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The benefits of being bilingual: Working memory in bilingual Turkish–Dutch children

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ABSTRACT

Whether bilingual children outperform monolingual children on visuospatial and verbal working memory tests was investigated. In addition, relations among bilingual proficiency, language use at home, and working memory were explored. The bilingual Turkish–Dutch children ($n = 68$) in this study were raised in families with lower socioeconomic status (SES) and had smaller Dutch vocabularies than Dutch monolingual controls ($n = 52$). Having these characteristics, they are part of an under-researched bilingual population. It was found that the bilingual Turkish–Dutch children showed cognitive gains in visuospatial and verbal working memory tests when SES and vocabulary were controlled, in particular on tests that require processing and not merely storage. These findings converge with recent studies that have revealed bilingual cognitive advantages beyond inhibition, and they support the hypothesis that experience with dual language management influences the central executive control system that regulates processing across a wide range of task demands. Furthermore, the results show that bilingual cognitive advantages are found in socioeconomically disadvantaged bilingual populations and suggest that benefits to executive control are moderated by bilingual proficiency.

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Introduction

Bilingual children outperform monolingual children on tasks that require inhibiting interfering task-incongruent information (Barac & Bialystok, 2011; Martin-Rhee & Bialystok, 2008) and also allocate their visuospatial working memory resources more efficiently than monolinguals (Bialystok, 2010; Morales, Calvo, & Bialystok, 2013). Both inhibition and working memory advantages can be subsumed under the umbrella of a domain-general executive control advantage (Costa, Hernández, Costa-Faidella, & Sebastián-Gallés, 2009; Hilchey & Klein, 2011). Adopting this framework for the current study, we investigated working memory performance in bilingual Turkish–Dutch children with low-SES (socioeconomic status) backgrounds. In the literature, there is some controversy about bilingual working memory advantages (Engel de Abreu, 2011; Engel de Abreu, Cruz-Santos, Tourinho, Martin, & Bialystok, 2012), and further research is needed to establish whether or not bilingualism has an effect on working memory abilities (Hernández, Costa, & Humphreys, 2012). The bilingual Turkish–Dutch children in this study are particularly interesting because these children's limited experience with Dutch has been found to hamper their verbal short-term memory outcomes in a recall task with Dutch language-like nonwords (Messer, Leseman, Boom, & Mayo, 2010). Using working memory tasks that rely less on knowledge of Dutch and involve more executive control in a two-wave longitudinal design, the current study allowed the identification of working memory strengths in the same children. In so doing, it adds to the limited but growing body of research showing that bilingual cognitive benefits are independent of SES background and are found in emerging bilingual children with unequal levels of proficiency in their two languages (Calvo & Bialystok, 2014; Carlson & Meltzoff, 2008; Engel de Abreu et al., 2012; Mezzacappa, 2004).

Executive control and working memory in bilingual children

It is well established that bilingual children show cognitive gains compared with monolingual controls in tasks where interference coming from competing cues is a major challenge, and a potential conflict between cues needs to be resolved (Adesope, Lavin, Thompson, & Ungerleider, 2010; Barac & Bialystok, 2011; Hilchey & Klein, 2011). Bilingual children's ability to successfully ignore task-incongruent information has been related to their permanent training of executive control mechanisms through dual language management (Bialystok, 2010; Bialystok, Craik, Klein, & Viswanathan, 2004; Costa et al., 2009; Hilchey & Klein, 2011). Dual language management may play a role in at least two ways. It has been suggested that bilinguals need to constantly solve the competition between their two language repertoires and, because of the simultaneous activation of lexemes in both languages, constantly inhibit one of their languages (Green, 1998; Jared & Kroll, 2001; Poarch & van Hell, 2012). In an alternative account, Costa and colleagues (2009) posited that continuous monitoring of which language to use for each communicative interaction plays a more crucial role than the search for appropriate lexicalization. Both views share the assumption that bilingualism enhances executive control.

If this assumption holds true, it is expected that cognitive gains go beyond inhibition and are also found in working memory tasks. Working memory refers to the mental processes allowing limited information to be held in a temporarily accessible state during cognitive processing (Cowan, Nugent, Elliott, Ponomarev, & Saults, 1999). Most working memory research has been conducted within the tripartite model of Baddeley (Baddeley & Hitch, 1974), which draws a distinction between two passive slave systems for the temporary storage of visuospatial information and verbal information and a domain-general central executive that controls attention (but see Alloway & Passolunghi, 2011; Friso-Van den Bos, Van der Ven, Kroesbergen, & Van Luit, 2013). The central executive regulates the allocation of finite attentional resources across a wide range of tasks (Baddeley, 1986; Engle, Tuholski, Laughlin, & Conway, 1999; Kane et al., 2004) through three core functions: inhibition (inhibition of prepotent responses), shifting (mental set shifting), and updating (information updating and monitoring) (Miyake et al., 2000). Individual differences in executive control have been argued to determine individual differences in working memory capacity (Engle, 2002; Engle & Kane, 2004), in particular in complex working memory tasks that require storage and processing of information (Gathercole, Pickering, Ambridge, & Wearing, 2004).

The relationship between executive control and working memory predicts that bilingual advantages are expected in more complex and executive-loaded working memory tasks. Indeed, Morales and colleagues (2013) found working memory advantages for 5- and 7-year-old bilingual children in the Frogs Matrices task. In this task, children needed to remember the location of a frog in a pond, represented by a 3 $\times$ 3 matrix. Multiple locations were shown either simultaneously or sequentially. The bilingual advantage was especially prominent in the executive-loaded sequential condition that required recalling both the locations of the frog and the order of the locations, in line with the hypothesized effect. However, Engel de Abreu (2011) failed to find bilingual visuospatial working memory advantages, even though the tasks used in her study and those used by Morales and colleagues (2013) were highly similar and children with the same ages and SES backgrounds were investigated in the two studies.

For the current study, we investigated both visuospatial and verbal working memory using tasks with different levels of executive control, that is, storage-only tasks and tasks that require both storage and processing of information. Although most research on bilinguals' advantages includes medium- and high-SES children who are highly proficient in their two languages, the current study was concerned with bilingual children from low-SES families who are less proficient in Dutch as a second language than monolingual Dutch controls. The next sections address these two factors—linguistic proficiency and SES—in turn.

Effects of bilingual learning context on linguistic proficiency and working memory

Psychologically and socially, bilingualism is a multifaceted phenomenon with no agreed-on definition (Butler & Hakuta, 2006). For the current study, we adopted the definition by Kohnert (2010), who stated that bilinguals are "individuals who receive regular input in two . . . languages during the most dynamic period of communication development—somewhere between birth and adolescence" (p. 456). The bilingual Turkish–Dutch children investigated for the current study often had different levels of proficiency in their two languages as an effect of the contexts in which they learned Turkish and Dutch. In The Netherlands, children typically speak Turkish, a minority language, at home, and outside their homes they are regularly exposed to Dutch, the majority language. Because the learning contexts for Turkish and Dutch tend to be distributed, many children acquire Turkish from birth and acquire Dutch later on in day care, in preschool, or at school. Consequently, most Turkish–Dutch children are sequential bilinguals rather than simultaneous bilinguals or somewhere in between these two types of bilingualism (Blom, 2010; Scheele, Leseman, & Mayo, 2010). Although Dutch is often the weaker language during the early school years (Appel & Vermeer, 1998; Droop & Verhoeven, 2003; Verhallen & Schoonen, 1993), it becomes the dominant language after several years of consistent exposure at school (Extra, Aarts, van der Avoird, Broeder, & Yagmur, 2001). This study focused on the early school years when bilingual Turkish–Dutch children typically lag behind their monolingual peers in their Dutch proficiency.

Two recent studies demonstrated cognitive strengths in populations with disadvantages in majority language achievements similar to the Turkish–Dutch children in the current study: Spanish–English children in the United States (Carlson & Meltzoff, 2008) and Portuguese–Luxembourgish children in Luxembourg (Engel de Abreu et al., 2012). Carlson and Meltzoff (2008) compared bilingual Spanish–English children with monolingual English children and observed a bilingual inhibition advantage after controlling for the bilingual children's lower English expressive vocabulary. The Portuguese–Luxembourgish children studied by Engel de Abreu and colleagues (2012) obtained higher receptive vocabulary scores in Portuguese than in Luxembourgish and scored lower on Portuguese vocabulary than monolingual Portuguese children. However, the bilingual children outperformed the monolinguals on measures of attentional control.

Building on these previous studies showing inhibition and attentional control advantages in sequential bilingual children in minority–majority learning contexts, the current study investigated working memory outcomes in a similar population: Turkish–Dutch children in The Netherlands. This study also complements other research showing that, compared with monolingual Dutch children, bilingual Turkish–Dutch children have less support from Dutch language knowledge in language-dependent verbal short-term memory tasks due to less entrenched knowledge of Dutch (Messer et al., 2010). More specifically, Messer and colleagues (2010) found that bilingual Turkish–Dutch children and monolingual Dutch controls performed equally well on a visuospatial storage task and a nonword recall task using nonwords with low phonotactic probability in Dutch, but the bilinguals performed more poorly on a Dutch-dependent nonword recall task using nonwords with high phonotactic probability in Dutch. For the purpose of the current study, data from the same sample were analyzed with three notable differences. First, working memory tasks were included that require more executive control and depended less on Dutch representations in long-term memory than the nonword recall task reported on by Messer and colleagues (2010). Second, due to many missing values for the executive-loaded tasks, we analyzed data in our study from ages 5 and 6 years. Messer and colleagues analyzed data from the same children at age 4 years. At ages 5 and 6, the bilingual children had experienced a longer period of dual language management and, as such, more opportunities for cognitive training than at age 4 when the children had just been immersed in Dutch in kindergarten. Third, we looked at individual differences within the bilingual sample to determine whether bilingual proficiency and language use at home influenced the children's working memory outcomes.

Bilingualism and socioeconomic status: Counteracting factors?

Most Turkish immigrants have come to The Netherlands as a result of labor migration and family reunion and have low-SES backgrounds (Backus, 2005; Sociaal en Cultureel Planbureau [SCP], 2005). A low-SES background is associated with lower executive control outcomes in children (Mezzacappa, 2004; Morton & Harper, 2007; Noble, Norman, & Farah, 2005), possibly because low-SES children are raised in cognitively less stimulating home environments (Bradley & Corwyn, 2002; Evans, 2004). Recent research has revealed that bilingualism leads to cognitive enhancement regardless of SES background in tasks testing inhibition and attention (Calvo & Bialystok, 2014; Engel de Abreu et al., 2012); hence, the effects of SES background and bilingualism may (partially) cancel each other out in low-SES children. Carlson and Meltzoff (2008) indeed found that low-SES bilingual Spanish–English children and monolingual English controls from higher SES families performed similarly on inhibitory control tasks without statistically controlling for SES background. With statistical control added, the bilingual children in their study outperformed the monolingual children.

With respect to working memory, positive effects of bilingualism on low-SES background are less evident. Morales and colleagues (2013), who found working memory advantages, focused on medium- to high-SES bilingual children (whose parents had at least a college-level education), but Engel de Abreu and colleagues (2012) compared low-SES bilingual Portuguese–Luxembourgish children in Luxembourg and low-SES monolingual Portuguese children in Portugal and did not find bilingual working memory advantages. Like Morales and colleagues (2013), Engel de Abreu and colleagues (2012) investigated visuospatial working memory, but there are differences across these two studies that may have contributed to the different outcomes apart from SES background. The children in the study conducted by Engel de Abreu and colleagues were older than the children investigated by Morales and colleagues (age 9 years on average vs. ages 5 and 7 years). In addition, Engel de Abreu and colleagues compared bilinguals and monolinguals living in different countries (Luxembourg vs. Portugal) and attending different schools, whereas the monolingual and bilingual children in the study by Morales and colleagues lived in the same country and attended the same neighborhood schools.

The children in the current study were ages 5 and 6 years and, in this respect, were comparable to the children investigated by Morales and colleagues (2013). The bilingual and monolingual children lived in the same country and attended the same schools. Like Carlson and Meltzoff (2008), we compared bilinguals with lower SES backgrounds than the monolinguals and analyzed cognitive performance—in our study working memory, in Carlson and Meltzoff's study inhibition—without and with statistically controlling for SES background differences between the two groups. In so doing, we could detect whether bilingualism counteracts negative effects of low-SES background and whether bilingual advantages are found when differences in SES backgrounds between bilinguals and monolinguals are partialled out.

Bilingual proficiency and language use at home

The primary goal of the study was to investigate working memory advantages in bilingual Turkish–Dutch children with low-SES backgrounds. The secondary goal of the study was to investigate individual difference factors that may predict working memory outcomes within the bilingual sample. Cummins (1976, 1978) argued that a high level of linguistic proficiency in both languages, and thus a high level of bilingual proficiency, is required before bilingualism can promote cognitive development. Therefore, in the current study, we examined the predictive value of bilingual proficiency on bilingual children's working memory outcomes. Bilingual proficiency is tightly interwoven with language balance because a lack of balance implies a lack of bilingual proficiency (although the two constructs are also to some extent separable in the sense that low proficiency in both languages implies balance but a lack of bilingual proficiency). In this study, the effect of bilingual proficiency was measured through combining the children's vocabulary in Turkish and Dutch. We expected that children who have a large vocabulary in both languages have a large shared vocabulary and many concepts for which they have forms in both languages available. As a result, these children experience more coactivation, and thus more lexical competition and cognitive training, than children with a small vocabulary in their two languages or unbalanced children whose two vocabularies are very different in size. Note that in this respect the contexts in which bilingual children are exposed to their two languages can also be relevant (Gathercole et al., 2010). Specifically, children exposed to two languages in the same context (e.g., home) may have more lexical overlap than children whose languages are bound to different contexts (e.g., home vs. school) (Oller & Eilers, 2002). For the current study, we investigated two individual difference factors that are expected to determine the amount of lexical overlap: bilingual proficiency indicating underlying shared conceptual knowledge and bilingual language use at home.

Research questions and predictions

Two research questions guided our study.

1. Do bilingual Turkish–Dutch children from low-SES backgrounds perform better on executive-loaded tasks testing visuospatial and verbal working memory than monolingual Dutch controls, and do results differ depending on whether between-group differences in Dutch vocabulary and SES background are controlled?

We expected the bilingual children to outperform the monolingual children. Bilingual–monolingual differences were expected to be particularly prominent in tasks that require both storage and processing and, thus, place heavier demands on executive control than storage-only tasks. Bilingual–monolingual differences may reach statistical significance only when Dutch vocabulary and SES background are controlled and held constant between bilinguals and monolinguals. If the analyses without Dutch vocabulary and SES as covariates reveal no difference between the bilingual and monolingual groups, this could be the result of bilingualism having a compensatory effect. In other words, the absence of a difference may actually point to a bilingual cognitive advantage (Carlson & Meltzoff, 2008).

2. Do bilingual proficiency and use of both Turkish and Dutch at home predict bilingual Turkish–Dutch children's performance in executive-loaded working memory tasks?

Positive relations were expected between bilingual proficiency and working memory in the bilingual sample, in particular for executive-loaded working memory tasks. In the current study, bilingual proficiency was investigated taking into account the role of balance between the two languages. Regarding language use at home, we expected bilingual children who are exposed to Turkish and Dutch in the home to outperform bilingual children exposed only to Turkish at home on executive-loaded working memory tasks.

Method

Participants

For the current study, data collected as part of a study conducted by Messer (2010; see also Messer et al., 2010) were analyzed. In Messer's study, Turkish–Dutch bilingual children and Dutch monolingual children were compared at ages 4 years (Wave 1), 5 years (Wave 2), and 6 years (Wave 3). We removed from the original sample 20 children who had been assigned to the monolingual group because their parents were foreign born and/or the interview data revealed that they (sometimes) used a language other than Dutch. In addition, 2 children from the bilingual sample were removed because no interview data were available; as a result, we could not confirm that these children were assigned to the right group. This brought the current sample to 68 bilingual Turkish–Dutch children and 52 monolingual Dutch children. The demographic properties of the excluded and original sample were largely the same. Nearly two thirds were boys. The average age at Wave 2 was 62 months, and nonverbal IQ scores were virtually the same. SES was slightly higher in the excluded sample than in the original sample (3.9 vs. 3.3) but was lower than in the monolingual sample (see Results; for an explanation on the measures, see below).

For the current study, only data from Waves 2 and 3 were analyzed, that is, when children were ages 5 and 6 years. Data from Wave 1 were not included in our study due to frequent missing values in the working memory tasks. The percentage of boys in the bilingual sample (58.5%) was lower than in the monolingual sample (65.4%), but this difference was not significant, $\chi^2(1) = 0.54$, $p = .57$. At Wave 1, children's nonverbal IQ was assessed through Raven's Colored Progressive Matrices (Raven, 1995). Based on raw accuracy scores, the monolingual and bilingual samples did not differ in nonverbal IQ as measured at Wave 1, $t(98) = -.32$, $p = .75$, *ns*), and for this reason we did not enter nonverbal IQ as a covariate in the analyses. As shown in Table 1, which summarizes the participant characteristics, the bilingual children were slightly older than the monolinguals. Because this could lead to an advantage for the bilinguals, age was included as a covariate in the comparisons of bilingual and monolingual children's working memory performance.

Measures

SES and language use at home

To obtain background information on children's home environment, at Wave 2 (when the children were age 5 years) oral interviews with the mothers were conducted by a research assistant who was a native speaker of Turkish. SES background was measured through parental level of education and was calculated as the mean of the highest attained educational level of both parents rated on a 6-point scale. Parental education is the most commonly used index of SES background, is highly predictive of other SES indicators (e.g., income, occupation), and is a better predictor of cognitive performance than other SES indicators (for further discussion, see Calvo & Bialystok, 2014). Among the mothers of the bilingual children, 33 reported speaking only Turkish at home, whereas 27 reported using both Dutch and Turkish at home. In addition, 4 mothers spoke only Dutch at home but reported that their partners spoke Turkish. For the remaining children, it was not specified how much Turkish and Dutch was used at home.

Table 1
Participant characteristics.

	Bilingual	Monolingual	F	p	η^2_p
Number	68	52	–	–	–
Girls	28	18	–	–	–
Nonverbal IQ (raw)	12 (2.6)	12.2 (3.6)	.11	.75	.00
Age in months at Wave 2	62.7 (2.6)	61.7 (2.1)	7.7	.01	.06
Age in months at Wave 3	71.8 (2.9)	70.4 (2.4)	7.0	.01	.06

Note. Standard deviations are in parentheses.

Dutch and Turkish vocabulary measure

To assess the children's knowledge of Dutch, Dutch receptive vocabulary outcomes were analyzed. Level of bilingualism was determined based on Dutch and Turkish receptive vocabulary. The *Toets Tweetaligheid* (Test for Bilingualism) was used to assess children's receptive vocabularies in Dutch and Turkish (Verhoeven, Narrain, Extra, Konak, & Zerrouk, 1995). This task was specifically designed for research into bilingual development given that it contains two language versions that can be considered equivalent and have been examined for cultural bias. In this task, children hear a word and then choose one of four line drawings presented on a laptop computer. The task starts with a short practice session. To avoid fatigue, the task was shortened by dividing it into 30 odd items for the Turkish version and 30 even items for the Dutch version. The Dutch test was expanded with 15 items from a vocabulary test, which is part of the *Taaltoets Alle Kinderen* (Language Test for All Children) (TAK; Verhoeven & Vermeer, 2002), to avoid ceiling effects. The TAK vocabulary test is applicable to a broader age range than the *Toets Tweetaligheid.* Cronbach's alpha for the receptive vocabulary measures ranged from .73 to .88 at the different waves and for the two groups separately (Messer, 2010).

Working memory measures

Working memory measures were adapted from the Automated Working Memory Assessment (AWMA; Alloway, 2007) and translated into Dutch (Messer, 2010). Four tasks were selected that varied in whether visuospatial working memory or verbal working memory were assessed and in whether both storage and processing were tested or only storage was tested.

Visuospatial working memory was assessed with the Dot Matrix and Odd-One-Out tasks. Instructions were translated and provided in either Turkish or Dutch to make sure that children understood the tasks. In the Dot Matrix task, children are shown a series of screens on which a red dot appears in a 4×4 matrix. Children's task is to recall the coordinates of the dots. Each dot in the matrix appears on the computer screen for 2 s. After two practice trials, the test starts with a block of six trials in which only one dot appears in the matrix, building up to a block of six trials with a sequence of seven dots presented across the matrix. In the Odd-One-Out task, children are presented with three shapes that are each in a different box presented in a row. Children's first task is to identify the odd-one-out shape. Then, at the end of each trial, children are presented with three empty boxes and asked to tap the box in which the odd-one-out shape was presented. Like in the Dot Matrix, the number of items to be remembered increases progressively over successive blocks. Both the Dot Matrix and Odd-One-Out tasks have been used in previous studies on bilingual children; Engel de Abreu and colleagues (2012) administered the same tasks, and the sequential condition in the Frog Matrices task used by Morales and colleagues (2013) is similar to the Dot Matrix task except that a frog is depicted instead of a dot and a 3×3 matrix is used instead of a 4×4 matrix.

Verbal working memory was assessed through Forward Digit Recall and Backward Digit Recall. Digit recall tasks were selected because we assumed that recalling digits is less dependent on language level than (non)word or listening recall (for further discussion of these tasks, see Messer, 2010). Bilingual children could choose the language in which they wanted to take the digit recall tasks; only 1 bilingual child did the tasks in Turkish. Both verbal working memory tasks were presented on a laptop, and prerecorded sentences by native speakers were used for the presentation of the stimuli. Prior to each task, children were presented with two practice trials to familiarize them with the procedure. The task then started with a block of one digit that children were asked to repeat and continued with blocks of increasing length up to a block containing sequences of seven digits. Each block contained six trials. In the Forward Digit Recall task, children were asked to repeat each sequence in the correct order. In the Backward Digit Recall task, children were asked to repeat each sequence in backward order.

The working memory tasks differ in modality and complexity. Complex working memory tasks require more support of the central executive system than simple working memory tasks and involve not only storage (like simple working memory tasks) but also processing of information. The Forward Digit Recall and Dot Matrix tasks are considered storage-only tasks (but see Discussion). The Odd-One-Out and Backward Digit Recall tasks require storage and processing. In these tasks, the processing component is tested through comparing (Odd-One-Out) and reversing (Backward Digit Recall) stored information.

For scoring, the AWMA procedure was applied. For the Forward and Backward Digit Recall tasks and the Dot Matrix task, this entailed scoring trials as incorrect if children omitted one or more of the digits/dots, if the sequence was incorrect, or if one or more digits/dots were recalled incorrectly. If children repeated the first four trials within a block correctly, they automatically received a score of 6 and continued with the next block. Testing stopped after three incorrect trials within one block. The scores could range from 0 to 42. Identifying the odd-one-out in the Odd-One-Out task was monitored, but errors were not included in the recall scores. Psychometric quality of the working memory measures was evaluated by Alloway (2007) and found to be satisfactory (for further details, see also Automated Working Memory Assessment (AWMA)—Reliability and Validity, 2014).

Procedure

Testing took place in a quiet room at the children's schools and was done by trained research assistants who were fluent in Turkish and Dutch. There were two sessions that were approximately 1 week apart. Each testing session lasted approximately 75 min, including play breaks and tasks that are not reported in the current study (cf. Messer, 2010). The tasks were administered in a fixed order that aimed to optimally vary the task demands from one task to the next and avoid fatigue. The memory and language tasks reported on below were administered in the following order: Dutch vocabulary and Odd-One-Out (Day 1); Turkish vocabulary (for bilinguals), Forward Digit Recall, Dot Matrix, and Backward Digit Recall (Day 2). Children were rewarded with a small sticker after each task to keep them motivated.

Results

Working memory in bilingual and monolingual children

The primary aim of this study was to investigate whether bilingual Turkish–Dutch children with low-SES backgrounds would outperform monolingual Dutch children on executive-loaded working memory tasks. Below, we first present the results on bilingual and monolingual children's performance on the four different working memory tasks without statistically controlling for differences between the bilinguals and monolinguals in Dutch vocabulary and SES. As a second step, results with statistical control for Dutch vocabulary size and SES are presented. As part of this analysis, we investigated whether the bilingual children indeed differ in Dutch vocabulary and SES, as was expected, and whether Dutch vocabulary, SES background, and working memory outcomes are related.

Children's scores on the four working memory measures at ages 5 and 6 years are summarized in Table 2 for both bilinguals and monolinguals separately. A multivariate analysis of covariance (MANCOVA) was run with group (monolingual or bilingual) as a between-participants variable, age as a covariate, and the four working memory measures as dependent variables. Because age was a covariate, separate analyses needed to be run for the two waves (age 5 or 6 years). No effect of group was found at age 5, $F(4, 111) = 1.50$, $p = .20$, $\eta_p^2 = .05$, or age 6, $F(4, 110) = 0.90$, $p = .47$, $\eta_p^2 = .03$.

Table 2
Mean scores (and standard deviations) on the working memory tests in the bilingual and monolingual groups at ages 5 and 6 years.

		Bilingual	Monolingual
Age 5	Dot Matrix	12.6 (3.2)	12.6 (3.6)
	Odd-One-Out	8.6 (2.9)	8.9 (2.7)
	FW Digit Recall	17.0 (3.1)	18.4 (3.6)
	BW Digit Recall	3.1 (2.6)	3.7 (3.0)
Age 6	Dot Matrix	15.5 (4.0)	14.5 (3.8)
	Odd-One-Out	11.3 (3.4)	10.5 (3.4)
	FW Digit Recall	19.0 (3.7)	19.6 (3.2)
	BW Digit Recall	6.1 (2.8)	5.8 (3.0)

Note. FW, Forward; BW, Backward.

A follow-up analysis was performed to investigate differences between the bilingual and monolingual groups in working memory outcomes when Dutch vocabulary and SES are statistically controlled. We expected both Dutch vocabulary and SES to be lower in the bilingual sample than in the monolingual sample, and these differences could mask effects of bilingualism on between-group differences in executive-loaded working memory tasks. Regarding Dutch vocabulary, the monolinguals had a mean score of 27.8 (*SD* = 4.8) at age 5 years and a mean score of 31.2 (*SD* = 2.9) at age 6 years. The mean vocabulary score for the bilingual sample was 18.2 (*SD* = 4.1) at age 5 and was 23.6 (*SD* = 3.1) at age 6. A repeated measures analysis of variance (ANOVA) with group as a dichotomous between-participants variable and age as a dichotomous within-participants variable indicated a main effect of group, $F(1, 113) = 182.00$, $p < .001$, $\eta_p^2 = .62$, and age, $F(1, 113) = 209.60$, $p < .001$, $\eta_p^2 = .64$. An interaction between group and age, $F(1, 113) = 10.90$, $p = .001$, $\eta_p^2 = .09$, indicates that the Dutch vocabulary gap between the monolinguals and bilinguals was more prominent at age 5 than at age 6, suggesting that the bilinguals catch up with age. In the monolingual sample, the SES scale mean was 4.1 (*SD* = 1.3) and skewed to the right, that is, to higher SES values. In the bilingual sample, the SES scale mean was 2.4 (*SD* = 1.1) and skewed to the left, that is, to lower SES values. The bilinguals' SES was significantly lower than the monolinguals' SES (Mann–Whitney *U* test, $p < .001$).

Table 3 lists the correlations among Dutch vocabulary, SES, and working memory outcomes at age 5 years (below the diagonal) and age 6 years (above the diagonal). Vocabulary correlated significantly with the verbal working memory tasks, but not with the visuospatial tasks, at both ages. SES correlated significantly with all working memory tasks at age 5, but at age 6 significant correlations emerged only for the verbal working memory tasks. The correlations were stronger for the monolinguals than for the bilinguals. We turn to this difference in the Discussion. The separate correlations for the two groups are shown in the Appendix.

MANCOVAs were then run with age (categorical variable), Dutch receptive vocabulary (continuous variable), and SES (continuous variable) as covariates; group as a between-participants variable; and the four working memory scores as dependent variables. We ran the analyses for the two waves separately, which allowed us to include the Dutch vocabulary scores that were relevant for ages 5 and 6 years. At age 5, the outcomes of the omnibus multivariate test revealed no difference for the bilinguals compared with the monolinguals, $F(4, 103) = 1.60$, $p = .18$. $\eta_p^2 = .06$. At age 6, the outcomes revealed a main effect of group, $F(4, 105) = 4.40$, $p = .003$. $\eta_p^2 = .14$, with overall better performance for the bilinguals than for the monolinguals. Univariate analyses of covariance (ANCOVAs) showed significant differences for the Dot Matrix and Backward Digit Recall tasks and a trend toward a significant difference for the Odd-One-Out task, as displayed in Table 4.

Bilingual proficiency and language use at home

The secondary aim of this study was to explore individual difference factors related to bilingualism that could be predictive of the bilingual children's working memory performance. Specifically, relations between working memory and bilingual proficiency and home language use were investigated. For determining bilingual proficiency, the children's vocabulary scores in both Dutch and Turkish were

Table 3
Correlation matrix at age 5 years (below the diagonal) and age 6 years (above the diagonal).

	Vocabulary	SES	Dot Matrix	OOO	FW Digit	BW Digit
Vocabulary		.60**	−.031	.022	.22*	.21*
SES	.60**		.14	.03	.23*	.21*
Dot Matrix	.15	.23*		.40**	.34**	.43**
OOO	.15	.19*	.30**		.18	.34**
FW Digit	.27**	.28**	.30**	.24**		.53**
BW Digit	.24**	.28**	.31**	.30**	.42**	

Note. SES, socioeconomic status; OOO, Odd-One-Out; FW Digit, Forward Digit Recall; BW Digit, Backward Digit Recall.
* $p < .05$.
** $p < .01$.

Table 4
Mean scores (and standard errors) on the working memory tests in the bilingual and monolingual groups at age 6 years when age, Dutch vocabulary, and SES are covaried, test statistic F for group, the associated p value, and the effect size η_p^2.

	Bilingual	Monolingual	F	p	η_p^2
Dot Matrix	16.1 (0.66)	13.6 (0.76)	4.0	.04	.04
Odd-One-Out	11.8 (0.57)	9.9 (0.66)	3.5	.06	.03
Forward Digit Recall	20.0 (0.58)	18.3 (0.67)	2.2	.14	.02
Backward Digit Recall	7.5 (0.45)	4.0 (0.52)	17.1	<.001	.14

taken into account. These scores are displayed in Table 5. The bilingual children scored higher on Dutch than on Turkish, but the difference was significant only at age 6 years: age 5, $t(64) = 1.58$, $p = .12$; age 6, $t(64) = 8.27$, $p < .001$. This pattern is reflected in the individual scores. At age 5, 27 bilingual children had a higher vocabulary score for Turkish than for Dutch, and 37 showed the reverse pattern (4 missing). At age 6, 11 children scored higher in Turkish than in Dutch, 52 children showed the reverse pattern, and 2 children had the same score for Turkish and Dutch (3 missing). Overall, the sample was rather balanced at both waves given that only 2 children had a 10-point or greater difference between the vocabulary scores in the two languages on scales of 0 to 30 (Turkish) and 0 to 45 (Dutch) in the two waves. In addition, the bilingual children became more proficient between ages 5 and 6 years in both Dutch, $t(63) = 13.20$, $p < .001$, and Turkish, $t(62) = 9.10$, $p < .001$, indicating an overall growing bilingual proficiency.

We calculated bilingual proficiency by averaging the Dutch and Turkish vocabulary scores after the raw scores were transformed into proportions to correct for differences in scale. This was done separately for both ages 5 and 6 years. A second measure was created where bilingual proficiency was corrected for balance by subtracting a child's balance score from bilingual proficiency. Balance was calculated by dividing a child's highest score (either Dutch or Turkish) by the lowest score (either Dutch or Turkish); thus, a higher balance score indexed less balance between the two languages. This second measure shared a significant amount of variance with the simple bilingual proficiency measure based on the average of children's Dutch and Turkish vocabulary scores (age 5: $r(65) = .39$, $p < .01$; age 6: $r(65) = .40$, $p < .01$), confirming that the sample was rather balanced.

To assess effects of bilingual proficiency and language use at home, multiple regression analyses were run with children's scores on the Dot Matrix and Odd-One-Out tasks and on Forward and Backward Digit Recall at ages 5 and 6 years as dependent variables and bilingual proficiency and language use at home as predictor variables. Language use at home was a dichotomous predictor variable that distinguished between mothers who spoke only Turkish at home and mothers who used Turkish and Dutch while conversing with their children. For the Backward Digit Recall task, a significant model was found at age 6. The two predictors explained 13% of the variance, $R^2 = .13$, $F(2, 61) = 4.70$, $p = .01$. Bilingual proficiency significantly predicted bilingual children's performance on the backward digit recall task, $\beta = .37$, $p < .01$. Mothers' language use at home did not turn out to be a significant predictor, $\beta = -.10$, $p = .42$.

Discussion

The current study investigated whether bilingual Turkish–Dutch children from low-SES backgrounds benefit from being bilingual and, thus, outperform their monolingual peers in working

Table 5
Bilingual children's raw receptive vocabulary scores in Dutch and Turkish: Mean scores (and standard deviations) at ages 5 and 6 years.

	Dutch	Turkish
Age 5	18.2 (4.1)	17.2 (3.2)
Age 6	23.7 (3.0)	20.2 (2.3)

memory tasks. The bilingual children were tested at ages 5 and 6 years and had less experience with Dutch than their monolingual Dutch peers. As expected, they scored lower on a Dutch receptive vocabulary test. SES scores in the bilingual sample were also lower than in the monolingual sample. Previous research with the same sample of children has shown that, at age 4 years, their limited experience with Dutch appeared to negatively influence their performance on a Dutch language-dependent memory task that tested the ability to recall Dutch-like nonwords (Messer et al., 2010). Assuming that bilingualism enhances domain-general executive control (Bialystok, 2010; Bialystok et al., 2004; Costa et al., 2009; Hilchey & Klein, 2011), we expected advantages for the same bilingual children in executive-loaded working memory tasks that rely less on experience with Dutch. In addition, we explored whether bilingual proficiency and language use at home predicted bilingual Turkish–Dutch children's working memory performance.

The first research question was focused on between-group differences in working memory outcomes. When no statistical control for Dutch vocabulary and SES background was exerted, no differences between the bilingual and monolingual children emerged. When statistically controlling for Dutch vocabulary and SES background, we observed no overall difference at age 5 years between the two groups. At age 6 years, an overall advantage for the bilinguals was found. The bilingual children outperformed the monolingual children on one visuospatial working memory task (Dot Matrix) and on one verbal working memory task (Backward Digit Recall), and a trend toward a bilingual advantage was found for the second visuospatial working memory task (Odd-One-Out).

Bilingual advantages emerged most consistently for the Dot Matrix and Backward Digit Recall tasks. The magnitude of the difference between bilinguals and monolinguals was larger for the Backward Digit Recall task than for any of the other working memory tasks. The Backward Digit Recall task requires both storage and processing; hence, bilingual advantages were expected for this task. The Forward Digit Recall task is a verbal working memory task like the Backward Digit Recall task, but in contrast to the Backward Digit Recall task, it involves hardly any executive control. Even after controlling for vocabulary and SES background, the Forward Digit Recall task did not reveal any between-group differences. Thus, the bilingual children's performance on both digit recall tasks is highly consistent with the hypothesis that bilingualism affects executive control. The Dot Matrix task is classified as a visuospatial storage task. The reason as to why the bilinguals outperformed the monolinguals on this task could be twofold. First, the dynamic format in which there is a sequel of dots in the Dot Matrix task still requires substantial processing and, thus, executive control (Alloway, Gathercole, & Pickering, 2006; Miyake et al., 2001). Second, visuospatial working memory tasks in general draw more on executive control than verbal working memory tasks (Alloway, Gathercole, Willis, & Adams, 2004).

Taken together, the differential outcomes for the two verbal working memory tasks and the bilingual advantages in the two visuospatial working memory tasks confirm the hypothesis that bilingualism enhances executive control in a sample of sequentially bilingual Turkish–Dutch children. The results of our study resemble the results reported by Morales and colleagues (2013), who found a bilingual advantage for 5- and 7-year-olds on visuospatial working memory. By demonstrating that bilingual low-SES children outperform monolingual children on executive-loaded working memory tasks, our study corroborates previous research with low-SES children that shows enhanced effects of bilingualism on inhibition and attentional control (Carlson & Meltzoff, 2008; Engel de Abreu et al., 2012) and supports the hypothesis that bilingual cognitive advantages are independent of SES background (Calvo & Bialystok, 2014).

In the current study, Dutch receptive vocabulary and SES background in particular were positively correlated with the outcomes on the working memory tasks (Table 3). The bilinguals scored lower than the monolinguals on Dutch receptive vocabulary and had lower SES backgrounds, yet no between-group differences were observed for working memory when vocabulary and SES background were not controlled. These results parallel the findings on inhibition in low-SES bilingual Spanish–English children of Carlson and Meltzoff (2008), who concluded that the absence of a difference between monolinguals and bilinguals suggests that bilingualism compensates for detrimental effects of low verbal ability and low-SES background on executive functioning. However, we cannot draw the same conclusion based on our results because correlations between vocabulary and SES background, on the one hand, and working memory, on the other, most often did not reach statistical significance in the bilinguals, who contrasted with the monolinguals in this respect. The absence of significant correlations is presumably caused by the effect that bilingualism has on working memory, but because other explanations cannot be excluded (e.g., years of parental education do not measure exactly the same construct in monolinguals and bilinguals; see Scheele et al., 2010), our conclusions regarding compensatory effects of bilingualism are limited.

The second research question addressed the issue of bilingual proficiency and home language use in relation to working memory outcomes. We hypothesized that proficient bilinguals might spend more effort to reduce interference between the two languages, whereas the unbalanced and less proficient bilinguals would work (less) to block access to one of their languages. Thus, with more exercise, advanced bilinguals may show more enhancement of executive control performance. In a similar vein, children who are exposed to the same languages in one environment may experience more interference, and thus more cognitive training, than children whose bilingual learning contexts are more separated.

To investigate the role of language distribution in the bilingual Turkish–Dutch children's environment, the predictive value of the mothers' language use at home, and whether or not mothers mixed the two languages, was examined. This variable did not affect the bilingual children's working memory outcomes, but bilingual proficiency was predictive of how well the bilingual children performed on the Backward Digit Recall task at age 6 years. The occurrence of an effect at age 6 but not at age 5, also expressed by the larger effect size at age 6 than at age 5, suggests that growing bilingual proficiency plays a role in bilinguals' executive function development (Costa & Santesteban, 2004). This conclusion ties in with Poarch and van Hell's (2012) study where a significant advantage in executive functioning was found between simultaneous bilingual German–English children and monolingual German children, whereas sequentially bilingual German–English children performed in between these two other groups. The sequential bilingual children were less bilingually proficient than the simultaneous bilingual children but were more bilingually proficient than the monolinguals. Our study contributes to the mounting evidence that executive control develops as a function of growing bilingual proficiency.

To conclude, in this study we found that, compared with Dutch monolinguals, a group of Turkish–Dutch bilingual children showed cognitive gains in visuospatial and verbal working memory tasks. The findings reported in this study converge with recent research showing bilingual advantages beyond inhibition (Bialystok, 2010; Morales et al., 2013) and support the hypothesis that bilingualism affects general executive control (Bialystok, 2010; Bialystok et al., 2004; Costa et al., 2009; Hilchey & Klein, 2011). The bilingual Turkish–Dutch children investigated for the purpose of this study were sequential bilinguals from low-SES families. The sequential bilingualism of the Turkish–Dutch children offered the opportunity to investigate the effects of growing bilingual proficiency on executive control development. This study shows that benefits to executive control are influenced by bilingual proficiency, in line with previous literature that has addressed this topic (Costa & Santesteban, 2004; Poarch & van Hell, 2012). Previous research has shown that less experience with Dutch places the sequentially bilingual Turkish–Dutch children in a disadvantaged position compared with monolingual children in working memory tasks that are influenced by representations of Dutch in long-term memory (Messer et al., 2010). The current study shows that (sequential) bilingualism can be advantageous for performance on working memory tasks that are less dependent on Dutch long-term knowledge and require a higher level of executive control. Moreover, the study contributes to a growing body of research showing that bilingual cognitive advantages develop regardless of SES background (Calvo & Bialystok, 2014) and that bilingualism can be an important source of enrichment for socioeconomically disadvantaged children (Carlson & Meltzoff, 2008; Engel de Abreu et al., 2012). This source of enrichment is naturally provided to children raised in immigrant families whose home language is different from the language spoken in the wider community and emphasizes the importance of supporting and fostering bilingual children's development in both languages.

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Appendix

Correlations at age 5 years (below the diagonal) and age 6 years (above the diagonal) among Dutch receptive vocabulary, SES, and working memory outcomes: Bilinguals (top) and monolinguals (bottom).

	Vocabulary	SES	Dot Matrix	OOO	FW Digit	BW Digit
Bilingual sample						
Vocabulary		.33**	−.06	.05	.14	.32*
SES	.33**		.17	−.06	−.06	.16
Dot Matrix	.04	.26*		.33**	.33**	.41**
OOO	.13	.13	.24*		.14	.23
FW Digit	.17	−.14	.21	.03		.54**
BW Digit	.22	.17	.38**	.30*	.26*	
Monolingual sample						
Vocabulary		.35*	.34*	.29*	.39**	.44**
SES	.35*		.36*	.32*	.56**	.42**
Dot Matrix	.38**	.28*		.48**	.40**	.46**
OOO	.29*	.32*	.38**		.28	.46**
FW Digit	.25	.52**	.39**	.48**		.54**
BW Digit	.30*	.37**	.25	.29*	.55**	

Note. SES, socioeconomic status; OOO, Odd-One-Out; FW Digit, Forward Digit Recall; BW Digit, Backward Digit Recall.
* $p < .05$.
** $p < .01$.

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