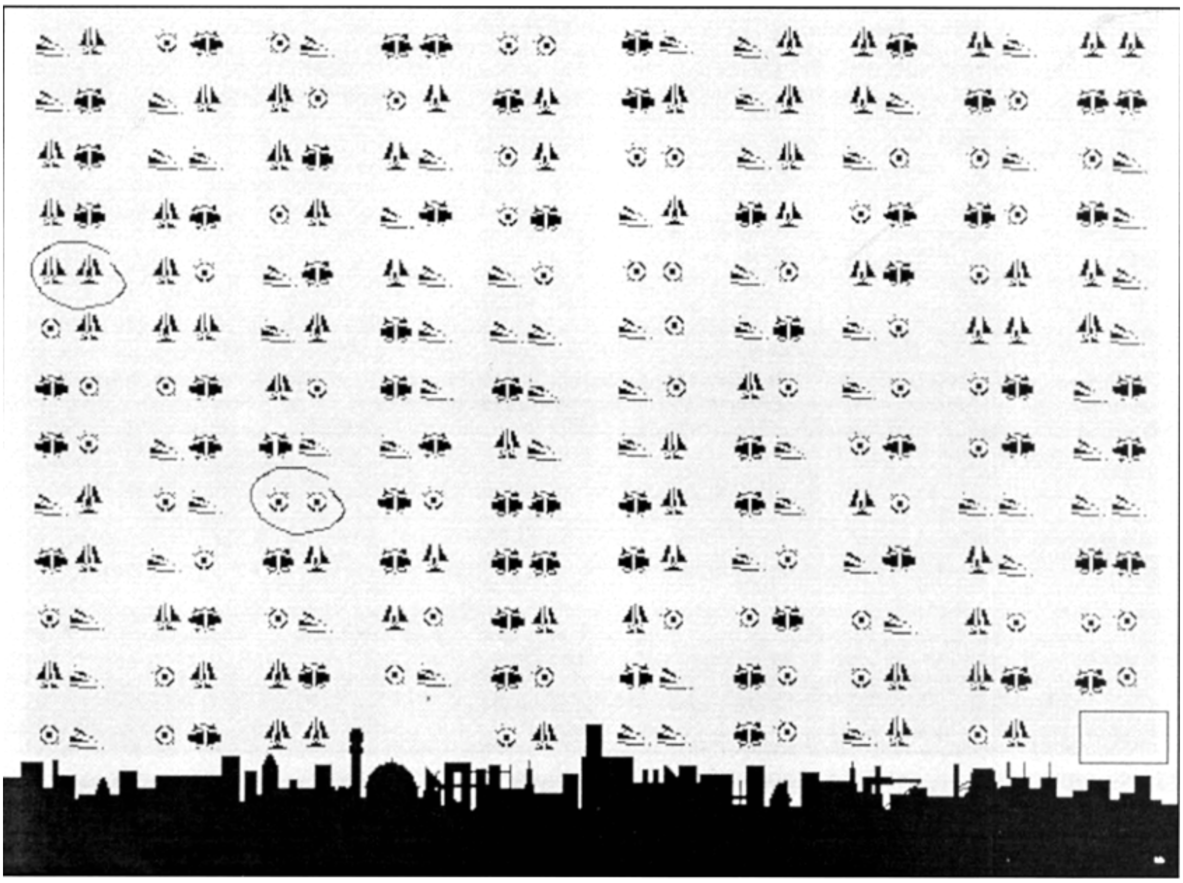

Figure 4. The Sky Search spaceship map with two correct pairs circled.

2.4 Procedure

The study consisted of 5 tests, was non-invasive, and took up approximately 40 minutes of the participants' time. The order in which the tests were conducted varied randomly per participant to eliminate chances of order effects (figure 4). The digit span and the dot matrix were never administered directly following the other, since they both measure working memory. The test examiners conducted the tests according to a strict manual to minimise any subjectivity. For example no correct answers were provided during the test procedure and the participants were only motivated by general remarks on endurance, not performance. After completing each digital test a score file was automatically created by E-prime. All these score files including the manual score form from the Sky Search test were implemented in tables in Microsoft Excel (Microsoft Corp., 2010).

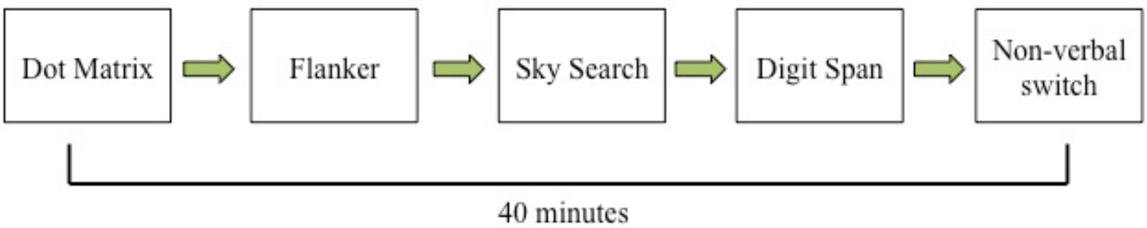

Figure 4. Example of one of the test orders used in this study.

2.5 Statistical Analyses

The experiment was set up as a between-subjects design. The independent variable consisted of 2 conditions: the group with bilingual immersion and the group without. The dependant variable consisted of the four cognitive tests, in which each cognitive test consisted of 2 outcome scores. The data were explored to test the assumptions of univariate normality, homogeneity, and sphericity. Shapiro-Wilk statistics indicated that the assumption of univariate normality was violated for the bilingual group (p = .011) on the Dot Matrix backward, for the bilingual group (p = .032) on the Digit Span forward, the monolingual group (p = .001) and the bilingual group (p = .016) on the Digit Span backward, for the monolingual group (p = .008) and the bilingual group (p = .001) on the number of incorrect responses on the Flanker test, for the monolingual group (p = .048) and the bilingual group (p = .022) on the average response time on the Flanker test, and for the monolingual group (p = .070) on the difference between incongruent and congruent reaction time responses on the Flanker test. Therefore, separate non-parametric Kruskal-Wallis tests were conducted. Bonferroni corrected Alpha levels were used to correct for multiple comparisons and p-values are reported as significant at $p <$ .007, as a consequence of conducting 7 separate analyses. For the 8^{th} score a Chi-square test was used for comparing differences in search styles on the Sky Search task, because the dependant variable was categorical. All 8 statistical tests concerning the scores on the 4 cognitive tests were performed using one-sided tests, unless otherwise stated, as there were clear hypothesised directions of effects.

3. Results

The current study set out to investigate whether immersive language schooling would have positive effects on children's verbal and non-verbal working memory, their selective attention, and their attention inhibition. The hypothesis was that children enrolled in the bilingual Dutch-English school programme would perform better on all cognitive tests than children enrolled in the monolingual Dutch programme. 7 separate Kruskal-Wallis tests were examined to compare the scores on all 4 cognitive tests between both groups. A Chi-square test was examined to compare the search styles on the Sky Search test between groups.

3.1 Dot Matrix test for non-verbal working memory

A Kruskal-Wallis ANOVA indicated that there were no statistically significant differences on the scores on the Dot Matrix forward between the monolingual group with a mean of 12.85 correct trials and a standard deviation of 1.42 (*Mean Rank* = 23.70), and the bilingual group with a mean of 12.04 correct trials and a standard deviation of 2.93 (*Mean Rank* = 20.52), $\chi^2 = 0.72$, $df = 1$, $N = 43$, $p = .199$ (figure 5). This indicated that there were no statistical differences between both educational groups on the forward non-verbal working memory task.

In addition, a Kruskal-Wallis ANOVA indicated no statistically significant differences on the scores on the Dot Matrix backward between the monolingual group with a mean of 6.80 correct items and a standard deviation of 2.14 (Mean Rank = 22.15), and the bilingual group with a mean of 6.38 correct items and a standard deviation of 3.80 (Mean Rank = 22.79), $\chi^2 = 0.03$, $df = 1$, N = 44, $p = .434$ (figure 5). This indicated that there were no statistical differences between both educational groups on the backward non-verbal working memory task.

3.2 Digit Span test for verbal working memory

A Kruskal-Wallis ANOVA indicated that there were no statistically significant differences on the scores on the Digit Span forward between the monolingual group with a mean of 14.30 correct trials and a standard deviation of 1.63 (*Mean Rank* = 22.83), and the bilingual group with a mean of 14.65 correct trials and a standard deviation of 2.12 (*Mean Rank* = 24.02), $\chi^2 = 0.09$, $df = 1$, $N = 46$, $p = .380$ (figure 5). This indicated that there were no statistical differences between both educational groups on the forward verbal working memory task.

In addition, a Kruskal-Wallis ANOVA indicated no statistically significant differences on the scores on the Digit Span backward between the monolingual group with a mean of 5.40 correct trials and a standard deviation of 1.76 (Mean Rank = 24.45), and the bilingual group with a mean of 5.04 correct trials and a standard deviation of 2.62 (Mean Rank = 22.77), $\chi^2 = 0.20$, $df = 1$, N = 46, $p = .329$ (figure 5). This indicated that there were no statistical differences between both educational groups on the backward verbal working memory task.

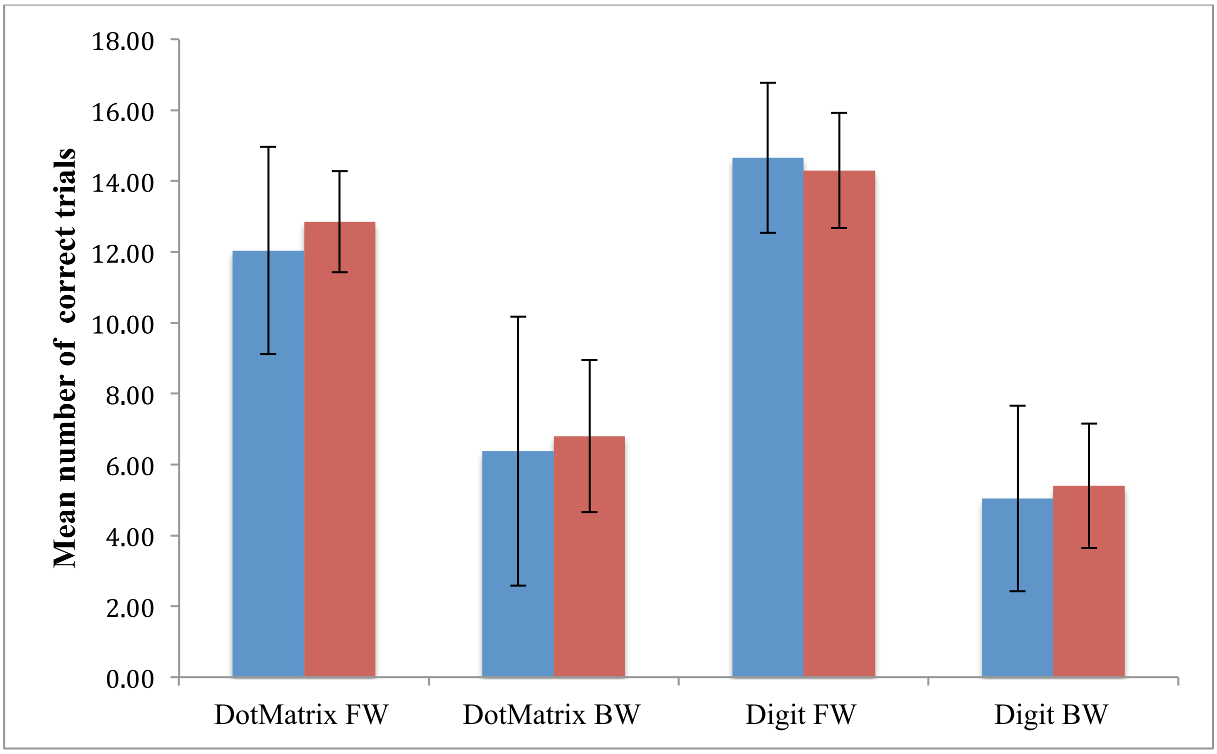

Figure 5. The mean number of correct trials on the Dot Matrix forward (FW) and backward (BW) and the Digit Span forward and backward. Blue represents the bilingual group and red represents the monolingual group. The error bars represent the standard deviations.

3.3 Flanker test for attention inhibition

A Kruskal-Wallis ANOVA indicated that there were no statistically significant differences on the average amount of incorrect answers on the Flanker test between the monolingual group with a mean of 1.85 incorrect items and a standard deviation of 1.63 (*Mean Rank* = 23.53), and the bilingual group with a mean of 1.39 incorrect items and a standard deviation of 1.16 (*Mean Rank* = 20.67), $\chi^2 = 0.60$, *df* = 1, *N* = 43, *p* = .220 (figure 6a). This indicated that there were no statistical differences on accuracy between both educational groups on the attention inhibition task.

In addition, a Kruskal-Wallis ANOVA indicated no statistically significant differences on the average reaction time scores in mili-seconds on the Flanker test between the monolingual group with a mean of 1711.38 mili-seconds and a standard deviation of 477.00 (Mean Rank = 26.50), and the bilingual group with a mean of 1579.58 mili-seconds and a standard deviation of 487.61 (Mean Rank = 21.98), $\chi^2 = 1.26$, *df* = 1, N = 47, *p* = .131 (figure 6b). This indicated that bilingual group responded slightly faster than the monolingual group, but there were no significant differences on reaction time between both educational groups on the attention inhibition task.

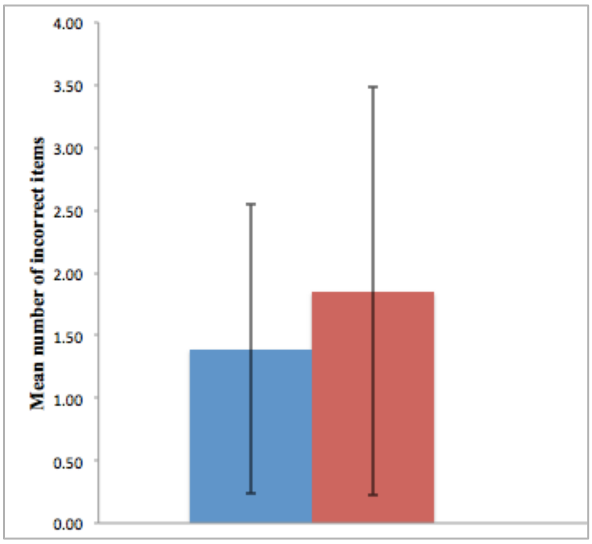

Figure 6a. Mean number of incorrect items on the Flanker test per group. Blue represents the bilingual group and red represents the monolingual group. The error bars represent the standard deviations.

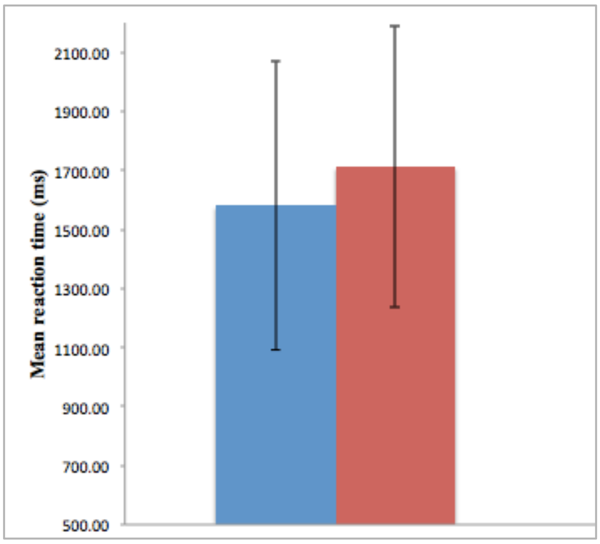

Figure 6b. Mean reaction time in mili-seconds on the Flanker test per group. Blue represents the bilingual group and red represents the monolingual group. The error bars represent the standard deviations.

3.4 Sky Search test for selective attention

A Kruskal-Wallis ANOVA indicated that there were no statistically significant differences on the time per target in seconds on the Sky Search test between the monolingual group with a mean of 15.09 seconds per target and a standard deviation of 5.57 (*Mean Rank* = 25.35), and the bilingual group with a mean of 13.12 seconds per target and a standard deviation of 4.55 (*Mean Rank* = 21.12), $\chi^2 = 1.15$, *df* = 1, *N* = 45, *p* = .142. This indicated that the bilingual group needed less time per target in identifying matching pairs of spaceships, but there were no significant differences between both educational groups on the selective attention task (figure 7).

In addition, a Chi-square test indicated that there was no statistically significant relationship between the search styles on the Sky Search test and the educational groups, $\chi^2 = 2.56$, *df* = 4, N = 47, *p* = .318. This indicated that there were no differences on the search method the child used between both educational groups on the selective attention task.

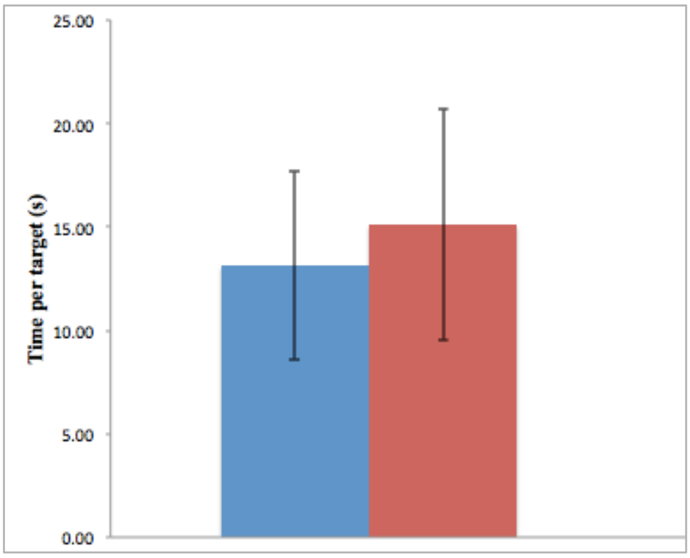

Figure 7. Mean time per target on the Sky Search task in seconds per group. Blue represents the bilingual group and red represents the monolingual group. The error bars represent the standard deviations.

3.5 Summary

To sum up, separate Kruskal-Wallis ANOVA's comparing the scores on all four cognitive tests between the two groups indicated that the groups did not differ significantly in their performance on all four cognitive tests. The Chi-square test to compare the search styles on the Sky Search also did not suggest any differences between the monolingual and the bilingual group. Overall the current study did not find indisputable cognitive differences between bilingually educated children and monolingually educated children.

4. Discussion

The fact that bilingual individuals experience cognitive advantages when compared to monolingual children is no novelty. Previous research provided compelling evidence for advantages of bilingualism in several cognitive areas, such as attentional control, working memory, inhibition, and shifting. However, previous research has mainly been focussed on the advantages found in individuals that were raised completely bilingual; little research has been done on the possibility of experiencing cognitive advantages purely based on immersive bilingual education.

The current study set out to explore whether the advantages found in fully bilingual children could be generalised to children enrolled in immersive bilingual education. The experiment investigated possible cognitive advantages in verbal and non-verbal working memory, non-verbal switching, selective attention, and attentional inhibition. It was expected that the children in the bilingual group would outperform the children in the monolingual group on all cognitive tests.

Cognitive performance was characterised by eight different test scores on four cognitive tests: forward and backward accuracy on the Digit Span and the Dot Matrix test, accuracy and reaction time on the Flanker test, and time per target and search style on the Sky Search test. The performance on all eight tests did not seem to differ between the bilingual and the monolingual group, despite observing slightly higher scores on four out of seven outcome measures in the bilingual group. The difference in performance was not large enough to conclude indisputable differences between both educational groups.

4.1 Possible Influences

The answers on the questionnaire, derived from the FoTo study (Driessen et. al., 2015), were examined and provided no evidence for differences in exposure to English outside of school, bilingual upbringing, and the parents' educational level between the monolingual and the bilingual group. Any differences in performance on the cognitive tests could therefore not be attributed to differences between the groups.

An important methodological concern is the relatively small sample size. There were 47 participants, but there was a lot of variance amongst the participants. These inconsistencies may have contributed to the lack of differences between both experimental groups. There were some slight advantages visible in the bilingual group, but to determine whether these advantages could prove convincing, the experiment would have to be carried out on a larger scale.

Another influence on the results may have been the years of exposure to the English language. Nicolay and Poncelet (2012) found compelling evidence for a cognitive advantage in children enrolled in an immersive second language programme. However, the children that participated in their study had been enrolled in these classes for three years. In the current study the children had only been exposed to English for a year and a half. Kapa and Colombo (2013) suggested that a longer duration of bilingual experience could have an effect on whether or not the bilingual children show cognitive advantages over monolingual children. Furthermore, Ricciardelli (1992) found that a high level of linguistic proficiency in both languages is required for the children to experience any cognitive benefits. Since the children in the current study have only been exposed to their second language for a short period of time, a suggestion for further research is to repeat the study at a later stage. It is very probable that cognitive advantages will be visible once the children have had at least three years of immersive second language education. In addition to this recommendation the linguistic proficiency of the children in both languages should be taken into account in future research to preclude any chances of their language proficiency to impede their cognitive abilities.

4.2 Limitations

When working with children certain external influences cannot be completely avoided. For example, children are only interested in a task for a short period of time. The experiment took up forty minutes of the participants' time, which for some children was too long to be able to stay concentrated and interested. Short breaks were inserted when necessary. Nonetheless, this did not entirely recover the level of concentration in every child. In addition, empty classrooms were used as test locations. On several occasions some noise could be heard during testing. However, these insuperable inconveniences were comparable between both experimental groups and could therefore not have accounted for any differences in results.

Another limitation may be that no intelligence test was conducted among the participants. Instead, the parents' level of education was used as a predictor for the children's intelligence. A difference in intelligence between groups may influence the results on the cognitive tests. To completely eliminate chances of initial differences in general intelligence between the monolingual and the bilingual group, a recommendation for future research is to conduct a validated intelligence test besides the cognitive tests.

Since the files on the non-verbal switch test were corrupted these could not be analysed. Bialystok (2011) found cognitive advantages in bilingual children on, inter alia, executive shifting. To examine whether children truly benefit from bilingual education in this regard, it is highly recommended for future research to explore the possible differences in executive switching between children that are enrolled in monolingual and bilingual education. In addition, the same study by Bialystok found that these advantages in executive functioning mainly occurred when tests combined both the visual and auditory modalities. To explore if bilingually educated children are more competent in dealing with multiple modality tasks, future research should include executive functioning tasks that combine two modalities.

4.3 Conclusion

To conclude, no effects were found that indicated overall cognitive advantages in the bilingual group over the monolingual group. However, slightly higher scores were visible on several tasks for the bilingual group. Future research will have to indicate whether an increase in sample size, longer exposure to the second language, and a task on executive switching will result in indisputable differences. Incorporating these recommendations will reveal whether children benefit cognitively from receiving immersive second language education in primary school.

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