The Bilingual Advantage in Practice

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Abstract

The discussion on the existence of a bilingual advantage in executive functioning is still going on to this day. But even if this advantage does exist, can we speak of a true advantage? In other words, how does this advantage resonate in real-life? This study translated executive functions into real-world competences and tested whether bilinguals score better on these as well as on their school performances. Results show very little to no evidence of the existence of a bilingual advantage in real life. The most likely explanations are that there either is no advantage or the advantage is very small and therefore masked by other factors influencing executive functioning and bilingualism.

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1. Introduction

The Bilingual Advantage: it sounds nice, an advantage in executive functioning for bilingual people, but the truth is that scientists have not yet reached an agreement on whether this advantage truly exists. Executive functions are cognitive functions that all have to do with decision making, inhibiting irrelevant information, and problem-solving. As bilinguals are always juggling with linguistic knowledge of two or more languages, they are constantly practicing these skills, which means they might be better at them. Therefore, many studies have investigated the bilingual advantage in executive functioning by using executive control tasks. Even many years into the research field, no consensus has been reached yet. Many studies have found bilingual advantages (Abutalebi et al., 2012; Bialystok 2008, 2010, 2011; Costa et al., 2009; Emmorey et al., 2008), but other studies have not found these advantages or have not been able to replicate the same results (Antón et al., 2014; Duñabeitia et al., 2014; Gathercole et al., 2014; Paap and Sawi 2014). Besides extensive research into the bilingual advantage on executive functioning, however, not much research has been done yet into bilingual advantages in a broader sense. Paap et al. (2015) argue that bilinguals probably have many personal, economic, social, and other advantages, but do not go into this any further. Khotemlyansky and Berge (2021) investigated if there was a bilingual advantage in high school students but did not look at actual school results. Instead, they used a flanker task as cognitive assessment scores as proxies for grades. Even though they found a bilingual advantage this way, the flanker task tests for executive functioning, and thus still does not look into more practical real-life advantages. They also asked the students in a survey whether they thought bilinguals performed better at school, which was neither confirmed nor denied, as thoughts on this were neutral. Students also had to fill out self-assessments on their school performances. Even though bilinguals scored themselves as 'well above average' more often than monolinguals, in total, 2% more of the monolinguals than bilinguals scored themselves 'average', 'above average' or 'well above average', suggesting that overall monolinguals evaluate their school performances slightly better than bilinguals. Schroeder (2018) found that bilingual children perform better at Theory of Mind tests, which suggests they are better at attributing mental states to other people, and thus better at predicting or explaining other peoples' actions. Schroeder proposes that this advantage may be due to enhanced executive functioning, due to enhanced metalinguistic awareness, or due to a socio-pragmatic account. The last would mean that bilingual children understand that not everyone speaks the same languages as they do and that they have thus learned that people may have different or similar states of mind. If this is indeed the case, this could lead to potential advantages in, for example, the development of prosocial behaviour.

As Khotemlyansky and Berge (2021) only performed a flanker task and asked participants if they *thought* bilinguals performed better, and Schroeder (2018) only *proposes* that advantages in the Theory of Mind may have real-world consequences, the question remains whether bilinguals have practical real-life advantages as opposed to monolinguals. The present study serves to investigate if there are practical advantages, based on executive functioning and school grades as well. The main questions of this study are:

RQ1: *To what extent does the bilingual advantage (that is sometimes) found in executive functioning tasks resonate in practice / real-life in bilinguals compared to monolinguals?*
RQ2: *Do bilinguals have an advantage in school performances compared to monolinguals?*

The first research question has two possible hypotheses. Advocates of the bilingual advantage in executive functioning may expect these advantages to resonate in real-life experiences too. If it is true bilinguals have enhanced executive functioning, they may be better at competences such as decision making or planning. On the other hand, opponents of the bilingual advantage will say it is not likely to find advantages based on executive functioning, because no robust advantages in executive functioning have been found in bilinguals. As many studies have not been able to replicate

results indicating a bilingual advantage, and as bilingualism is a very broad term with lots of variances, it may be very likely that if the bilingual advantage exists, it only exists under specific conditions (Paap et al. 2015), and thus no bilingual advantages will be found in the current study. As for the second research question, the same may be predicted. Additionally, it may be that bilinguals score better on languages courses in school as they have more metalinguistic knowledge and might be better at languages in general as they already speak multiple languages.

To answer the research questions, this thesis first presents a theoretical framework, that starts by defining what it means to be bilingual. Next, the current status of the discussion on the bilingual advantage, in which the current research is placed, is set out. The theoretical framework also goes into the definition of executive functioning more precisely. Lastly, the flanker task, one of the most prominent tasks to test executive functioning, will be discussed in detail, including factors that may be of influence on executive functioning and thus on the results of the current research. After the theoretical framework, the methods will follow in section three, results in section four, and a final discussion in section five.

2. Theoretical framework

In this chapter, I will discuss the most important literature that forms the theoretical framework in which the current research is placed. Firstly, I will try to define what it is to be 'bilingual' and what important divisions to make in the age of onset of acquisition. Secondly, the discussion concerning the 'bilingual advantage' will be set out, considering both literature in favour of the bilingual advantage, as well as literature arguing against the existence of a bilingual advantage in executive functioning. To test executive functioning multiple cognitive tests are used in the literature. One of the tasks that have been used in many different studies is the flanker task. For the current research, I have chosen to focus on the flanker task as well. Therefore, the last section of this chapter discusses the flanker task in more detail, including factors that may influence performance on the flanker task, i.e., that affect executive functioning in general.

2.1 Bilingualism

To study differences between bilinguals and monolinguals, it is important to first establish when a person is 'bilingual'. The definition of a bilingual that is given in the Oxford dictionary is "*a person who can speak two languages equally well*". The Cambridge dictionary adds that places or groups might be bilingual as well if they are "*using two languages as main languages*". A Google search on the term 'bilingual' gives the definition of "*a person speaking two languages fluently*".

A more scientific and complete definition of bilingualism is discussed by Hamers and Blanc (2000), who show that it is not an easy task to properly describe bilingualism. They distinguish between 'bilingualism' and 'bilinguality'. With the term 'bilingualism' they refer to a linguistic community in which two languages are spoken and in which at least some individuals are bilinguals. The term 'bilinguality' refers to individuals who are bilingual. The current research will focus on individuals rather than linguistic communities when using terms such as bilingual and bilingualism. The short definition Hamers and Blanc give, is as follows (Hamers and Blanc 2000, 6):

"*Bilinguality is the psychological state of an individual who has access to more than one linguistic code as a means of social communication; the degree of access will vary along a number of dimensions which are psychological, cognitive, psycholinguistic, social psychological, social, sociological, sociolinguistic, sociocultural and linguistic (Hamers, 1981)*".

This definition illustrates that there may be huge interpersonal differences between bilingual individuals and their fluency in a second language. An important factor Hamers and Blanc add to the

definition of a bilingual is that they must be able to use multiple languages as a means of 'social communication'. This thus implies that a bilingual must be able to use a second language in a certain social setting.

To better, or more precisely, asses bilinguality, Hamers and Blanc propose a multidimensional theoretical model. In this model, they consider six different dimensions and four different levels at which you can look at these dimensions. The dimensions that should be taken into account, leading to interpersonal differences in bilingualism, are (1) relative competence, so whether a person is a balanced bilingual or whether one of the languages is dominant, (2) cognitive organisation, (3) the age of onset of acquisition, (4) the availability of a language in a speech community or in the environment in which someone is learning a language, (5) the social and cultural status of the languages spoken and (6) the cultural identity of an individual. These dimensions should be assessed at different levels, being the individual level, the interpersonal level, the level of social networks, and the level of social structures. The dimensions are not independent but are in dynamic interaction (Hamers and Blanc 2000).

This multidimensional model does not provide us with a clear-cut definition of a bilingual to work with in the current research, but it does provide a theoretical framework in which current views on bilingualism generally fit. As described by Marian and Hayakawa (2021) most researchers agree that bilingualism is best viewed as a continuum rather than a category. Even though most researchers agree on this, it is still common practice to divide participants of studies into a monolingual and a bilingual group. This means that researchers must decide on boundaries within the continuum to categorize these groups. The problem with this is not only that many researchers draw those boundaries in different ways, but also that many differences within the groups of monolinguals and bilinguals are disregarded this way. Marian and Hayakawa argue that to compare data from different studies, it would be beneficial if researchers drew the same boundaries and if there would be a single definition of bilingualism. Nevertheless, as long as there is no 'bilingualism quotient', researchers will still have to decide on the division between monolinguals and bilinguals themselves.

One of the most common ways to measure bilingualism in recent times is by use of *The Language Experience and Proficiency Questionnaire* (LEAP-Q) by Marian et al. (2007). In this questionnaire, participants are asked which languages they speak, in which order they have learned them, and what their relative proficiency is in these languages. Participants are also asked how much they are exposed to the languages they speak, and whether they have preferences for the use of either of the languages they speak. The questionnaire then continues with a second part (and optionally a third or more, depending on the number of languages a participant speaks), in which questions are asked about, amongst others, the main source of acquisition of the second language (e.g., through contact with friends or family, or schooling), age of onset of acquisition, the current and total exposure to the second language and the participant's accent. With the answers to these questions, it is possible to draw a specific profile of every bilingual, while taking individual differences into account. This way, a researcher can see to what degree someone is bilingual at different levels and dimensions. Nevertheless, even with this questionnaire, that has been cited over 800 times (Kaushanskaya et al. 2019), there is still the issue of dividing monolinguals and bilinguals into groups if you want to compare the two groups for research. Kaushanskaya et al. (2019) explain that any work on bilingualism these days at least considers the ages of onset of acquisition of the languages a participant speaks, the current and past exposure, and estimates of proficiency or dominance. Finally, they conclude that it is up to each research team to decide for their research which questions of the LEAP questionnaire to consider, and moreover, to decide for their research which boundaries and thresholds to use, fitting their specific research question. The LEAP questionnaire is also the starting point for questions on linguistic background in the current research. Section 3.2.1 Linguistic background explains how the LEAP questionnaire has been used in the present study.

2.1.1 Bilingualism and age of onset of acquisition

One important factor of bilingualism, which is one of the dimensions of Hamers and Blanc (2000) as well, is the age of onset of acquisition. The theory that adult second language acquisition differs from language acquisition by children prevails. Meisel (2008) takes the next step and investigates whether children learning a second language learn this the same way they learn their first language, or whether they learn it more in the same way adults learn a second language. For his research, Meisel adopts the idea of the Critical Period Hypothesis, which states that there are critical periods for children to learn certain grammatical features. After a certain age, the acquisition of these features will not be impossible but much harder to achieve. Meisel adds that there are different sensitive periods for morphology, syntax, and phonology. There is, thus, not one static critical period, but a range of sensitive phases. Adopting this theory means one would expect to find differences in learning patterns across different ages. In his research, Meisel indeed found that children who learn a second language not from birth but later, acquire certain features more like adult second language learners. He also found that the changes in child second language learning already start happening between the age of 3 to 4 years. According to Meisel, to obtain a native-like competence in a language, one should start learning the language before the age of 4. After the age of 8-years-old, Meisel already speaks of adult second language acquisition.

While children with two first languages (2L1), as well as child second language learners (cL2) as well as adult second language learners (aL2) may all be bilinguals, it is still important to keep the differences between these bilinguals in mind. The fact that older children and adults may acquire their second language differently, and the fact that they may not be able to obtain a native-like competence, implies that there may be more differences between bilinguals whose ages of onset of acquisition differ. Therefore, the current research also asks for the age of onset of acquisition of participants' second language, to establish if this influences the results.

2.2 The bilingual advantage

In the literature, there is an ongoing discussion on the existence of a bilingual advantage in executive functioning. Executive functioning is a broad term for many different neural functions. The definition that will be adhered to in the current research is the definition given by Paap and Sawi (2014, 1) which is as follows:

"*Executive functions (EFs) consist of a set of general-purpose control processes believed to be central to the self-regulation of thoughts and behaviors that are instrumental to accomplishing goals. Across many theoretical frameworks these functions include planning, organizing, sequencing, problem solving, decision-making, goal selection, switching between task sets, monitoring for conflict, monitoring for task-relevant information, monitoring performance levels, updating working memory, interference suppression, and inhibiting prepotent responses*."

Nigg (2017) adds to this definition that executive functioning involves not only behaviour and thoughts but emotion as well. Besides, executive functions are cognitive functions that involve manipulating two things in the mind at once.

Bialystok (2011) explains that different studies have shown that for bilinguals there is always interference from one language to the other, showing that both languages are active at the same time in a bilingual's mind, even in a strongly monolingual context. The fact that both languages are activated, means the bilingual always needs to choose between two languages and to mentally suppress the language they are not using. This means that bilinguals are constantly making use of multiple executive functions, such as inhibition of the language they are not using, suppressing interfering linguistic knowledge, and selecting the right language. As is generally accepted in neuroscience, the continuous practice of certain skills influences neural development. Therefore, the hypothesis is that bilinguals develop an enhanced executive functioning as opposed to monolinguals, as they are constantly practicing these skills. Neuroimaging studies support this view, as they have

shown that the brain regions activated when bilinguals use either language are the same as the regions that are activated in standard executive control. If bilinguals indeed have an enhanced executive functioning, they are likely to perform better than monolinguals on tasks, such as the Simon, Stroop, or flanker task, which require ignoring irrelevant information, switching and conflict resolving.

2.2.1 Pro bilingual advantage

Several studies have found evidence for a bilingual advantage. To support the existence of a bilingual advantage, Bialystok (2011a) discusses three of her own studies that have found bilingual advantages. The first one (Bialystok 2010) was performed with a group of 25 monolingual 6-year-olds and a group of 25 bilingual children of the same age, who performed a global-local test with letters or shapes, including congruent, incongruent, and neutral trials. Results showed that bilinguals had faster response times on the incongruent trials, whereas there was no significant difference on congruent trials. This illustrates that the bilingual children were better at inhibition. Bilinguals also had faster response times in the mixed blocks, containing both congruent and incongruent trials, showing that they were better at switching and working memory, as they were better able to hold multiple things in the mind at once for the task, while only manipulating one of them at a time. The second study (Bialystok 2011b) Bialystok (2011a) discusses included a monolingual and a bilingual group of 30 eight-year-old children. The children were asked to perform three classification tasks with animals and musical instruments. In the first task, children had to indicate with a key whether a picture showed an animal or musical instrument. In the second task, children heard sounds either made by an animal or a musical instrument and they had to indicate which one it was by saying it out loud. Lastly, the children got a mixed test with pictures as well as sounds. Results of this study showed that bilinguals and monolinguals scored equally well on the separate tasks, with only pictures or only sounds, but bilinguals outperformed monolinguals in terms of accuracy in the mixed task. The third study Bialystok (2011) discusses, is her work from 2008, where younger and older adults, monolingual and bilingual, were asked to perform the Stroop task. The Stroop task contains congruent, incongruent and control trials and the Stroop effect is calculated from the extra time participants need to name the ink colour when the ink colour is not the same as the colour name given, as opposed to the time they need when the colour name and ink colour are the same. Results showed that bilinguals structurally outperformed monolinguals as monolinguals needed significantly more time in the incongruent trials.

All in all, the three studies show that, first, the enhanced executive control appears across all ages, in children as well as in young and older adults. Secondly, all participant groups were carefully matched based on intelligence and social background, with bilingualism or monolingualism being the only distinctive feature. Therefore, Bialystok argues, the benefits must be due to linguistic experience. Finally, the advantage was not limited to specific elements of executive functioning, but was found on inhibitory control, working memory, and on shifting.

Bialystok (2011) also aims to show that the bilingual advantage found, is due to the competition between the two languages. She shows this by reference to the study by Emmorey, Luk, Pyers, and Bialystok (2008), which looked at differences in performance on a flanker task between monolinguals, bilinguals, and bimodal bilinguals. As bimodal bilinguals can use both their languages at the same time, their languages are not competing and thus the bilingual advantage is not expected for this group. The results indeed showed that bilinguals outperformed both the monolinguals as well as the bimodal bilinguals. In addition, the monolinguals and bimodal bilinguals did not differ significantly in their performance.

The question remains why other researchers have not always been able to replicate these findings and why many new studies do not find differences between monolinguals and bilinguals (Paap and Sawi 2014). Kroll and Bialystok (2013) explain that this may be due to two methodological problems in the research on the bilingual advantage. The first methodological problem is that there are many task effects, group effects, individual differences and other factors that may intervene with

the results that are not always accounted for by the researchers. Secondly, bilingualism is a multidimensional continuum and people may be bilingual to different degrees. Because of these intervening factors, and because bilingualism is a continuum, Kroll and Bialystok conclude that it is striking that there are in fact researchers who find significant differences, as it is much more likely to find no differences in such variable groups. So, they conclude, the studies that do find differences are much more informative than studies that do not find any differences.

2.2.2 Contra bilingual advantage

Apart from research in favour of a bilingual advantage, there is also much research that does not find evidence for a bilingual advantage. Paap and Sawi (2014) discuss three studies by Duñabeitia et al. (2014), Antón et al. (2014), and Gathercole et al. (2014), that show that evidence for a bilingual advantage is not consistently found. These three studies all contained highly proficient bilinguals from communities where two languages were actively used. These studies are important, as it is more likely that bilingual advantages appear when people are *more* bilingual, considering bilingualism is a continuum. Duñabeitia et al. (2014) had a very large sample size, with 252 Spanish monolinguals and 252 Basque-Spanish bilinguals. Both groups had to perform a verbal Stroop task and a number-size congruency task, on which they turned out to perform equally well. Antón et al. (2014) looked at 180 Basque-Spanish bilinguals and 180 monolinguals, who performed an Attentional Network Test, and found no advantages for either group. Gathercole et al. (2014) looked at Welsh-English bilinguals and English monolinguals on three different executive functioning tasks and also found no bilingual advantages.

In their own research, Paap and Sawi (2014) used four different executive functioning tasks, namely the antisaccade task, the attentional network test, the Simon task, and a colour-shape switching task, and constructed 13 different measures of executive functioning, based on different response time calculations. The research contained 85 bilinguals and 62 English speaking monolinguals. The results showed no evidence supporting the bilingual advantage. In the light of the methodological issues proposed by Bialystok (2011), Paap and Sawi also performed a regression analysis, which still did not result in significant differences indicating a bilingual advantage. Besides that, Paap and Sawi found that there was little to no convergent validity between the different measures of executive functioning on the different tasks. In short, this means that the results on different executive functioning tasks or measures are not closely related, while that is to be expected when tasks measure the same concept. They conclude that further research is thus needed to define the constructs that can be used as measures for executive functioning.

Lastly, Paap and Sawi (2014) discuss studies by Salthouse, who had found strong correlations between measures of executive functioning and measures of general fluid intelligence. In addition, he found that neuropsychological variables, such as verbal fluency, that were previously attributed to executive functioning, were more associated with other general cognitive constructs such as speed. Paap and Sawi conclude that it is thus not even completely certain that the measures and tasks used to measure executive functioning actually test for executive functioning and not for other cognitive abilities, such as general fluid intelligence. This is in line with the conclusion Nigg (2017) draws, namely that executive functioning is a too broad notion and that there are no consensus measurements for it yet. Therefore, it must be operationalized more narrowly to be useful for research.

Paap et al. (2015) argue that bilingual advantages in executive functioning either do not exist or are very restricted. Studies that do find evidence for a bilingual advantage are not always reliable according to Paap et al. (2015), due to different Type 1 errors, ranging from failing to report all the study's dependent measures to unjustly rounding of p-values to a point below significance. The second type of problems that appear are problems with confounds of demographic factors. These demographic factors are especially important as they may influence executive functioning in general. Factors such as socioeconomic status, immigrant status and cultural background may all influence performance on executive control tasks. Therefore, to properly investigate differences between

monolinguals and bilinguals, all these other factors must be accounted for, which is not always the case according to Paap et al. (2015), meaning that the reported advantages may be due to other factors than bilingualism.

Paap et al. (2015) also performed a meta-analysis of different studies that investigated the bilingual advantage, and results showed that null results were obtained in studies with small, medium, and large group sizes, whereas bilingual advantages were only found in studies with relatively small group sizes ($n < 30$). This is striking, as increasing sample sizes generally result in more evidence against the null hypotheses, given that the null is indeed false. As there are however null results on studies with large sample sizes as well, it appears more likely that in this case the null hypothesis, being that there is no bilingual advantage, is true.

Another problem is that there are no, or hardly any, studies that have replicated the results of studies that did find a bilingual advantage. Even exact replications, with the exact same tests and only different participants, have not yet been able to replicate positive results either. This is a problem as science is generally self-correcting when results are replicable. However, Paap et al. do say that due to the design and samples sizes, the statistical chances of replicating results are really low too.

Lastly, Paap et al. (2015) argue that the contribution of results found in neuroscience studies is debatable. They agree that bilingualism to some degree changes neurological functioning, but, they say, change does not necessarily mean it is for the better. Different studies show that bilinguals activate different neural regions from monolinguals while performing executive control tasks such as the Simon, flanker or switching tasks. However, these same studies do not always show additional behavioural differences between monolinguals and bilinguals. That means that the two groups simply reach the same results with different neural activity. Besides that, there are even studies, discussing the same neural activity, that interpret the increase of neural activity either as an advantage or as a disadvantage.

2.2.3 Meta-analyses

As the discussion on the existence of the bilingual advantage is still going on, with evidence supporting the theory as well as evidence against the theory, more meta-analyses are performed in studies, to try to draw conclusions from these conflicting results. A meta-analysis by Donelly et al. (2019) investigated 80 different published studies on the bilingual advantage and thereby looked into the influence of age, different tasks, and age of onset of acquisition on the results. Two meta-analyses were performed, one using a broad definition of bilingualism and only standard interference control tasks, the other using a narrower definition of bilingualism and various different tasks, and different ages of onset of acquisitions and treatments of outliers. The tasks that were included in the analysis were versions of the flanker, Stroop, Simon, and Attentional Network Test. Results showed that, after correction for publication bias, there was no significant bilingual advantage in global response time in either analysis. The analyses showed only a small significant bilingual advantage for interference costs, but only for late bilinguals. There was also no significant interaction with task or age. All in all, Donelly et al. (2019) conclude that there is very little evidence supporting the bilingual advantage theory, and if there is an advantage (in interference costs, for late bilinguals) it is overstated in the literature supporting the bilingual advantage.

Another meta-analysis, however, by Ware et al. (2020) did find main effects of task and age. They looked into 170 published and unpublished studies and tested for a bilingual advantage on effect sizes of incongruent trials and interference costs and investigated the influence of task and age on the results. Seven tasks were included, namely the Stroop task, the Simon task, the Attentional Network Test, the flanker task, the trail making test, task-switching paradigms, and card sorting tasks. Ware et al. (2020) found bilingual advantages on four of these tasks, namely on the Stroop task, the Attentional Network Test, the task-switching paradigms and on the card sorting tasks. Bilingual advantages were only consistently found on the Attentional Network Test. Besides that, results showed that bilingual advantages were more likely to be found in adults over the age of 30

and effect sizes were larger with adults above 50-years-old. Lastly, Ware et al. (2020) performed four different tests for a publication bias, and only found mixed evidence for a publication bias on one test. In contrast to Donelly et al. (2019), they thus do not think a publication bias plays such a big role in the evidence found for bilingual advantages.

The possible presence of a publication bias that comes forward in the studies by Donelly et al. (2019) and Ware et al. (2020), has been investigated before. De Bruin et al. (2015) looked at 104 different conference abstracts on the topic of the bilingual advantage, of conferences between 1999 and 2012. All abstracts were divided into four categories, which were 1) studies that found a bilingual advantage, 2) studies that found mixed results but supported the bilingual advantage, 3) studies that found mixed results and, in the end, challenged the bilingual advantage, and lastly 4) studies that fully challenged the bilingual advantage. De Bruin et al. investigated whether the studies of those abstracts were published before the end of February 2014. Results showed significant differences in the number of times studies from the four different categories were published: studies supporting the bilingual advantage were published significantly more often than studies opposing the bilingual advantage. Besides, they created a funnel plot that also indicated that studies with smaller effect sizes may not have been published. Lastly, De Bruin et al. calculated the probabilities of the studies with null effects, to find a bilingual advantage, based on published studies that did find evidence favouring the bilingual advantage using the same tasks. Results showed that studies with null effects had a medium-to-high probability of finding a bilingual advantage, suggesting it is quite remarkable that they did not find this advantage. While the meta-analysis by De Bruin et al. did show the existence of a bilingual advantage, they argue that that can hardly be taken as evidence for the existence of a bilingual advantage, as it was performed with published articles and the data were thus already biased. They point out that this should always be kept in mind with other meta-analyses of the bilingual advantage, as most are performed with published articles, which means they may all be slightly biased.

2.3 Flanker task

The flanker task is also known as the Eriksen flanker task, as it was first done by Eriksen and Eriksen (1974). The goal of their research was to find out the effect of 'noise letters'. Therefore, they constructed a task with five letters in a row, and participants had to indicate with a keystroke which letter was the middle letter. The four target letters were H, K, S and C. To indicate H or K required striking one particular key, while to indicate S or C required striking another key. The letters appeared in three conditions, either in congruent trials (e.g., HHHHH), or incongruent trials (e.g., SSHSS), or in trials that were somewhere in-between, as the flankers were the other letter that required the same response (e.g., KKHKK). The response time was longest in the second condition, incongruency, in which the noise letters were letters that required the other response. If the noise letters were identical to the target letter the response time was the shortest. However, the difference between congruent trials and the third condition, in which the noise letters were the other letters that required the same response, was not significant. The effect of a slower response time for incongruent flanker pairs is referred to as the flanker effect.

The flanker task has been used in different studies on the bilingual advantage, one of which is the research by Abutalebi et al. (2012) that investigates the cognitive areas involved in language-specific conflict as well as in domain-general conflict, and also looks into differences between monolinguals and bilinguals. Participants performed a language-switch task as well as the flanker task, and results showed the same neural areas were activated during the two tasks. Results also showed that bilinguals outperformed monolinguals on the flanker task, as they needed less brain activity to perform better. In addition, the flanker effect decreased significantly for bilinguals, but not for monolinguals in the second session. This suggests that bilinguals adapt better or faster to conflicting situations. Other studies that have found evidence for a bilingual advantage using the flanker task are studies by Emmorey et al. (2008) and Costa et al. (2009).

2.3.1 Factors that influence results on the flanker task

Age

One of the most prominent factors that influences performance on the flanker task is age. Servant and Evans (2020) investigated the influence of age on the performance on the flanker task with a group of older adults, whose ages varied between 60 and 73 and a group of younger adults between 18 and 25 and found that the older adults were generally slower than the younger adults. This was in line with previous research. In addition, the flanker effect was significantly larger for older adults than for younger adults, when the spacing between the target and flanking letters was small. However, the older adults were generally more accurate than the younger adults. A diffusion decision model showed that the difference in response time between the older and younger adults was most likely due to a longer non-decision time and the fact that older adults made more cautious decisions. As age may thus influence executive functioning, my research only looks into differences between monolinguals and bilinguals of the same age group.

Culture

Another aspect that has been said to be of influence on flanker task performance is culture. One possible explanation for cultural differences is that people of different cultures may either distribute their attention more widely over a surface or may show differences in selective focusing. Gutchess et al. (2020) compared performance on flanker tasks between participants with a western cultural background and participants with an eastern cultural background. For their research, they used Americans to represent the western culture and Turks to represent eastern cultures. Results showed that Turks scored significantly higher on accuracy than Americans for all reaction times. Besides that, they found that even though both groups scored significantly lower on accuracy on the incongruent trials, the Americans had worse scores than the Turks. Apart from differences in accuracy, Gutchess et al. did not find other significant differences relating to culture on the flanker effect or for the reaction times. Paap et al. (2015) also established that cultural background may influence executive functioning in general. Therefore, the current study asks for the mother tongues of participants and their parents as a means of checking the cultural background.

(Exer)gaming

Another aspect that may influence executive functioning, is the activity of gaming or exergaming, i.e., both games that require physical activity and sedentary games. Flynn and Richert (2018) compared performance on the flanker task between groups of children, using the same game (Nintendo's Dance Dance Revolution) for both the sedentary game as well as the exergame. To find out whether executive functioning was mainly affected by exercise or by the cognitive involvement in gaming, which requires executive functions such as goal-directed activity, planning, inhibition and selective attention, participants were divided into four groups. The first group did the dance game while dancing, so with physical activity, the second group had to play the same game but sedentary, with a controller, the third group did some aerobic exercises that were very much like the dance moves in the game, and the fourth group was a control group that did nothing and took part in some conversation with the researcher. Results of a pre-test and a post-test were compared and showed differences between the children who participated in the sedentary and physical gaming, and the children who were doing mere physical exercise or who were involved in conversation. Children that had gamed improved their accuracy scores on a switch-flanker task significantly more than children who had not been involved in gaming. Reaction times on the standard flanker task also improved significantly for the children that had been involved in gaming. As gaming experience thus enhances executive functioning, participants with gaming experience in the present study might score better and thus influence the results, regardless of being bilingual or monolingual. Therefore, the current research checks participant's gaming experience to exclude the possibility that this influences the results.

Musical training

Another aspect influencing performance on the flanker task is musical training. D'Souza et al. (2018) investigated the effects of musical training and bilingualism on working memory and inhibitory control. The research consisted of four groups: monolingual musicians, monolingual non-musicians, bilingual musicians, and bilingual non-musicians. The musicians all had at least eight years of experience, and they practised approximately 6 to 9 hours per week. Besides that, they had, on average, 12 years of formal musical training. Participants performed different tasks, including a digit span task, a reading span task, an operation span task, a stop signal task, a Stroop task, and a flanker task. Results showed that there was a significant effect on working memory for musicians who scored better as opposed to non-musicians. There were no significant differences found between monolinguals and bilinguals. For inhibition, they found that musicians performed significantly faster than non-musicians. They did not find any significant advantages for bilinguals on inhibitory control. Because musical training appears to enhance executive functioning, musicians in the present study may score better and thus influence the results. Therefore, the current study asks for participants' musical training, to exclude possible interference thereof with the results.

Sense of agency

There are not only aspects that influence performance on the flanker task, but the flanker task itself may also influence certain things, such as sense of agency, i.e., the feeling that we are in control of our actions and thus of the consequences. Sidarus and Haggard (2016) had their participants perform a flanker task, and after each trial a coloured circle appeared. The colour of the circle depended on the condition of the trial, i.e., congruent, incongruent, or neutral, and on the required action, i.e., pressing a left or right key. Participants were instructed to pay special attention to the relation between their actions and the outcomes. Afterwards, participants had to evaluate their sense of agency over the coloured circles. Results showed a significant effect of congruency on the experienced sense of agency. The sense-of-agency scores were significantly lower for the incongruent trials, compared to neutral and congruent trials. No significant difference was found between neutral and congruent trials in sense of agency ratings. Sidarus and Haggard explain that the conflicting information and the cognitive processes involved in incongruent trials thus result in a reduced sense of agency.

If bilinguals indeed have an advantage in executive functioning, shown in the flanker task, that means they are less bothered by noise than monolinguals. Therefore, the correlation between incongruent trials and a reduced sense of agency is expected to be lower for bilinguals than for monolinguals. In other words, if bilinguals are less receptive to disturbing factors, it seems likely that they have a higher sense of agency in general compared to monolinguals. This hypothesis will be tested in the current research as well.

3. Methods

3.1 Participants

Ninety participants took part in the present study, of which 60 were categorized as monolingual and 30 were categorized as bilingual. Participants were acquired through social media such as Facebook and WhatsApp and through announcements on Brightspace courses at Leiden University. Participants were selected based on two major restrictions. The first restriction was age. As shown by Servant and Evans (2020) there is an effect of age on executive functioning. Therefore, participants in the current research all belonged to the same age group, namely young adults below the age of 30. To make sure all participants are within this age range, it was mentioned in the introduction of the survey (see below) that participants should be between 18 and 29 years old. The first question of the

survey asked for participants' ages and if a participant filled out any age under 18 or above 29, they would get a notification that they could not participate in the research.

The second major restriction for participants of the survey was their educational level. As level of education is generally correlated with level of intelligence, it was of importance that all participants had (almost) equal levels of education, and around the same number of years of education. This is because intelligence may influence not only results on the flanker task, but also results on the other aspects of executive functioning that are being tested. Therefore, people could only participate when they had done HAVO or VWO in high-school and HBO or University afterwards. This leads to somewhat equal educational levels and around the same number of years of education (5 or 6 years in high school, and an average of around 4 years for HBO or University).

3.2 Survey

The survey used for this research was an online survey built in Qualtrics. The advantage of an online survey is the ease to reach a large audience, especially in the current pandemic situation. A disadvantage of such a survey is that the researcher cannot control or see his participants. However, as participation and filling out the survey was completely voluntary, it is likely that the participants who chose to fill out the survey, performed the task in a serious way. The complete survey can be found in the Appendix. The survey came with a short message explaining what the purpose of the survey was and how much time it would take to fill it out. It was also pointed out that the best option was to fill out the survey on a computer, as there would be a test at the end of the survey that could not be performed on a mobile device. The survey remained online for people to fill out for a total of 3 weeks.

The survey started with an opening text. This text explained that participants had to be of the right age and educational level. After that, it explained what participants could expect and it informed them of what would happen with the data gathered. Participants were also informed that the survey results would be completely anonymous. This text also served to get prior and informed consent of the participants, as it stated that by continuing the survey participants agreed that their data would be used in the explained way. The consent was actively given as there was a page break at the end of the opening text, so participants had to click to continue. After this, the survey started, with the first two questions checking for age and educational levels. After that, questions on linguistic background and other background questions followed.

3.2.1 Linguistic background

To compare monolinguals and bilinguals in the analysis, participants had to be divided into two groups based on their language background. For this purpose, a shortened version of the Dutch version of the Language Experience and Proficiency Questionnaire (LEAP-Q) by Marian et al. (2007) was used. Since the survey would be too long and would thus take too much time for the participants to fill out if the complete LEAP-Q would have been included, a selection of questions was made. Kaushanskaya et al. state (2019) that contemporary work on bilingualism should at least include the ages of onset of acquisition of the languages spoken by the participants, the extent of exposure and estimates of proficiency or dominance. Therefore, the survey included the LEAP-Q questions about those aspects. Participants were asked about their mother tongue, which languages were spoken in their parents' or caregivers' home, and what the mother tongues of their parents or caregivers were. After that, they were asked to sum up the languages they could speak, both in order of proficiency and in order of age of acquisition. Next, participants had to indicate in percentages how often they had been exposed to each of the languages they spoke in the past period. The survey automatically asked only about the languages that the participant had filled out. After that, participants were asked the following questions on their second language: (1) at what age did they start learning the language, (2) what was their proficiency in reading, speaking, and listening, on a scale from 1 to 10, (3) how often had they been exposed to the language in certain settings, and (4) how many months had they spent in a country, family or school where the language was spoken. The survey

automatically focused on the language that had been provided by the participant as a second language based on proficiency. If a participant had not added a second language, they were forwarded to the first subsequent question that was not about linguistic background.

3.2.2 Background questions

After the questions about linguistic background, the survey continued with background questions on aspects that may influence executive functioning as discussed above in 2.3.1 Factors that influence results on the flanker task. The questions about factors that may influence performance on the flanker task that were included in the survey, are discussed below. Finally, the survey asked if the participants had ADD or ADHD or any other condition that influenced their ability to concentrate or focus, as these conditions might affect executive functioning and the qualities that are tested in the current research in general.

Culture

As shown in the research by Gutchess et al. (2020), there is an interaction between cultural background and performance on the flanker task. Even though Gutchess et al. did not find significant differences in the flanker effect, they did find significant differences in accuracy rates. It is not exactly clear what this might implicate for the present study, but it does show that there might be an influence of culture. Therefore, the survey of the current research contained some questions on the participants' backgrounds. To establish which culture was prominent in a participant's life, there were two questions on the language background. Firstly, it was asked what their mother tongue was, and secondly which language was spoken with their parents or caregivers. These languages were taken as a proxy of cultural background, to establish whether participants had a western or non-western cultural background. In addition, for practical reasons, the survey was in Dutch, as an attempt to reach an audience with a relatively homogeneous (cultural) background, as an English survey could have attracted a very wide audience with a too broad range of linguistic and cultural backgrounds for the current research.

Gaming

The research by Flynn and Richert (2018) showed that there is a direct influence of sedentary gaming and exergaming on performance on the flanker task. Because gaming might thus also influence executive functioning in general, the survey of the current research contained a background question asking whether participants liked to game and how much time they spent gaming. This information was used as a control, to make sure any differences found in the data were not due to gaming experience instead of bilingualism.

Musical training

Another aspect that is of influence on performance on the flanker task and executive functioning is musical training, as was shown by D'Souza et al. (2018). D'Souza et al. argued that musicians have a cognitive advantage in working memory, one of the executive functions. This means that musicians may score better in the current research. Therefore, the survey contained questions regarding musical training, based on D'Souza et al. Participants were asked whether or not they played an instrument, for how long they have played this instrument and if they played their instrument for at least 6 hours per week. These results were also used as a check, to ensure any obtained differences were not due to musical training instead of bilingualism.

3.2.3 Grades

After all background questions, the participants were asked for their final grades in high school for the subjects of Dutch, English language and culture, maths, and social studies. They were asked for these grades to be able to compare the school performances of monolinguals and bilinguals directly

and objectively through their grades. The choice of subjects was based on the fact that these subjects are compulsory for everyone in the Netherlands, regardless of your educational level or educational profile. That means that everyone had to do final exams in those subjects, which makes them ideal for comparison. Participants were instructed to give their grades with one decimal point.

3.2.4 Assessment statements

After the grades, the part with statements based on executive functioning followed. Because these statements were all rather psychological and personal, participants were first reminded that all their answers would remain anonymous. Participants were instructed to answer the questions based on what was generally the case for them, i.e., not in any specific situations. Twelve different statements then followed, and participants had to judge to what degree they agreed with the statements on a seven-point Likert scale. On the left side of the scale, it said "totally disagree" and on the right side of the scale it stated "totally agree". There were no specifications in words in-between, only numbers from 1 to 7. The statements were sometimes formulated positively and sometimes negatively, to ensure that in some statements it would be better to score 1 and in others it would be better to score 7. This way the chance of participants adjusting their answers to prevent giving the same score on multiple questions was diminished. These statements thus tested participants' own judgements about how they experienced certain things. All statements were based on competences that, based on the literature, bilinguals would be better at if there were indeed a bilingual advantage in executive functioning. The statements were in Dutch, just like the rest of the survey. The original Dutch versions of the statements can be found in the Appendix. Twelve different statements were constructed and were given in random order in the survey.

Based on Sidarus and Haggard (2016), bilinguals are likely to have a higher sense of agency than monolinguals. Therefore, the survey included three different statements to test for sense of agency, based on Tapal et al. (2017, 3), which is a study on a sense of agency scale, to measure people's consciously perceived control of one's mind. The following statements were taken directly from this study: "*I am in full control of what I do*", "*my movements are automatic—my body simply makes them*" and "*the consequences of my actions feel like they logically follow my actions*". The next statement is "*I am in full control of my thoughts*" and is based on sense of agency, as well as on the work by Paap and Sawi (2014), who discuss that executive functions consist of control processes that are central to the regulation of thoughts as well as behaviours for accomplishing goals. The next seven statements are all also based on the definition as given by Paap and Sawi (2014), discussed in 2.2 The bilingual advantage. The first straightforward statements based on this in the survey are *"I have difficulty making decisions*" and "*I am good at planning*". As executive functioning is focussed on thoughts and behaviours for accomplishing goals, real-life competences such as discipline and working on goals are likely to be influenced by executive functioning, resulting in the statements "*I have no trouble with my discipline*" and "*when I set myself a goal, I start working on it easily*". The next two statements are based on interference suppression and inhibition. If interference suppression and inhibition are indeed enhanced in bilinguals, you would expect them to be better at real-life skills such as concentrating and ignoring irrelevant impulses around them. This is why the survey included the statements "*I can generally concentrate/focus easily*" and "*I have a lot of trouble working/studying in an environment with a lot of background noise*". Furthermore, Paap and Sawi (2014) stated that executive functions include monitoring for task-relevant information. This would be translated into the real-life ability to distinguish main from side issues, resulting in the statement "*I am good at distinguishing between side issues and main issues*" in the survey. Lastly, based on the work by Nigg (2017), who explained that executive functioning consists of cognitive functions involved in top-down control of behaviour as well as emotions, the statement "*I can cope well with strong emotions*" was added, to also include the emotional aspect in the survey besides the aspects of behaviour and thoughts.

3.2.5 Flanker task

As a way of checking the data in this research, all participants were asked to perform a short version of the flanker task. The task they had to do is similar to the original task by Eriksen and Eriksen (1974). The version of the flanker task the participants were asked to perform is available on psytoolkit.org. The test requires the participants to press A on the computer keyboard if the target letter is X or C, and press L if the target letter is V or B. The target letter may be flanked by the same letter, the other letter that requires the same response, or either of the letters that require the opposite response. At the end of the task, the participant's results in milliseconds for compatible and incompatible trials are presented, as well as a number for the flanker effect. All participants were asked to perform the test twice, once as a practice round, and once for real, and write down the scores of their second performance in the survey.

The purpose of adding this task to the survey was to see whether the bilingual participants in the current study did indeed score better on the flanker task than the monolingual participants. It is solely used as a check, and not as a research goal on its own. The version available on psytoolkit.org is a shorter version of the flanker task. The choice for a shorter version was made to make sure the test and the complete survey did not take up too much of the participants' time, as this might discourage them from participating at all. The additional practical advantage was that this version was available online for everyone.

3.3 Analysis

3.3.1 Bilingualism

With the answers to the questions on language background, all participants were divided into monolinguals and bilinguals. Based on Kaushanskaya et al. (2019), and based on the current research and target audience, the following boundaries for bilingualism were set. The participant must have had naturalistic exposure from native speakers; thus, they must have spent some time in a family or country where the language is spoken. The minimum amount of time for this, based on Kaushanskaya et al., is six months. Besides that, they should have a high proficiency level, especially in the active use of the language. Kaushanskaya et al. point out that a 7 or higher is considered 'good', but for this research, the boundary is set higher, namely on a 9 for speaking and an 8 for listening as well as reading. The reason to set the boundary higher is that the target audience of the current research consisted of people who go to university and are all thus relatively highly proficient in English as a second language (in the case that the participant has Dutch as their mother tongue). Lastly, the participants should use the second language for a certain percentage of time to be considered bilingual. The threshold for this is set at 30% for the second language. Besides that, this 30% should consist largely of naturalistic input, like interaction with friends and family.

3.3.2 Statistical analysis

To perform the statistics on the data, the response data has been imported from Qualtrics into SPSS. All participants were divided into monolinguals and bilinguals, based on the boundaries set above. All statistical tests were done between subjects.

To ensure that the factors of musical training and gaming experience did not influence the results of this research, the influence of both factors had first been calculated using a one-way ANOVA, and a Tukey post hoc test. This gave insights into the differences between monolingual musicians, bilingual musicians, monolingual non-musicians, and bilingual non-musicians, as well as monolingual gamers, bilingual gamers, and monolingual and bilingual non-gamers. The musicians were defined a little differently from how they were defined in the research by D'Souza et al. (2018). They defined musicians as those people who had played their instrument for longer than 8 years and who played their instrument on average 6-9 hours per week. There were only 2 participants in the current research who matched those requirements. Therefore, everyone who currently played an

instrument was categorized as “musician”. For gamers versus non-gamers, everyone who gamed daily or weekly was regarded as a gamer and everyone who played only once a month or less as a non-gamer. Besides that, using an independent sample T-test, the participants who filled out that they had ADD/ADHD or any other condition that influenced their ability to concentrate or focus, were set apart to see if they influenced the results of the study.

After ruling out these other factors, monolinguals and bilinguals were compared using independent sample t-tests to see if there were any significant differences in their school grades, as well as in the statements and the flanker task results. Finally, independent sample t-tests were performed between early bilinguals (age of onset of acquisition before 8 years old) and monolinguals, as the age of onset of acquisition influences how people learn their second language, as described by Meisel (see 2.1.1 Bilingualism and age of onset of acquisition). Note that this means that people who were labelled as bilingual but who had a later age of onset of acquisition, were not considered in those calculations.

4. Results

4.1 Participants

A total of 72 respondents filled out the survey completely, while 18 respondents filled out the entire survey except for the flanker task at the end. Those 18 participants were included in the analysis of grades and statements too, creating a total of 90 participants. The average age of the participants was 21.78 years old, with a standard deviation of 2.9 years. The youngest participants were 18 years old, and the oldest participants were 29 years old.

Firstly, all participants were labelled “monolingual” or “bilingual”, based on the conditions discussed in 3.3.1 Bilingualismhierboven. This resulted in a group of 77 monolinguals and only 13 bilinguals. Since the bilingual groups would be too small for proper statistics, the requirement that participants had to have spent at least six months in a family or country where their second language was spoken was dropped, as this requirement was considered the least important one for the current research. This then resulted in a group of 60 monolinguals and 30 bilinguals.

Of the 90 participants in total, 83 participants (92%), had Dutch as their mother tongue, 6 of which also filled out having a second mother tongue. The remaining 7 participants had other mother tongues such as Afrikaans, Hungarian, Kurdish, Papiamento and Croatian. Eighty-one participants filled out English as their second language based on proficiency, and 7 participants reported English as their most proficient language. Furthermore, there were 7 participants whose parents or caregivers did not speak Dutch and who thus also did not speak Dutch at home. All others had Dutch as their mother tongue or as a language they spoke at home with their parents.

4.2 Factors that influence executive functioning

The survey asked participants for gaming experience and musical training, as these factors may influence executive functioning. To test the influence of musical training, a one-way ANOVA was performed on the dataset. The ANOVA included four groups (monolingual musicians, bilingual musicians, monolingual non-musicians, bilingual non-musicians) and results showed no significant differences between any of the groups. There was just one significant difference on one of the statements, between the bilingual musicians and monolingual musicians. However, the group of bilingual musicians only consisted of 9 participants, which is not a large enough number to run proper statistics. Since the difference was between two groups of musicians and on only one of the twelve statements, musical training does not appear to affect the results in the current research. Therefore, all answers filled out by the musicians were included in the other statistical tests.

Another one-way ANOVA was done to compare the scores of monolingual gamers, bilingual gamers, monolingual non-gamers, and bilingual non-gamers. This ANOVA showed that there were

significant differences on two of the statements. The statements on which significant differences were found were "*I have no trouble with my discipline"* and "*when I set myself a goal, I start working on it easily"*. Significant differences on the first statement were found between bilingual gamers and monolingual non-gamers (p = .031) and between monolingual gamers and monolingual non-gamers (p = .016). On the second statement, significant differences were found between bilingual gamers and monolingual non-gamers (p = .027). The gamers thus scored significantly worse on those two statements, suggesting they have more trouble with discipline and working on goals than non-gamers. However, since these differences only appeared on two statements, and not between monolingual gamers and bilingual non-gamers nor between bilingual non-gamers and bilingual gamers, it does not appear to be the case that gaming experience truly interfered with the results in the current study. Therefore, all answers by gamers were included in the other statistical tests as well.

4.3 School grades, statement scores and flanker effect

To see if there were significant differences between monolinguals and bilinguals, independent sample t-tests were performed. Results on the school grades are shown in Table 1. Since not all participants were able to retrieve (all of their) final grades, the numbers of participants that were included in the statistical tests are given in the table as well.

Course		**Number of participants**	**Mean**	**Standard deviation**	**Significance (p < 0.05)**
Dutch	*Bilingual*	23	7.096	0.776	p = .537
	Monolingual	55	7.209	0.720	
English language and culture	*Bilingual*	24	8.317	0.887	p = .037
	Monolingual	57	7.872	0.854	
Maths	*Bilingual*	24	6.992	1.488	p = .161
	Monolingual	57	7.470	1.346	
Civics	*Bilingual*	20	7.340	0.754	p = .498
	Monolingual	49	7.498	0.916	

Table 1: Results on school grades

The table shows that there was only a single subject on which bilinguals scored significantly higher, namely English language and culture. However, it must be noted that all bilinguals had indicated English as either their second or even their first language, based on proficiency. This makes the advantage on the subject of English a logical one, that may very well not be attributed to enhanced executive functioning but simply to language experience.

For the statements, all 60 monolinguals and all 30 bilinguals scored each statement. Independent sample t-tests were performed for each statement. Results on the statements are given in Table 2. As becomes clear from the table, only non-significant p-values were obtained, so there is no evidence of a bilingual advantage between these groups on any of the statements.

Statement		**Mean**	**Standard deviation**	**Significance (p < 0.05)**
1. I am in full control of what I do.	*Bilingual*	5.10	1.296	p = .185
	Monolingual	4.73	1.191	
2. I am in full control of my thoughts.	*Bilingual*	4.50	1.456	p = .275
	Monolingual	4.13	1.512	

3. My movements are automatic—my body simply makes them.	*Bilingual*	4.53	1.676	p = .778
	Monolingual	4.43	1.533	
4. The consequences of my actions feel like they logically follow my actions.	*Bilingual*	5.57	1.040	p = .266
	Monolingual	5.30	1.078	
5. I can cope well with strong emotions.	*Bilingual*	4.20	1.627	p = .217
	Monolingual	3.77	1.522	
6. I have no trouble with my discipline.	*Bilingual*	3.50	1.408	p = .242
	Monolingual	3.92	1.660	
7. When I set myself a goal, I start working on it easily.	*Bilingual*	3.63	1.542	p = .252
	Monolingual	4.05	1.651	
8. I can generally concentrate/focus easily.	*Bilingual*	4.13	1.479	p = .923
	Monolingual	4.17	1.553	
9. I have difficulty making decisions.	*Bilingual*	4.33	1.561	p = .111
	Monolingual	4.90	1.581	
10. I am good at distinguishing between side issues and main issues.	*Bilingual*	5.13	1.613	p = .113
	Monolingual	4.60	1.429	
11. I am good at planning.	*Bilingual*	4.50	1.852	p = .437
	Monolingual	4.78	1.497	
12. I have a lot of trouble working/studying in an environment with a lot of background noise.	*Bilingual*	4.67	1.688	p = .966
	Monolingual	4.65	1.793	

Table 2: Results on executive functioning statements

As for the results on the flanker task, not all participants filled out their scores. In total 26 Bilinguals and 42 monolinguals provided data for the independent sample t-test. Results showed no significant difference between monolinguals and bilinguals in the flanker effect, as can be seen in Table 3.

		Number of participants	**Mean**	**Standard deviation**	**Significance ($p < 0.05$)**
Flanker effect	*Bilingual*	26	25.62	66.498	p = .502
	Monolingual	42	36.48	63.101	

Table 3: Results on flanker task

4.4 Discussion

Next to gaming experience and musical training, general executive functioning may also be influenced by ADD/ADHD or other conditions that affect the ability to focus. In the current study there were 14 participants with such disorders, of whom 6 were considered bilingual and 8 were considered monolingual. Results of participants with disorders were compared to results of the other participants using an independent sample t-test, which showed that this group scored lower and even significantly worse on two statements, due to having more problems with concentrating or focussing in general and also being significantly worse at planning. Because 20% of the bilinguals indicated having attention disorders and only 13% of the monolinguals, these participants may have

influenced the results; the presence of a small bilingual advantage might have been obscured by the lower scores of the participants with attention disorders, of which there were relatively more in the bilingual group. Therefore, the same statistical tests were run again but without the 14 participants with disorders. This left the dataset with 24 bilingual participants and 52 monolingual participants, so 76 participants in total. This resulted again just in a significant difference in the school subject of English language and culture ($p = .019$) In addition, one statement "*I have difficulty making decisions*" reached a significant difference between the groups, with a p-value of $p = .047$. No significant differences were found in any of the other grades or statements, nor for the flanker effect. Attention disorders thus influenced the results only slightly in this study.

As described by Meisel (2008), early bilinguals learn their second language in a different way from late bilinguals, and early bilinguals have higher chances to reach native-like proficiency. Since bilingualism is a continuum, early bilinguals may thus be seen as more bilingual. Therefore, the statistical tests in this research have been performed again to measure differences between early bilinguals and monolinguals. Bilinguals were considered early bilinguals if their age of onset of acquisition was below 8 years old. It must be noted that the bilingual group that was created this way was too small for proper statistics. Nevertheless, results are given in Table 4 to give an impression of these results.

Course/statement/flanker effect		**Number of participants**	**Mean**	**Standard deviation**	**Significance ($p < 0.05$)**
Dutch	*Early bilingual*	14	7.143	0.684	p = .992
	Monolingual	49	7.141	0.699	
English language and culture	*Early bilingual*	14	8.343	0.865	p = .038
	Monolingual	50	7.808	0.835	
Maths	*Early bilingual*	14	6.664	1.159	p = .046
	Monolingual	50	7.464	1.334	
Civics	*Early bilingual*	12	7.283	0.863	p = .530
	Monolingual	44	7.470	0.919	
1. I am in full control of what I do.	*Early bilingual*	16	5.63	0.957	p = .018
	Monolingual	52	4.81	1.237	
2. I am in full control of my thoughts.	*Early bilingual*	16	4.63	1.204	p = .295
	Monolingual	52	4.19	1.496	
3. My movements are automatic—my body simply makes them.	*Early bilingual*	16	4.56	1.209	p = .681
	Monolingual	52	4.38	1.586	
4. The consequences of my actions feel like they logically follow my actions.	*Early bilingual*	16	5.50	0.894	p = .375
	Monolingual	52	5.23	1.096	
5. I can cope well with strong emotions.	*Early bilingual*	16	4.44	1.548	p = .108
	Monolingual	52	3.73	1.510	
6. I have no trouble with my discipline.	*Early bilingual*	16	3.94	1.289	p = .974
	Monolingual	52	3.92	1.643	
7. When I set myself a goal, I start working on it easily.	*Early bilingual*	16	4.06	1.124	p = .955
	Monolingual	52	4.04	1.584	
8. I can generally concentrate/focus easily.	*Early bilingual*	16	4.50	1.095	p = .525
	Monolingual	52	4.23	1.567	

9. I have difficulty making decisions.	*Early bilingual*	16	4.13	1.258	p = .123
	Monolingual	52	4.83	1.654	
10. I am good at distinguishing between side issues and main issues.	*Early bilingual*	16	5.44	1.365	p = .061
	Monolingual	52	4.67	1.410	
11. I am good at planning.	*Early bilingual*	16	5.06	1.611	p = .778
	Monolingual	52	4.94	1.447	
12. I have a lot of trouble working/studying in an environment with a lot of background noise.	*Early bilingual*	16	4.56	1.548	p = .686
	Monolingual	52	4.37	1.738	
Flanker effect	*Early bilingual*	12	17.17	54.800	p = .261
	Monolingual	35	41.20	65.546	

Table 4: Results early bilinguals versus monolinguals

The table shows that there are two more significant results, in addition to the significant advantage for bilinguals on the English school course. The first new significant result is for the grade on the subject maths, but this is a monolingual advantage (p = .046) and not an advantage for bilinguals. The second significant difference appears on the first statement "*I am in full control of what I do"*, on which bilinguals scored significantly higher (p = .018). However, when controlled for multiple comparisons using a Bonferroni correction this was no longer significant.

Setting the boundary for early bilinguals at the age of 4 instead of 8 results in only 6 bilinguals, which is not enough for meaningful statistical results. However, to be complete: this resulted in one more statement (*I can cope well with strong emotions*) that reaches a significant advantage for bilinguals (p = .035). The advantage on the school subject of English remains, but there is no advantage on maths or any of the other subjects.

5. General Discussion

The current research aimed to find out to what extent bilinguals have an advantage compared to monolinguals in school performance and real-life situations based on executive functioning. As for the school grades, only a consistent advantage was found for the subject of English language and culture, not on any of the other subjects. This advantage is, however, most likely not due to an advantage in executive functioning, but because all bilinguals either indicated English as their first or second language based on proficiency. This causes a logical advantage over the monolinguals who may have had English as their second language but did not use it enough or did not reach high enough proficiency to be considered bilingual. The data do not suggest a general advantage in language skills for bilinguals, since the bilinguals did not score higher grades for Dutch, and no other grades for language subjects were compared. This could be an interesting addition to future research. When comparing only early bilinguals with monolinguals, another significant difference appeared, on the subject of maths. However, this was a monolingual advantage and the sample sizes were actually too small for proper statistics. The fact that the monolinguals scored better than the few bilinguals here is thus probably a coincidence.

As for the statements based on executive functioning, none of them showed significant differences. When leaving out participants with disorders one statement reached a significant bilingual advantage, namely "*I have difficulty making decisions"*, which they more often denied, and in the comparison of early bilinguals and monolinguals the statement "*I am in full control of what I do"* also reached a significant difference as the early bilinguals agreed more with this statement.

However, since both significant advantages only appeared when reducing the sample size by extra restrictions, this is not very strong evidence for a bilingual advantage. Moreover, using a Bonferroni correction to control for multiple comparisons, these differences were no longer significant. The flanker task that was used in this research as a check-up also did not show any significant differences between monolinguals and bilinguals. Besides that, results showed that there were high standard deviations on the flanker task, suggesting that there were large differences between participants and that some may have scored exceptionally bad and others exceptionally good. It must be noted however that this was only a simplified version of the flanker task and not all participants performed the flanker task. However, these null results are in line with the other results in this study, which suggest that bilingual participants of the current research did not have any advantages over monolinguals.

Apart from the apparent conclusion that there may not be a bilingual advantage in real-life situations based on executive functioning, there are some other possible explanations for the results. One logical explanation is that there are many factors that influence executive functioning, and the current research simply did not consider all of them. For example, socioeconomic status and immigrant status are not included in the current study. Besides that, though the influence of cultural differences on the results does not seem likely, as 92% of the participants had Dutch as their mother tongue and only very few participants had another mother tongue than a western language (e.g., Papiamento, Kurdish), the influence of culture has not been tested for statistically. The second logical explanation for not finding any significant differences is the fact that bilingualism should be seen as a continuum, and boundaries are drawn artificially. It may be the case that bilinguals in this study did not fit the right conditions for advantages to be found. However, this study did also look at early bilinguals separately, who may be seen as more bilingual on the continuum, versus monolinguals, and found hardly more evidence supporting a bilingual advantage. An aspect that may be seen as an issue in judging bilingualism in the current study, is the fact that the data partly depended on self-ratings of proficiency of participants. However, Paap and Sawi (2014) explain that self-ratings are highly correlated with standardized and more objective measures of language proficiency. Therefore, it is not likely that this influenced the results of the current research. One way to properly investigate the influence of the degree of bilingualism in future research would be to use a regression analysis taking into account the answers participants gave on language background questions. Lastly, it may be the case that no bilingual advantages were found because, even though evidence for advantages has been found across all ages (Bialystok 2011), it is more likely to be found in older adults. Bialystok (2013) states that it seems that there is a cumulative effect that produces advantages later in life. Ware et al. (2020), in their meta-analysis, indeed showed that the bilingual advantage in executive functioning was more likely to be found in adults older than 30-years and that the advantage was larger for adults of 50+ years old.

The current research also had a couple of limitations and methodological issues. One of the limitations was the fact that all participants had high educational levels. While it is good for comparison that participants were matched for educational level, this does mean that the data does not represent the entire population. Moreover, people with high educational levels may even be better at certain skills such as planning or distinguishing main from side issues in general, which might have masked the presence of small bilingual advantages. Another limitation is that the survey was completely online, so there was no supervision of the participants while they were filling out the survey. However, as participation was completely voluntary, it seems safe to assume participants filled out everything honestly and seriously. One problem that appeared in the survey concerned the question about how many months people had spent in countries or families where their second language was spoken. This question gave quite a few strange or illogical answers and even answers in years. However, the condition of spending at least six months in a country or family where the second language was spoken to be considered bilingual was omitted, so this did not influence the results of the current research.

All in all, the current research provides little to no evidence for a bilingual advantage in real-life based on a presupposed enhanced executive functioning. This does not mean, however, that the

study completely disputes the theory of a bilingual advantage. Because there are so many variables influencing executive functioning and so many variables in bilingualism, it may still be that there are small advantages, but that those are not found consistently due to the influence of other factors (Kroll and Bialystok 2013). At the same time, this may in turn mean that it may be overstating to speak of a 'bilingual advantage' in executive functioning, as it is easily masked by other factors and thus also has no measurable real-world advantages. Altogether, more research on the topic is still necessary and more participants should either be matched very carefully on all different aspects, or there must be such a large data set that the other variables play off against each other and bilingualism remains as the decisive factor.

6. Conclusion

The current research investigated to what extent there is a bilingual advantage in real-life situations based on executive functioning and school grades. Results showed a significant advantage on the school subject of English language and culture, but this is most likely because English was the bilinguals' first or second language. No advantages were found in real-life competences where advantages would be expected if bilinguals indeed had enhanced executive functioning. There may be an effect of age of onset of acquisition, as early bilinguals seemed to feel more in control of what they do, but sample sizes of the current study were too small to give decisive evidence. All in all, a bilingual advantage in real-life competences based on executive functioning either does not exist or is masked by other factors.

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Appendix

Start of Block: Opening

0
Beste deelnemer,

Dankuwel dat u via deze manier wil deelnemen aan mijn afstudeeronderzoek voor de masteropleiding Applied Linguistics aan de Universiteit Leiden. Om deel te nemen aan het onderzoek is het van belang dat u tussen de 18 en 29 jaar oud bent, en dat u op de middelbare school HAVO/VWO heeft gedaan en/of een HBO/universitaire opleiding volgt of heeft gevolgd.

In dit onderzoek zullen eerst enkele achtergrondvragen gesteld worden, daarna volgen stellingen waarbij u moet aangeven in welke mate die voor u gelden. De resultaten van dit onderzoek zullen anoniem worden verwerkt en worden uitsluitend gebruikt voor mijn onderzoek. Aan het eind van de vragenlijst wordt u gevraagd een kort testje uit te voeren. Dit testje kan alleen op een pc of laptop worden uitgevoerd, en niet op uw mobiele apparaat. Zorg dus dat, wanneer u deze survey op uw telefoon invult, u ook een computer tot uw beschikking heeft. U kunt er tussentijds voor kiezen te stoppen en de survey op een later moment te hervatten. Het totale onderzoek, de survey en het testje gezamenlijk, kost niet meer dan tien tot vijftien minuten van uw tijd.

Als u vragen heeft over het onderzoek kunt u een bericht sturen naar n.schotman@umail.leidenuniv.nl.

Door verder te gaan, gaat u akkoord met het gebruiken van de door u ingevulde antwoorden.

End of Block: Opening

Start of Block: Achtergrondvragen

*

Q1 Wat is uw leeftijd?

_____

Q2 Welke middelbareschoolopleiding heeft u gedaan?

- Havo (1)
- Vwo (atheneum) (2)
- Gymnasium (3)
- Tweetalig VWO (4)

Q3
Wat is het hoogste opleidingsniveau dat u heeft afgerond?
Als u nog studeert, selecteer dan uw huidige opleidingsniveau.

- HBO (1)
- Universitaire Bachelor (2)
- Universitaire Master (3)
- PhD (4)

Q4 Wat is uw moedertaal?

_____

Q5 Welke taal wordt er bij uw ouder(s)/verzorger(s) thuis gesproken?

_____

Q6 Wat zijn de moedertalen van uw ouder(s)/verzorger(s)?

_____

Q7 Noteer alle talen die u beheerst in volgorde van dominantie/vaardigheid (de taal die u het beste kent eerst). Indien u geen andere talen spreekt dan uw moedertaal, laat dan de andere opties leeg.

- 1 (1) _____
- 2 (2) _____
- 3 (3) _____
- 4 (4) _____
- 5 (5) _____

Q8 Noteer alle talen die u beheerst, in de volgorde waarin u ze geleerd heeft (uw moedertaal eerst). Indien u geen andere talen spreekt dan uw moedertaal, laat dan de andere opties leeg.

- 1 (1) _____
- 2 (2) _____
- 3 (3) _____
- 4 (4) _____
- 5 (5) _____

Skip To: Q14 If Condition: 2 Is Empty. Skip To: Gamet u graag in uw vrije tijd? Onder....

Page Break

Q9 Geef aan hoe vaak u de afgelopen periode gemiddeld met elk van deze talen in aanraking bent gekomen. Doe dit in percentages. Het totaal moet uitkomen op 100%.

${Q7/ChoiceTextEntryValue/1} : _____ (1)
${Q7/ChoiceTextEntryValue/2} : _____ (2)

Display This Choice:

If If Noteer alle talen die u beheerst in volgorde van dominantie/vaardigheid (de taal die u het beste kent eerst). Indien u geen andere talen spreekt dan uw moedertaal, laat dan de andere opties leeg. Text Response Is Not Empty

${Q7/ChoiceTextEntryValue/3} : _____ (3)

Display This Choice:

If If Noteer alle talen die u beheerst in volgorde van dominantie/vaardigheid (de taal die u het beste kent eerst). Indien u geen andere talen spreekt dan uw moedertaal, laat dan de andere opties leeg. Text Response Is Not Empty

${Q7/ChoiceTextEntryValue/4} : _____ (4)

Display This Choice:

If If Noteer alle talen die u beheerst in volgorde van dominantie/vaardigheid (de taal die u het beste kent eerst). Indien u geen andere talen spreekt dan uw moedertaal, laat dan de andere opties leeg. Text Response Is Not Empty

${Q7/ChoiceTextEntryValue/5} : _____ (5)
Total : _____

Q10 Op welke leeftijd bent u begonnen met het leren van het ${Q7/ChoiceTextEntryValue/2}?

- ○ Tussen 0 en 4 jaar (1)
- ○ Tussen 4 en 8 jaar (2)
- ○ Tussen 8 en 12 jaar (voor de middelbare school) (3)
- ○ Tussen 12 en 18 jaar (op de middelbare school) (4)
- ○ 18 jaar of ouder (5)

Q11 Geef uw niveau van bekwaamheid aan voor het ${Q7/ChoiceTextEntryValue/2} in de volgende gevallen, op een schaal van 1 tot 10.

	Spreken (1)	Begrijpen van gesproken taal (2)	Lezen (3)
${Q7/ChoiceTextEntryValue/2} (1)			

Q12 Geef aan in hoeverre u in de afgelopen periode in aanraking bent geweest met het ${Q7/ChoiceTextEntryValue/2} in de volgende situaties

	Nooit / De helft van de tijd / Altijd 0 1 2 3 4 5 6 7 8 9 10
Interactie met vrienden of familie ()	
Lezen ()	
Opleiding / zelfinstructie ()	
Televisie / radio ()	

Q13 Hoeveel tijd heeft u doorgebracht in deze taalomgeving in maanden.

○ Een land waar ${Q7/ChoiceTextEntryValue/2} wordt gesproken. (1)
_____

○ Een familie waar ${Q7/ChoiceTextEntryValue/2} wordt gesproken. (2)
_____

○ Een school/werkomgeving waar ${Q7/ChoiceTextEntryValue/2} wordt gesproken. (3)
_____

Q14
Gamet u graag in uw vrije tijd?
Onder gamen wordt verstaan: zowel het zittend spellen spelen op een computer / Xbox / PlayStation / ander apparaat, als games waarbij je beweegt zoals Just Dance of Wii Sports.

- ○ Nee (1)
- ○ Ja, dagelijks (2)
- ○ Ja, wekelijks (3)
- ○ Af en toe (1 keer per maand of minder) (4)

Q15 Bespeelt u een instrument, en zo ja, hoe lang al?

- ○ Ik bespeel geen instrument. (1)
- ○ Ik heb vroeger een instrument bespeeld, maar nu niet meer. (2)
- ○ Ja, ik bespeel een instrument, maar minder dan 8 jaar. (3)
- ○ Ja, ik bespeel een instrument, al 8 jaar of langer. (4)

Q16 Indien het antwoord op de vorige vraag ja was, en u een instrument bespeelt, hoeveel uur per week bespeelt u het instrument gemiddeld?

- ○ Ik bespeel mijn instrument gemiddeld minder dan 6 uur per week. (1)
- ○ Ik bespeel mijn instrument gemiddeld meer dan 6 uur per week. (2)

Q17 Heeft u ADHD/ADD of een andere aandoening die van invloed is op uw concentratievermogen?

- ○ Ja, namelijk (1) _____
- ○ Nee (2)

End of Block: Achtergrondvragen

Start of Block: Cijfers

Q18
Wat waren uw eindexamen cijfers in de volgende vakken? (Afgerond op 1 cijfer achter de komma).
NB: indien u de cijfers niet kunt achterhalen kunt u overal - invullen.

- Nederlands (1) _____
- Engels (2) _____
- Wiskunde (3) _____
- Maatschappijleer (4) _____

End of Block: Cijfers

Start of Block: Uitleg

In het volgende deel van de survey volgen enkele stellingen waarbij u een oordeel moet geven over uw eigen ervaringen. Er zijn geen goede of foute antwoorden, het is alleen belangrijk dat u eerlijk antwoord geeft. De vragen zijn persoonlijke vragen, daarom wil ik u er aan herinneren dat alle antwoorden die u geeft volkomen anoniem zijn en blijven. Bij het beantwoorden van de vragen moet gedacht worden aan wat normaliter van toepassing is, en niet aan specifieke gevallen.

End of Block: Uitleg

Start of Block: Beoordelingsvragen

Q19 Ik heb de volledige controle over wat ik doe.

- 1. Helemaal niet mee eens (1)
- 2. (2)
- 3. (3)
- 4. (4)
- 5 (5)
- 6. (6)
- 7. Helemaal mee eens (7)

Q20 Ik heb de volledige controle over mijn gedachten.

- 1. Helemaal niet mee eens (1)
- 2. (2)
- 3. (3)
- 4. (4)
- 5. (5)
- 6. (6)
- 7. Helemaal mee eens (7)

Q21 Mijn bewegingen zijn automatisch, mijn lichaam maakt ze gewoon.

- 1. Helemaal niet mee eens (1)
- 2. (2)
- 3. (3)
- 4. (4)
- 5. (5)
- 6. (6)
- 7. Helemaal mee eens (7)

Q22 De gevolgen van mijn daden voelen alsof ze logisch volgen op mijn acties.

- 1. Helemaal niet mee eens (1)
- 2. (2)
- 3. (3)
- 4. (4)
- 5. (5)
- 6. (6)
- 7. Helemaal mee eens (7)

Q23 Ik kan goed overweg met heftige emoties.

- 1. Helemaal niet mee eens (1)
- 2. (2)
- 3. (3)
- 4. (4)
- 5. (5)
- 6. (6)
- 7. Helemaal mee eens (7)

Q24 Ik heb geen enkele moeite met mijn discipline.

- 1. Helemaal niet mee eens (1)
- 2. (2)
- 3. (3)
- 4. (4)
- 5. (5)
- 6. (6)
- 7. Helemaal mee eens (7)

Q25
Wanneer ik mijzelf een doel stel, ga ik hier gemakkelijk aan werken.

- 1. Helemaal niet mee eens (1)
- 2. (2)
- 3. (3)
- 4. (4)
- 5. (5)
- 6. (6)
- 7. Helemaal mee eens (7)

Q26 Ik kan mij over het algemeen gemakkelijk concentreren / focussen.

- 1. Helemaal niet mee eens (1)
- 2. (2)
- 3. (3)
- 4. (4)
- 5. (5)
- 6. (6)
- 7. Helemaal mee eens (7)

Q27 Ik heb moeite met knopen doorhakken / beslissingen nemen.

- 1. Helemaal niet mee eens (1)
- 2. (2)
- 3. (3)
- 4. (4)
- 5. (5)
- 6. (6)
- 7. Helemaal mee eens (7)

Q28 Ik kan goed bijzaken en hoofdzaken van elkaar onderscheiden.

- ○ 1. Helemaal niet mee eens (1)
- ○ 2. (2)
- ○ 3. (3)
- ○ 4. (4)
- ○ 5. (5)
- ○ 6. (6)
- ○ 7. Helemaal mee eens (7)

Q29 Ik ben goed in plannen.

- ○ 1. Helemaal niet mee eens (1)
- ○ 2. (2)
- ○ 3. (3)
- ○ 4. (4)
- ○ 5. (5)
- ○ 6. (6)
- ○ 7. Helemaal mee eens (7)

Q30 Ik heb veel moeite met werken / studeren in een drukke omgeving met achtergrondlawaai.

- 1. Helemaal niet mee eens (1)
- 2. (2)
- 3. (3)
- 4. (4)
- 5. (5)
- 6. (6)
- 7. Helemaal mee eens (7)

End of Block: Beoordelingsvragen

Start of Block: Block 5

Q31
Tot slot de vraag of u het testje wil doen via https://www.psytoolkit.org/experiment-library/experiment_flanker.html (kopieer de link in een nieuw tabblad). De demo kost u slechts 2-3 minuten tijd.

Aan het eind van de test worden drie scores gegeven. Vul die scores hieronder in.
Het beste is om de test twee keer te doen, eerst om een keer te oefenen, en vervolgens voor de echte resultaten. Indien u besluit de test maar één keer te doen, geef dat dan aan bij uw antwoorden.

- Compatible (in ms) (1) _____
- Incompatible (in ms) (2) _____
- Flanker effect (in ms) (3) _____

End of Block: Block 5