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The Threshold Hypothesis Revisited: bilingual vocabulary development and non-verbal IQ scores

Astract

The threshold hypothesis (Cummins 1976 et passim) is one of the most influential theoretical frameworks on the relation between bilingualism and cognition. It has, however, not been fully operationalised. The aim of our study is to contribute towards an operationalisation of the threshold hypothesis. We analyse data from 100 Turkish-English successive bilingual children and from their parents, and investigate the relation between bilingualism and cognition in terms of vocabulary knowledge and parental support for L1. The data from the children are scores on receptive and productive vocabulary tests and a non-verbal intelligence test (Raven's Coloured Progressive Matrices; Raven 1962; Raven, Raven & Court, 2004). The parents filled in a questionnaire on language use at home (based on Luk and Bialystok, 2013) and a questionnaire on language dominance (Bilingual Dominance Scale, Dunn & Fox-Tree, 2009). In addition, we have data from age-matched monolingual children in both languages (n = 25 for each group). Our findings show that parental support for L1 correlates significantly with higher vocabulary sizes of the children in both languages and with higher non-verbal IQ scores. We also investigate the so-called "bilingual gap" in vocabulary size, which seems to be existing when the bilinguals are compared with the monolinguals groups. However, this gap is only a methodological artefact when the two languages are compared separately. No such "gap" exists when both languages are taken together and the total conceptual vocabulary is computed. Therefore, there is no bilingual disadvantage in terms of vocabulary and available concepts. There is, however, a bilingual advantage for those children whose parents use more L1 at home and have higher dominance scores for L1. These children outperform the monolingual control groups in terms of non-verbal intelligence scores. The originality of the present study resides in the fact that, to our knowledge, for the first time parental support for L1 is linked to the cognitive development of the children, both verbal concepts and non-verbal IQ scores. In this way, we can operationalise the threshold hypothesis and get further insights in the relation between bilingualism and cognition. This will allow informed decisions on the use and support for L1 in

bilingual families. One limitation of the present study is the fact that our sample is only from middle class bilingual families with a high educational level, and conclusion about other bilingual settings are therefore limited.

1. Literature review

1.1 Bilingualism and Cognition

The relation between bilingualism and cognition has been under investigation as early as the first half of the 20th century, where research found a bilingual disadvantage and negative correlations between bilingualism and general cognition. Saer (1923) reported negative effects of bilingualism for general intelligence scores of children in Wales. It has been argued that this study and other studies of that time were methodologically weak for a number of reasons, including lack of control for socio-economic-status (SES), schools attended and a lack of appropriate statistical procedures (for a detailed critique see Baker 2011). These studies were also probably politically biased, because bilingualism was seen at the time as a "psychological and educational problem" (Darcey, 1946: 21). A comprehensive overview of earlier research can be found in Hakuta (1989). Peal and Lambert (1962) were one of the first researchers who reported positive effects of bilingualism on intelligence. They report that bilingual children (mean age 10) outperformed monolingual peers both in verbal and non-verbal intelligence tests. Their findings are not undisputed as there was a possible bias in the selection of the participants (see Hakuta & Diaz 1985: 322/323). However, the discussion needs to go beyond the identification of possible methodological flaws to develop a more in-depth understanding on the relation between bilingualism and cognition. We therefore need to discuss first relevant theoretical frameworks on this relation.

One of the most influential theoretical frameworks on the relation between bilingualism and cognition is Cummins' "threshold hypothesis" (1976 et passim). This hypothesis assumes that bilingualism has negative cognitive effects below a certain threshold of proficiency. Above this level, there is no negative effect, and if the proficiency rises above the second threshold level positive effects can be found. In other words, only a high proficiency in both languages leads to positive effects on cognition of a bilingual. One aspect of cognition that is investigated in several studies on bilingualism is based on non-verbal special tasks. This means that a link is made between a linguistic characteristic (bilingualism) and non-linguistic cognition. In a summary of previous research, Diaz and Klinger (1991: 167) conclude, “children’s bilingualism is positively related to concept formation, classification, creativity, analogical reasoning, and *visual-spatial skills*” (Italics added). In the context of the present study, the last part of this statement is especially important as it includes a non-verbal aspect of the advantages of bilingualism (see also Hakuta & Diaz 1985). Diaz (1985) investigates bilingual non-verbal cognition with 100 first grade Spanish-English bilinguals using Raven’s Coloured Progressive Matrices (RCPM). He finds significant correlations between measures of verbal and non-verbal intelligence (r = .39, p < .05) but concludes that contrary to Cumin’s “two-threshold hypothesis” not only children with high proficiency in both languages show cognitive advantages. Jarvis, Danks and Merriman (1995) try to replicate Diaz’s findings with 50 Spanish-English bilingual children at an average age of 9.7 from middle-class backgrounds. They could not identify any significant correlation between degree of bilingualism and cognitive advantages.

Bialystok and Majumder (1998) investigated the effects of bilingualism on non-verbal problem-solving abilities of children (n = 71, average age 8:8). They compared a group of "balanced French-English bilingual children, a group of "partial"[1] Bengali-English bilinguals for whom English was the dominant language and a group of monolingual English speaking children, all from middle class backgrounds. The study shows that the French-English bilingual children have a significant advantage on a non-verbal task, the Block Design Task. This task is part of the Wechsler Intelligence Scale for Children-Revised (Wechsler 1974), where children are required to use coloured blocks to duplicate patterns that are presented in pictures. Bialystok and Majumder argue that the metalinguistic advantages of bilingual children "extend into non-linguistic problem solving" (1998: 81) even when the tasks are spatial in nature. They give a tentative explanation for this advantage by explaining that bilinguals "must be attentive to non-salient features of the input, such as the language in which messages are spoken" and that this will lead to the "ability to focus attention selectively on required aspects of a problem" (1998:83). In other words, the bilingual experience requires a constant attention to the language of the input, which in turn improves the ability of the children to focus their attention on problem solving in general. This explanation is tentative but may be a first step towards explaining why a linguistic capacity (bilingualism) may lead to advantages with non-linguistic, e.g. spatial, tasks. This is supported by Bialystok and Martin (2004), who report on three studies where bilingual children (average age 5 years) outperformed monolingual children in non-verbal cognitive tasks (a dimensional change and card sorting task and a colour-shape task) but

[11] For a discussion of the concept “balanced bilinguals” see Treffers-Daller (2011, 2015)

not on semantic tasks. Their interpretation is that bilinguals constantly have to inhibit the non-relevant language in a given context and that “the inhibition of the non-relevant language is controlled by the same cortical centres used to solve tasks with misleading information” (2004: 338). This leads to non-verbal cognitive advantages.

After a discussion of several studies, Kroll and Bialystok (2013:504) conclude that the influence of bilingualism on non-verbal cognitive processing is “unique to this research and unexpected”. However, there are also quite some conflicting results in research on bilingual (dis)advantages. In a meta-analysis Costa, Hernandez, Costa-Faidella and Sebastián Gallés (2009) show that exactly 18 of the studies show a bilingual advantage and 18 do not. There are also a number of more recent studies that do not show a bilingual advantage. Paap (2015) and Paap, Johnson and Sawi (2015) point to the scarcity of large scale studies who identify a bilingual advantage. Valian (2015) gives an overview of current research comparing advantages of executive functioning of bilinguals over monolinguals and concludes that the outcomes of these studies are inconsistent. The reason for these inconsistencies is probably the fact that there are too many independent variables, and that therefore different studies cannot be compared. In a similar vein Thordardottir (2011) argues that there are many different bilingual populations and that many factors influence the outcomes of studies on bilinguals, such as time of onset, amount of exposure, status of the two languages and socio-economic status (SES) of the parents. In this context, it is important to note that Luk and Bialystok (2013) argue that bilingualism is not a categorical variable and that at least two dimensions have to be included in studies on bilingualism that is “language proficiency and usage” and we follow this approach in the present study. Luk (2015) argues that inconsistent results for studies of executive function advantages which compare bilinguals to monolinguals may be explained by different monolingual and bilingual “experience” (2015: 35), that is differences in language usage, language acquisition settings, language proficiency and socio-economic background, which are confounding factors in these studies. Overall, there is no agreement in the literature whether there is a bilingual cognitive advantage, nor whether there is a threshold or a certain degree of bilingualism that ensures a possible cognitive advantage.

1.2 Cognitive Development and Support for L1

A further theoretical framework that is important for an analysis of the cognitive development of bilingual children is the Common Underlying Proficiency hypotheses (CUP, Cummins 1976, 1979, 1980, 1991), which states that support for one language of a bilingual is also beneficial for the other language (see Cummins & Swain 1986: 87). Cummins (1991) reports on a series of studies that show a close relation between proficiency in L1 and L2 in bilinguals. These studies show that reading skills, writing skills, and vocabulary knowledge in the two languages of a bilingual are related. One reason for this might be that conceptual information acquired in L1 transfers to L2, and "minority-language children learn a second language best when their first language is maintained and developed" (McLaughlin, 1986: 35; see also Umbel, Pearson, Fernández & Oller, 1992). According to this framework, the development of vocabulary in L1 and the development of concepts of bilingual children are linked and this knowledge is beneficial for the acquisition of L2 vocabulary. For this reason Cummins (1976 et passim) argues that support for the minority language in an immigrant setting (L1) is crucial for the development of both languages of a bilingual child. This is supported by Collier's (1989) meta-analysis of research on bilingualism. She concludes "Preschool children who begin second language acquisition any time between ages 3 and 5 (sequential bilingualism) are not at any disadvantage as long as they continue to develop their first language at the same time that they are acquiring the second language." (1989: 511).

1.3 Vocabulary and Cognition

An intriguing aspect of vocabulary knowledge is its close relation with cognitive ability measured either with standardised IQ scores or with other ability tests in an experimental setting. One of the earliest studies on the relation between vocabulary and intelligence is Terman, Kohs, Chamberlain, Anderson and Bess (1918). They reported a correlation of .91 (Pearson) between mental age and the vocabulary sub scale of the Stanford Revision of the Binet-Simon IQ test (Binet & Simon, 1905/1916). The authors claim that vocabulary tests can be used as a short measure for intelligence tests in general (see Terman et al. 1918: 454). Anderson and Freebody (1979) give an overview of studies where vocabulary subtests are correlated with other subtests of IQ tests. These correlations range from .71 to .98 and the authors conclude, "the strong relationship between vocabulary and general intelligence is one of the most robust findings in the history of intelligence testing" (1979: 2; see also Hakuta 1987). In a similar vein, Sternberg (1987: 90) concludes, "Vocabulary is probably the best single indicator of a person's overall level of intelligence". One has to bear in mind that many IQ tests, such as the Binet scale that Terman used, rely also at least partially on language and there is the potential of a circular argument when vocabulary size and IQ test scores are correlated (for a discussion see Kaplan & Saccuzzo 2012). However, this circularity is not given when non-verbal IQ scores are used, e.g. the RCPM, as this test format is entirely non-verbal.

In this context, it is important to discuss the so-called “bilingual gap” where a deficit in vocabulary knowledge is attested for bilinguals when they are compared with monolingual control groups. This can be used as an argument for a bilingual cognitive disadvantage. This “bilingual gap” is identified in many studies (Bialystok, Craik, Green, & Gollan, 2009, Bialystok & Feng 2010; Bialystok, Luk, Peets & Yang, 2010; Bialystok & Martin 2004, Bialystok and Viswanathan, 2009; Eilers, Pearson & Cobo-Lewis, 2006; Oller & Eilers, 2002; Oller, Pearson & Cobo-Lewis, 2007; Pearson, Fernán-dez, Lewedeg, & Oller, 1993; for a detailed overview see Thordardottir 2011). These studies typically measure only one language of the bilinguals (generally English) because standardised vocabulary tests in other languages are not always available (see Bialystok & Martin, 2004). However, even when both languages are investigated this gap is found when bilinguals are compared to their monolingual peers, especially with regard to productive vocabulary (Junker & Stockmann, 2002; Marchman, Fernald & Hurtado, 2008; Oller & Eilers, 2002; Pearson, Fernandez & Oller, 1993, 1995; Petitto & Kovelman, 2003). These findings are based on a separate comparisons for each language of the bilinguals with monolingual control groups. These separate comparisons seem to indicate a bilingual disadvantage for vocabulary size. However, this does not account for the fact that bilinguals use their two or more languages in different domains, e.g. school and home language, and the development of their proficiency in their language follows the “complementary principle” (see Grosjean 1982, 2001, 2015). Therefore, it is natural that bilinguals develop smaller vocabularies in certain domains and larger vocabularies in others in each language. A comparison of the vocabularies of bilinguals with monolinguals needs to take both languages of a bilingual into account and the vocabularies need to be studied together, not separately. In line with this the is the approach of the total conceptual vocabulary was developed (TCV, see Swain 1972; Pearson, Fernandez and Oller, 1993) where both languages of a bilingual child are taken together and the knowledge of lexicalized meanings is counted regardless in which language these meanings can be understood or expressed by the child. “Bilingual TCV, then, abstracts away from the number of languages a particular meaning is known” (De Hower, Bornstein & Putnick, 2013: 4). The child gets credit for the knowledge of concepts rather than for knowing the word for it in both languages. One specific aspect of TCV is the unit of counting for translation equivalents (TE), that is words that have the same meaning in both languages, e.g. “cat” in English and “kedi” in Turkish. Within the framework of TCV a child is only credited once for the knowledge of TEs even if s/he knows the word in both languages. TCV is therefore smaller than the sum of the words in both languages, but normally larger than the vocabulary in each language of a bilingual. For monolingual control groups TCV is identical with their vocabulary size. The total conceptual vocabulary of bilinguals reaches or exceeds that of demographically matched monolinguals in many studies (De Hower et al., 2013; Hoff et al., 2012; Oller, Pearson & Cobo-Lewis 2007; Pearson, Fernandez & Oller, 1993; Vermeer, 1992), although there are studies that confirm this only for receptive vocabulary (Gross, Buac & Kaushankayav 2014). Overall, there seems to be no bilingual disadvantage when TCV is taken into account and a certain exposure to both languages is provided. Thordardottir (2011) investigates the vocabulary development of 84 children (age range 4;6 to 5;0) in a Canadian bilingual context. 49 children were French-English bilinguals, 19 French monolinguals and 16 English monolinguals. She draws the conclusion that bilinguals have in their two languages together "roughly the same number of things and concepts for which monolingual children of the same age have a single label" (2011: 443), provided there is a minimal critical level of exposure and a supportive environment. Poulin-Dubois, Bialystok, Blaye, Polonia and Yott (2013) carried out a study with 43 monolingual and bilingual aged 24 months. The vocabulary size of the children was estimated with a parental questionnaire. In line with the expectations, the vocabulary size of the bilinguals was significantly smaller than of the monolinguals when only one language was compared. However, when taking both vocabularies of the bilinguals together there were no significant differences between the groups in vocabulary size. A bilingual disadvantage in the area of vocabulary or a "vocabulary gap" might be simply an artefact of the research methodology and might be non-existent if the total conceptual vocabulary is taken into account.

2. Research Questions

Based on the literature review on a possible bilingual advantage in cognition and the role of vocabulary the present study tries to answer the following research questions:

1. Is there a bilingual advantage in non-verbal cognition?
2. Which factors influence a possible advantage?
3. How is vocabulary size related to this possible advantage?
4. What is the role of parental support?
5. Can a certain threshold for this advantage be identified?

3. Hypotheses

Between-group comparison:

1. Bilinguals have a smaller vocabulary (productive and receptive) in each language when compared with monolinguals for each language separately ("vocabulary gap").
2. The total conceptual vocabulary (TCV) of bilinguals will be equal or larger than that of monolingual controls.

Within-group comparison:

3. There is a positive and significant correlation between the vocabulary sizes of bilinguals in both languages (see CUP).
4. There is a positive and significant correlation between bilinguals' vocabulary sizes in both languages and non-verbal IQ scores.
5. Parental support for L1 will be beneficial as it improves exposure to the minority language, and this might in turn have positive consequences for the cognitive development of the children.

4. Methodology

4.1. Participants

The participants in this study were 100 Turkish-English sequential bilingual children living in the UK, as well as 25 English monolingual children in the UK and 25 Turkish monolingual children living in Turkey. There were 43 male and 57 female children in the bilingual group (mean age = 9;4 years; range 7;1 – 11;9), 12 male and 13 female children in the Turkish monolingual group (mean age = 9.3 years; range 7;1 – 11;10) and 12 male and 13 female children in the English monolingual group (mean age = 9.4 years; range 7;1 – 11;6). All children come from a middle class background as at least one of the parents has a university or college degree. The parents of the bilingual children all emigrated from Turkey and the children were all born in the UK. The children first exposed Turkish at home and then gradually had more contact with English speakers especially after entering pre-school around the age of 4. In addition to the data from the children, we have questionnaire data from the parents. In contrast with many other studies, the bilingual children in the present study have only occasional contact with Turkish speakers outside the family as they live in different areas and do not have Turkish neighbors.

As mentioned earlier, bilinguals are tested in many cases only in one language, mainly English. This is because standardised tests are not available for many immigrant languages or because the participants have a wide range of other languages, and it is not possible to analyse the proficiency of all informants in these languages. The present study controls for L1 background by including only bilinguals that have the same "other language", namely Turkish.

4.2. Measures and Procedures

All tasks for the bilingual group were administered in the homes of the children in the UK. The monolinguals carried out the tasks in schools in the UK and in Turkey, whereas the bilingual children were tested individually in a separate room with which they were familiar. All data were collected by the second author of this study. The language of test instruction was Turkish for the Turkish tests and English for the English tests. The following tests were administered:

The receptive vocabulary of the bilinguals was measured with "X-lex" in English and Turkish (for the test format see Meara & Milton, 2003). X-lex is based on the yes-no format where participants have to indicate whether they know a word or not. It is originally designed for EFL learners at college level but has been used in with children aged 7 years (Milton 2006). Each test includes 100 words ordered according to frequency bands (20 words from K1, K2, K3, K4 and K5). For English we used the existing test (Meara & Milton, 2003), for Turkish we created a comparable test based on the frequency data based on a 3.3 million word corpus provided by sketch engine (Ambati, Reddy & Kilgarriff 2012, Kilgariff et al. 2004). Every 50th word from the first 5000 words in this frequency list was selected and included in the Turkish X-lex. The order of the words in the tests was based on a random number generator (https://www.random.org/). Both tests also include 20 pseudo words that are phonologically plausible in each language but do not exist. These words are included to correct for possible guessing. In line with Meara and Milton (2003), the final score for each language was then computed by giving 50 points for each accepted real words and - 250 points for each accepted pseudo word. By this, a maximum score of 5000 (all real words but no pseudo word accepted) and a minimum score of zero (all real words and all pseudo words accepted) could be obtained. The tests were administered orally to avoid potential problems with unfamiliar spelling. The test instructions were given in the same language as the tests.

The productive vocabulary was measured with a verbal fluency test, which are widely used for psychological and neuropsychological assessments (Deutsch, 1995; Lezak, 2010). These tests have also been used for the measurement of verbal abilities and vocabulary knowledge and lexical access (Cohen et al., 1999; Federmeier et al., 2002, Milton and Roghani, 2015). Participants are either asked to produce as many words in 60 seconds that start with a certain letter (phonemic fluency task) or words that belong to a certain semantic category (category fluency task), such as animals fruits or colours. According to Friesen et al. (2015), the lexical fluency task demands more resources from executive control than the semantic task, and in addition, you need to be literate in both languages.
For our sample, we therefore decided to use the semantic fluency task and to give the participants two minutes rather than one because of the age range of our participants. The categories in our study were names for food, body parts, clothing and colours. The test was administered in both languages with a time gap of two weeks between the recordings to avoid priming effects. The language of instruction was English for the English task and Turkish for the Turkish task, and the participants did not attempt to use the other language during the test. The answers were tape recorded and then transcribed for the analysis.

As a test of non-verbal intelligence, we used Raven's Coloured Progressive Matrices (Raven, 1962; Raven, Raven & Court 2004). Test-takers are asked to complete a set of abstract graphical patterns with a matching pattern from a multiple-choice set of possible answer patterns (maximum score = 36). According to Raven et al. (2004: 1) the test "is designed to assess … mental development up to intellectual maturity". It is described as "non-verbal estimate of fluid intelligence" (Bilker et al., 2012: 354). For our study, it is important to stress that this test is non-verbal.

The Bilingual Dominance Scale (Dunn & Fox-Tree, 2009) was used as a questionnaire for the parents of the bilingual participants. This questionnaire consists of 12 questions about the language dominance of the participants. There are different weightings for each question, and in total, a maximum score of 31 was possible for dominance in each language. We computed a dominance score (scores for Turkish - scores or English) which leads to a scale from -31 (only English preferences) to + 31 (only Turkish preferences). Mothers and fathers were interviewed separately and did not know the score of the other partner. The average score of the parents was then counted as parental dominance score.

In addition, we administered a questionnaire about language use at home. This questionnaire includes 12 questions and is part of the language and social background questionnaire (Luk and Bialystok, 2013). The questions were on the proportion of English and Turkish usage in daily life at home.

5. Results

5.1. Receptive vocabulary of the bilinguals

The results of the receptive vocabulary tests (X-lex format) for the bilinguals are given in Table 1 for English and Turkish.

Table 1

Receptive vocabulary scores in Turkish and English

	n	min	Max	mean	St.Dev
Receptive Turkish	100	3900	4650	4337.0	162.0

Receptive English	100	3900	4750	4328.0	208.9

The correlation between the scores in both languages is strong and highly significant (r = .611, $p < .001$). Figure 1 shows how the scores are related to the age of the participants.

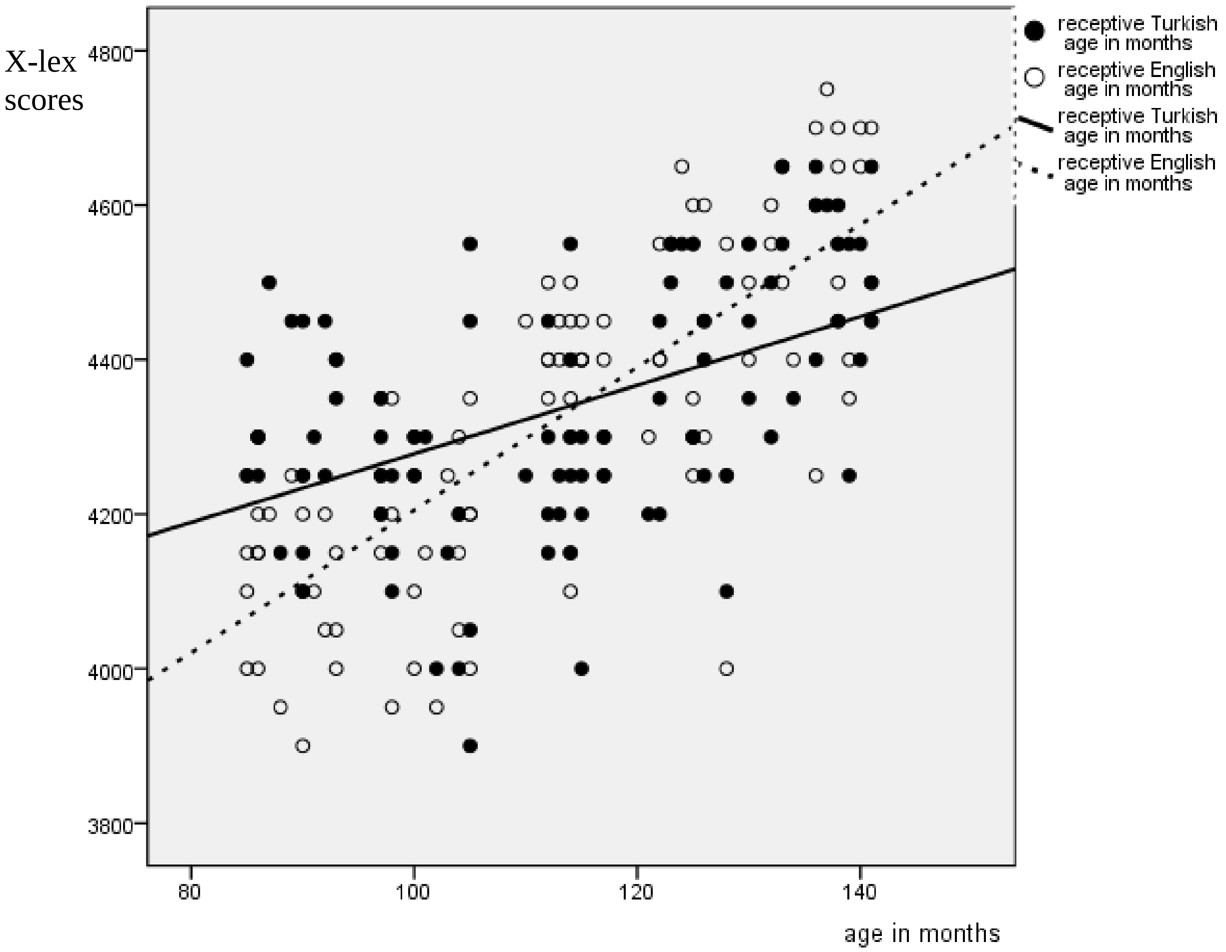

Figure 1

Receptive vocabulary (X-lex scores) in Turkish and English by age

For the youngest children the scores are higher in Turkish than in English, but the English scores increase rapidly and equal the Turkish scores at the age of 9 – 10. Then the English scores increase at a higher rate than the Turkish scores but both scores are still increasing steadily. This pattern is most likely the effect of school attendance (all participants attend English speaking schools). The most important finding in the given context is that the scores go up in both languages. The correlation between age and receptive vocabulary is significant for Turkish ($r = .477$, $p < .001$) and English ($r = .77$, $p < .001$).

5.2. Productive vocabulary of the bilinguals

In order to establish the reliability of our fluency tests we computed Cronbach's alpha for the four productive subtests (food, body parts, clothing and colour terms) in each language. Cronbach's alpha for Turkish is .829 and for English .841, which is a high value for tests, which consist of four items only (see Nunally, 1978). This is a clear indication that the test as a whole is uni-dimensional and that it measures only one trait, namely productive vocabulary in each language. The results of the productive vocabulary tests for the bilinguals are given in Table 2 for English and Turkish.

Table 2
Productive vocabulary scores in Turkish and English

	n	min	Max	mean	St.Dev
Productive Turkish	100	19	65	37.41	12.20
Productive English	100	16	87	42.25	14.01

Receptive and productive vocabulary correlate highly for each language individually (Turkish: $n = 99$, $r = .782$, $p < .001$; English: $n = 100$, $r = .437$, $p < .001$), which is in line with the expectations. What is more surprising is that both receptive and productive vocabulary correlate significantly between the languages (receptive Turkish/English: $n = 100$, $r = .611$, $p < .001$; productive Turkish/English: $n = 99$, $r = .732$, $p < .001$). Productive and receptive vocabularies are clearly related and this relation is similar in both languages. Participants with a higher receptive vocabulary also have a higher productive vocabulary.

5.3. Comparison of productive and receptive vocabulary with the control groups

A comparison of the bilinguals (n = 100) and the monolingual control group (n =25) for Turkish is shown in Figure 2 (receptive vocabulary) and in Figure 3 (productive vocabulary)

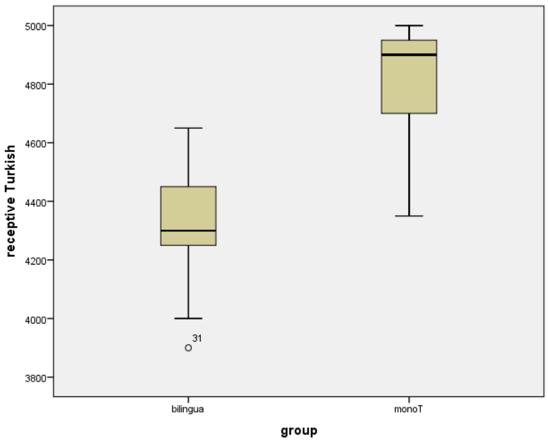

Figure 2

Bilingual and monolingual scores for receptive vocabulary in Turkish (X-lex scores)

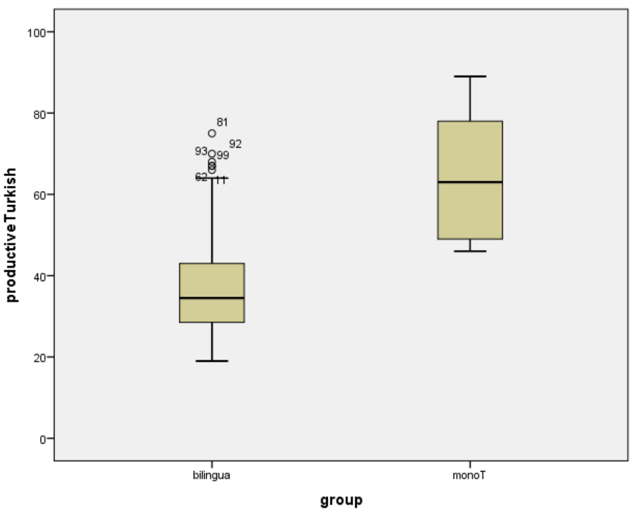

Figure 3

Bilingual and monolingual scores for productive vocabulary in Turkish (verbal fluency scores)

The bilinguals have a significantly lower vocabulary than the monolinguals for receptive ($t = 12.033$, $df = 123$, $p < .001$, $\eta^2 = .541$, $r^2 = .495$) and for productive vocabulary in Turkish ($t = 9.22$, $df = 32.670$, $p < .001$; equal variance not assumed, $\eta^2 = .409$, $r^2 = .409$). Figures 4 and 5 show the comparison between the bilinguals and the English monolingual control group ($n = 25$) for receptive and productive vocabulary in English.

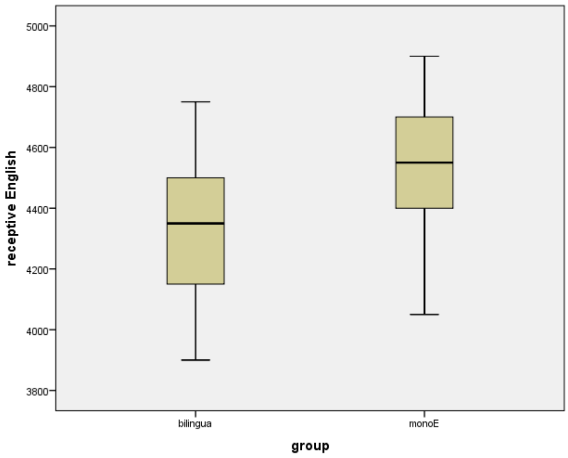

Figure 4

Bilingual and monolingual scores for receptive vocabulary in English (X-lex)

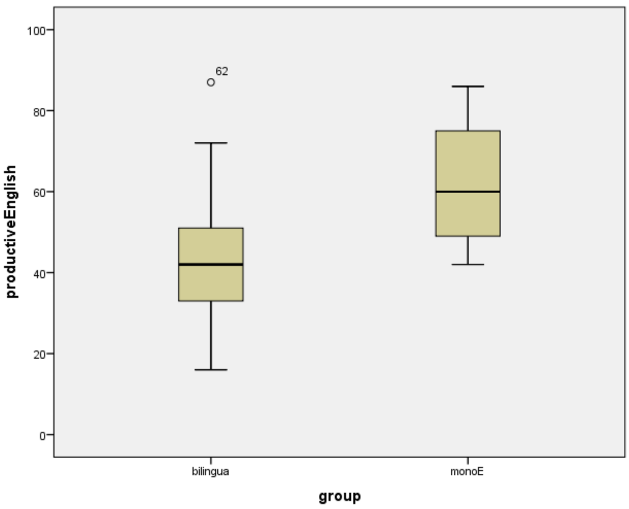

Figure 5

Bilingual and monolingual scores for productive vocabulary in English (verbal fluency scores)

The bilinguals also have significantly lower vocabulary sizes for the receptive ($t = 4.054$, $df = 123$, $p < .001$, $\eta^2 = .118$, $r^2 = .118$) and the productive vocabulary in English ($t = 6.484$, $df = 122$, $p < .001$, $\eta^2 = ,256$, $r^2 = .259$). The effect sizes for the differences in Turkish are much larger than for the differences in English, both for productive and receptive vocabulary.

The question is whether the discrepancy between the vocabularies of bilinguals and monolinguals manifests itself also in the total conceptual vocabulary. However, a comparison of the total conceptual receptive vocabulary is not possible with the receptive vocabulary size tests used in this study because the yes-no tests in both languages contain partly different test items. There is no bilingual vocabulary test, which measures the same concepts in both languages, whilst being representative for different frequency layers in the lexica of each language and ensuring that item difficulty in each language is matched. For the productive vocabulary, however, this analysis is less difficult as a conceptual match of the items (food, body parts, clothing and colour terms) is more obvious. We analysed the productive conceptual vocabulary of the bilinguals by adding up the number of items that were named in the fluency test in both languages minus the number of translation equivalents, e.g. counting a certain body part item only once if it was given in both languages. The results are given in Figure 6. For the control groups their conceptual vocabulary is identical with their total vocabulary.

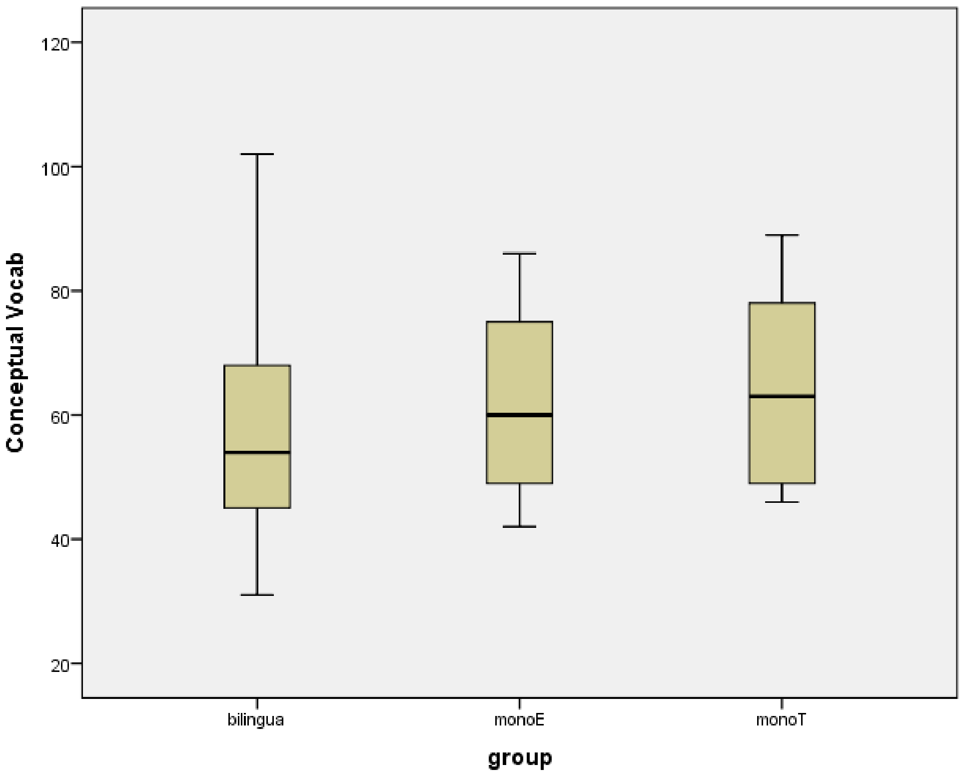

Figure 6

Conceptual productive vocabulary of bilinguals and control groups

There is more variance in the bilingual group, which indicates that there are individual cases below or above the monolingual controls but, overall, the differences between the groups are not significant, neither for English nor for Turkish. This means that the vocabulary gap that could be identified in each language separately does not exist when the total conceptual vocabulary is taken into account. One has to bear in mind that the two languages involved are structurally different and that there are not many cognates between these languages. (see also Meara 1993).

5.4. Vocabulary knowledge and IQ scores

We administered RCPM to measure non-verbal IQ and correlated the IQ scores of our bilingual participants with their vocabulary scores in both languages controlling for age through partial correlation. Table 3 shows the partial correlations of the IQ scores with the vocabulary scores.

Table 3

IQ scores and vocabulary scores of the bilinguals (n = 96[2], controlling for age)

	Receptive Turk	Productive Turk	Receptive Eng	Productive Eng
Non-verbal IQ	r = .266	r = .186	r = .209	r = .188
	p = .008	p = .067	p = .038	p = .064

The receptive vocabulary in both languages correlates significantly with the IQ scores, whereas the correlations for productive vocabulary and IQ scores approach significance.

5.5. IQ scores for bilinguals and monolinguals

The IQ scores of the bilinguals and the two monolingual groups are almost identical (mean for bilinguals = 34.25, for monolingual Turkish speakers = 34.2 and for monolingual English speakers = 34.24 , and the small differences are far from being statistically significant (one-way Anova, $F(2, 147) = .023$, $p = .977$). We therefore conclude that in our study there is no general bilingual advantage with respect for non-verbal IQ scores.

However, the picture changes when the parental language dominance for L1 is taken into account (language dominance questionnaire, Dunn and Foxtree, 2009). When we split the bilingual group at the median of the parental dominance scores into two sub-groups, one with strong L1 dominant parents (DomHigh) and one with less strong L1 dominant parents (DomLow), the group of strong L1 dominant parents seems to outperform all other groups, including the two monolingual groups as shown in Figure 7.

[2] A full set of data was only available for 96 participants due to various organizational reasons (see also Table 4)

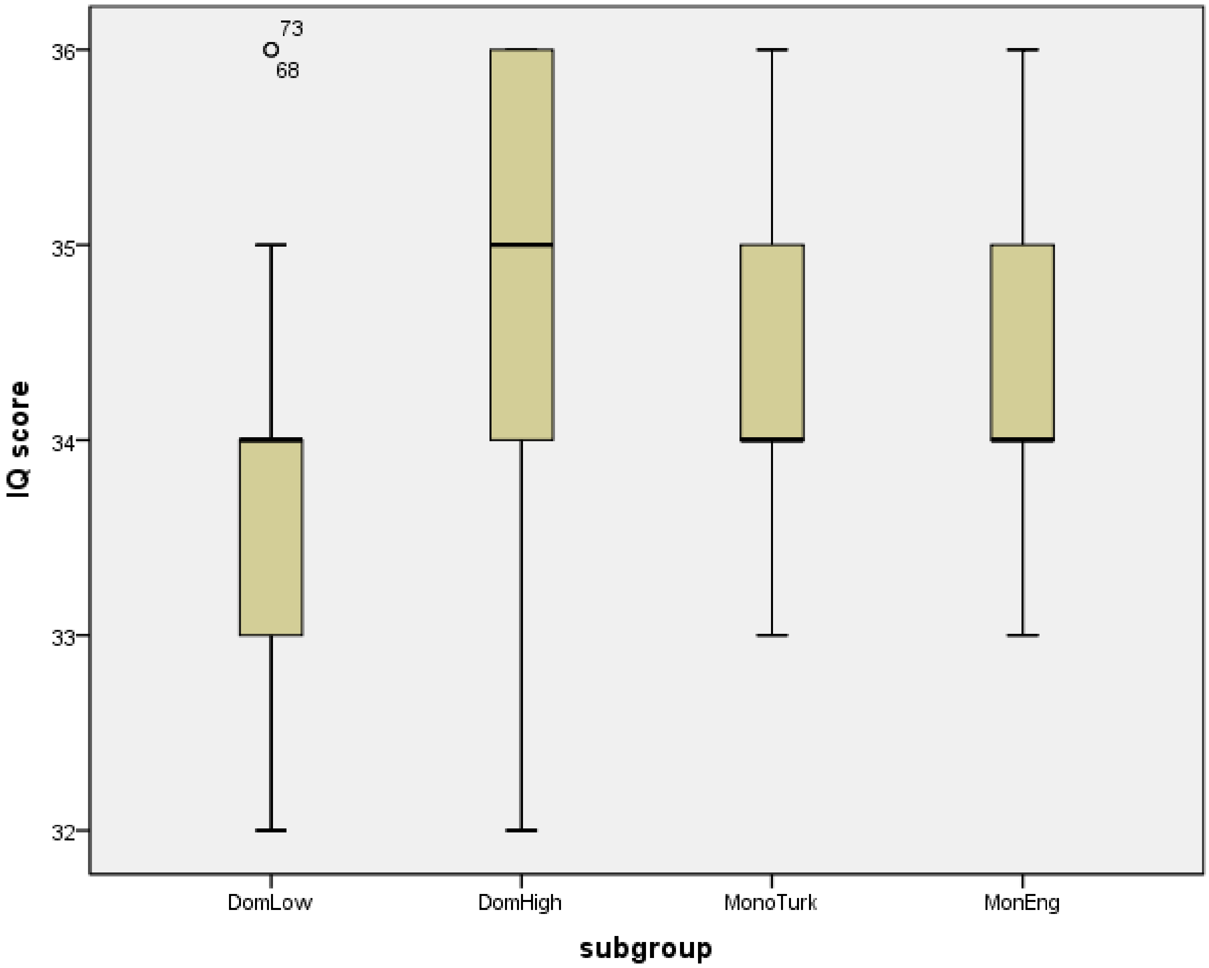

Figure 7

Bilingual IQ scores according to parental dominance preferences and monolingual control groups

An omnibus Anova shows that there is an overall difference between the four groups (one-way Anova, $F (3, 146) = 12.487$, $p < .001$; $\eta^2 = .217$), but a multiple comparison (post hoc Tukey) reveals that the only significant difference between groups are between the bilingual group with high parental dominance for Turkish and the other three groups. The development of IQ scores according to the age of the bilingual children is shown in Figure 8.

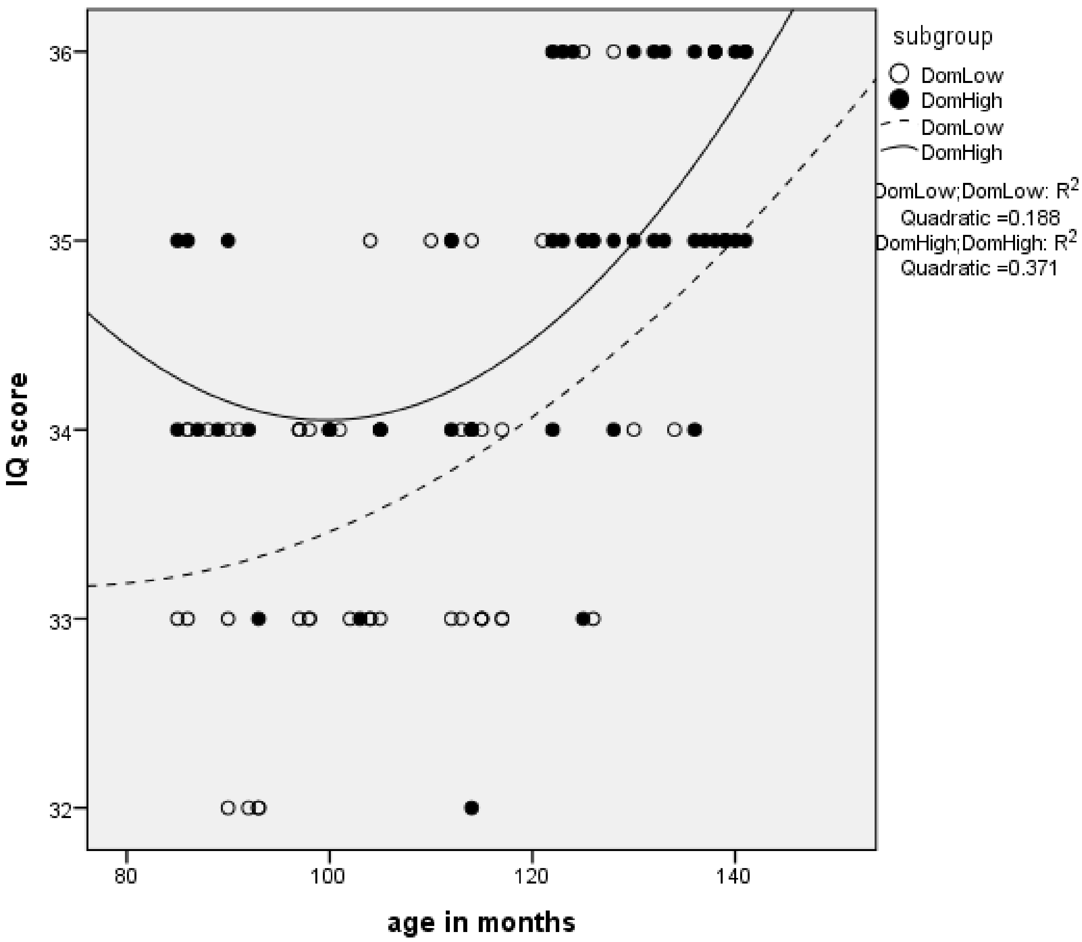

Figure 8

Development of IQ scores bilinguals according to their parental language dominance

Obviously the IQ scores of the children are higher for older children, but the children of parents with a lower dominance preference for L1 start at a lower level and do not seem to catch up with the children of parents with a higher parental dominance preference for L1.

In addition to the dominance questionnaire we administered a questionnaire about language use at home (Luk & Bialystok, 2013) to the parents (see methodology). A partial correlation (controlling for the age of the children) between the two parental reports, the vocabulary measures and the IQ scores of the children was carried out. The results are shown in Table 4.

Table 4

Parental language dominance and language use at home and children test scores (n = 96)

Parental preferences	Children’s scores					
	Non-verbal IQ	Productive Turkish	Productive English	Receptive Turkish	Receptive English	Conceptual Vocabulary
Dominance	.433**	.405**	.422**	.716**	.303*	.389**
Language use at home	.398**	.367**	.437**	.361**	.368**	.381**

* $p < .01$; ** $p < .001$

Both questionnaires of the parents correlate significantly with the vocabulary and the IQ scores of the children in the same direction. A higher dominance score for Turkish and a higher score for the use of L1 at home goes together with higher receptive and productive vocabulary scores of the children in both languages and with a higher score for the non-verbal IQ test. We also split the group of bilinguals at the median for the language use questionnaire (Luk and Bialystok, 2013). The group with higher use of Turkish at home had a significant higher IQ score ($t = 6.3$, $df = 98$, $p < .001$). Table 5 shows the differences between the two groups.

Table 5

IQ scores of children and reported language use by parents

Group	N	Mean	St. Dev.
more Turkish use at home	50	34.84	0.955
more English use at home	50	33.66	0.917

Although the actual difference in the IQ scores (mean difference 1.18 out of a possible maximum score of 36) seems to be small at first sight, there is a large effect size of Cohen’s $d = 1.26$. Values for Cohen’s d above 1.0 are rare, but since this statistic is based on the ratio between the numerator (mean difference) and the denominator (SqR of pooled St.Dev) a low pooled standard deviation can lead to such a high value for the effect size. A multiple regression with “Dominance” and “Language use at home” as independent variables and IQ scores as dependent variables is not possible in the present study because the two independent variables correlate strongly with each other ($r = .901$, $p < .001$) and there would be problems with multicollinearity. Parents with dominance preferences for L1 also report using L1 more at home.

6. General Discussion and Conclusion

As an answer to the research questions, the present study shows that there is a bilingual advantage in non-verbal cognition but only for those children whose parents are in support for L1 both in language use at home and in their language preferences (dominance for L1). This clearly supports Cummins' threshold hypothesis but adds the factor of parental support to this framework. The bilingual vocabulary and its development plays a crucial role for this cognitive advantage as the vocabulary sizes of the children are related to the non-verbal IQ scores. The receptive vocabulary sizes in both languages are significantly correlated with the IQ scores and the productive scores approach significance. This is an indication that receptive vocabulary is more important for the cognitive development than productive vocabulary. Receptive vocabulary is therefore a clear predictor of non-verbal IQ scores. When compared with monolingual control groups the bilingual children in the present study apparently show a "gap" in their vocabulary knowledge in both languages. This supports Hypothesis 1, which assumes that bilinguals have smaller vocabularies when compared with monolinguals for each language. This "gap" seems to narrow down for L2 when children are getting older and have more input in L2 within the school environment. The effect sizes are much larger for Turkish than for the language of schooling (English), and this can be interpreted in a way that the bilinguals catch up with their monolingual peers at English schools but that they have a larger backlog in Turkish where they do not receive input in a school context (see also Daller 1999). However, this "gap" is only apparent when the two vocabularies of the bilinguals are compared separately against those of monolingual peers. When the two languages of the bilinguals are taken together as total conceptual vocabulary, no such gap can be identified. The bilinguals know as many concepts as their monolingual peers but these concepts are either related to L1 or to L2, or to both. Hypotheses 2 which predicts no vocabulary gap for the children's total conceptual vocabulary scores is therefore confirmed. A bilingual vocabulary "gap" is just an artefact of the research methodology when the two languages are compared separately with monolingual peers. It is worth bearing in mind that in the present study the bilingual children have only access to Turkish within the family, and that they are not part of a wider Turkish speaking community. This might reduce the Turkish input that the children get. Nevertheless, their conceptual vocabulary is still comparable with the monolingual peers. Hypothesis 3, which assumes that the vocabulary sizes in L1 and L2 are related in bilinguals could clearly be supported. In our study both vocabularies are significantly related both for productive and receptive vocabulary. The correlation between the two vocabulary sizes is much higher than found in other studies (r = .61 for receptive and r = .732 for productive vocabulary in the present study) and both vocabularies develop in parallel, although L2 seems to take over in a later stage, probably as a result of school input. Our findings clearly support Cummins' Interdependence Hypothesis. The vocabularies of our participants in L1 and L2 are related and the development of the lexicon in L1 has a positive effect on the development of the lexicon in L2. The findings also support Cumin's Common Underlying Proficiency hypothesis for the vocabulary in both languages. The notion of conceptual vocabulary can be used as an explanation for the relation between L1 and L2. Concepts that are developed in L1 are more easily available in L2 and this supports the development of L2 vocabulary. Hypothesis 4, which assumes a positive relation between vocabulary sizes and non-verbal IQ scores for the bilingual group is supported by our findings. Higher vocabulary sizes are related to cognitive advantages, which is in line with Cumin's Threshold Hypothesis that assumes cognitive advantages from a certain proficiency level onwards. When the bilinguals are divided into two subgroups according to parental dominance for L1, the group with the more L1 dominant parents outperforms the group with the less L1 dominant parents in non-verbal intelligence. A similar result is found when the language use at home is taken into account. Those bilinguals with more L1 use at home show significant higher non-verbal IQ scores than those with more use of L2. This supports hypothesis 5, which proposes that parental support for L1 will have a positive effect for the cognitive development of the children. Cummins' Threshold Hypothesis, which assumes a bilingual advantage for children with high proficiency in both languages, is also supported in our study but needs to be revised. High language proficiency, in our case, operationalized as vocabulary sizes in both languages, is related to general cognitive development, e.g. high non-verbal IQ scores. Parents who have a positive attitude towards L1 and use it at home support the cognitive development of their children. Further studies need to identify possible thresholds of parental support for a positive cognitive development of bilingual children. However, the overall positive findings for bilinguals in the present study have to be taken with some caution. The standard deviations for all bilingual measures, be it conceptual vocabulary or IQ scores are always higher than that of the monolingual groups, which indicates that some bilinguals score lower than the monolingual control groups. Our findings are also based on bilingual children from a middle-class background, and we cannot draw conclusions beyond this specific bilingual setting. What becomes clear from our study is that bilingualism is a very complex issue and that the discussion on a bilingual (dis)advantage in any area (vocabulary, cognitive development or executive control) needs to take into account the crucial role of the home environment and parental support for L1. Our findings clearly have pedagogical and language policymaking implications. Language policy that advocates the use of the dominant language in society (L2) at home may not be in the best interest of the bilingual children, and there is clear evidence that support for L1 is beneficial for the cognitive and linguistic development in both languages of the children.

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