THE EFFECTS OF DIGLOSSIA ON COGNITION: EVIDENCE FROM EXECUTIVE FUNCTIONS

Submitted in partial fulfilment of the requirements for the degree of

Doctor of Philosophy

School of Psychology and Clinical Language Sciences

Najla Alrwaita

June 2021

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

DEDICATION

They say people are either lucky or doomed by their geographical location. I believe this is particularly true for the household you grow up in. I was fortunate to have parents who believed in me and taught me, from a very young age, the value of education and self-enlightenment. I grew up looking up to my parents; they were always my role models in life, and it is easier to navigate your way through life and to reach your dreams when you have living proof that successful people exist. To my great parents who, despite the pain of my absence, have continuously supported my dreams: you always believed that I will reach high places in life, and that made me go a long way. I am truly nothing but a product of all the love, support and encouragement you have given me throughout the years. And for that, I owe every success I have in my life to you.

This thesis is dedicated to you.

Mom and dad..

ACKNOWLEDGMENT

My PhD journey was very eventful. I got married during the first PhD year and became pregnant during the last year; in-between these years there were many nights of many days where it seemed more convenient to give up, go home and be surrounded by my family and my husband, instead of battling for a PhD dream. I know for a fact that I could not have overcome these moments without my husband's support. To my dear husband, Fahad, you were the voice pushing me to continue every time it seemed too difficult to do so. Thank you for putting up with the distance and many difficult days, only for me to accomplish my dream. Thank you for your unconditional love. You have been, and you will always be, my backbone in this life.

Thanks to all my family members and close friends who have handled my absence, my mood swings and my complaints throughout the years. I am lucky to have you.

I am full of gratitude for all the hard work my supervisors have put into this thesis. Special thanks is extended to my supervisor and mentor Dr Christos Pilatsikas. It has been the greatest pleasure to work with you. You made this journey not only achievable, but also enjoyable. The process of shaping and reshaping this thesis was never easy, and for that I owe a deep sense of gratitude to you for all the hard work, insight and dedication you have put into this thesis. A special thanks also to my colleague Toms Voits for helping with data collection.

DECLARATION

This thesis comprises three papers of which all are under review by different journals.
1- The effects of using two varieties of one language on cognition, evidence from bidialectalism and diglossia. *Submitted to LAB: Linguistic Approach to Bilingualism.*

2- Is there an effect of diglossia on cognition? An investigation of the relationship between diglossia and Executive Functions in young adults. *Submitted to PLOS ONE.*

3- Executive Functions are modulated by the context of dual language use: comparing diglossic and bilingual older adults. *Submitted to BLC: Bilingualism Language and Cognition.*

I confirm that this is my own work and the use of all material from other sources has been properly and fully acknowledged.

Najla Alrwaita

ABSTRACT

Studies investigating the cognitive effect of bilingualism have yielded mixed results. Recently, interest has shifted to exploring the cognitive effects of speaking two varieties of one language (bidialectalism/diglossia) (Antoniou & Spanoudis, 2020). To explain the inconsistences, Green and Abutalebi (2013) introduced the Adaptive Control Hypothesis (ACH), which highlights the role of contexts in modulating Executive Functions (EFs) differently. The role of dual language use has commonly been investigated in bilingual settings, but rarely in bidialectalism/diglossia. In diglossia, the two varieties are separated by context, making it an ideal case for testing the Single Language Context (SLC), as defined by the ACH. In the first paper, all available evidence on the effects of diglossia/bidialectalism on EFs is reviewed in relation to the ACH. The findings from this study encourage future studies investigating bilingualism to consider the role of context. In the second paper, Arabic diglossic and English monolingual young adults were compared on tasks covering EFs' three main domains (Miyake, 2000): inhibition (Flanker and Stroop tasks), switching (Colour–shape task), and updating (Nback task). The results revealed a diglossic disadvantage in Flanker and no diglossic advantages in the other tasks. Considering that advantages in young adults have been rarely reported (Bialystok, Martin, & Viswanathan, 2005), and due to the lack of a bilingual group to compare the ACH's predictions in different contexts, in the third paper three groups of older adults were compared: Arabic–diglossics, bilinguals, and English monolinguals using the same tasks. The results revealed a diglossic advantage in Flanker when compared to bilinguals and a diglossic advantage in Stroop when compared to

monolinguals. However, no advantages were found for the bilingual group. The results are discussed in terms of conversational contexts, and the related control processes.

CHAPTER 1 : INTRODUCTION

1.1. General introduction

It was estimated that half of the world's population are bilinguals (Ansaldo, Marcotte, Scherer, & Raboyeau, 2008). Considering the large number of languages and dialects in the world, and as a result of the yearly migration of around a hundred million people, the number of bilinguals can be expected to continue to increase over the years (Ansaldo et al., 2008). It was even suggested that in the near future monolinguals might be difficult to find (de Groot, 2012). With this growth in the number of individuals speaking two languages, the question of whether bilingualism brings about social or socio-economic benefits has been an interesting topic for many decades. From a social perspective, it was suggested that the benefits of bilingualism can be seen in more social networks (Callahan & Gándara, 2014). From a socio-economic perspective, bilinguals are believed to have more chances for improved salaries and better job positions (Callahan & Gándara, 2014). Not only are there social and socio-economic benefits of bilingualism, but it has been argued that bilingualism also brings cognitive benefits. Investigating the relationship between bilingualism and cognition dates back to the early 20th century (de Groot, 2012). While some of the early studies indicated that bilingualism has positive effects on cognitive development, as well as academic achievements (Portes & Schauffler, 1994), there is still an ongoing debate of whether bilingualism may affect (aspects of) domain-general cognitive skills.

1.2. The history of investigating the effect of bilingualism on cognition

Very early studies looking at the effect of bilingualism on cognition were in opposition to bilingualism. It was believed that bilingualism creates mental confusion and negatively affects children's intelligence and their academic success (Portes & Schauffler, 1994). Most of these studies reported that monolinguals had higher or similar scores to bilinguals in tasks measuring intelligence (for a review, see Darcy, 2012). McLaughlin (1978) argued that children who learned a minority language at home find it difficult to use another language in school, leading to deficits in language skills and academic performance (see Grosjean, 1982). A study by Peal and Lambert (1962) marked a change in how bilingualism is perceived. The authors studied two groups of monolingual children who spoke either French or English, and one group of bilingual children speaking both languages. The bilingual children performed significantly better than monolinguals, especially in tasks that required manipulation or the activation of inhibitory control such as the Flanker and Stroop tasks, where participants have to avoid misleading stimuli and focus on a certain target. Peal and Lambert (1962) claimed that previous studies indicated a bilingual disadvantage did not control for factors such as age and language proficiency (see Peal & Lambert, 1962). After controlling for these factors, bilinguals should be expected to demonstrate higher performance than monolinguals in cognitive abilities. This study paved the way for other researchers to question the assumption that bilingualism has negative implications on cognition. Gradually, more studies began to challenge the widely accepted belief regarding the bilingual disadvantage (de Groot, 2012). It was also suggested that the advantages found in bilinguals could be related to factors other than bilingualism (Antón, Fernández García, Carreiras, & Duñabeitia, 2016).

1.3. Parallel activation

Linguists had long assumed that the bilingual mind deals with each language independently and uniquely (Macnamara & Kushnir, 1971). However, it has now been agreed that both languages are constantly active in the bilingual mind (Kroll, Dussias, Bogulski, & Kroff, 2012). It had also been argued that if the two languages are separate in the bilingual mind, then it would be logical to assume that a bilingual's performance in each language resembles a monolingual's performance. However, research has demonstrated that there is a parallel activation of the two languages: both languages are active in the bilingual mind, even when only one language is used (Kroll et al., 2012). This means that features associated with the language not in use are still activated in bilinguals (Kroll et al., 2012). Relevant evidence comes from tasks such as cross-language priming (when one word from one language facilitates the retrieval of another word from another language), and lexical decision (when participants decide if a string of letters can form a word in one of the languages) (see Beauvillain & Grainger, 1987; de Groot & Kroll, 2014). Parallel activation of the two languages can also be seen in reading, which suggests cross-language interaction. For example, it was reported that bilinguals recognise cognate words (words with forms or meanings that are similar to another language, e.g., *piano* in both English and Spanish), faster than interlingual words (words with similar forms but different meanings, e.g., *pie* in Spanish, meaning foot, which is different from the meaning of *pie* in English) (Kroll, Bobb, & Hoshino, 2014). Interestingly, cross-language interaction can be seen from Language one (L1) to Language two (L2), as well as from L2 to L1 (when bilinguals become more proficient in L2) (see Kroll et al., 2014; Schweizer, Ware, Fischer, Craik, & Bialystok, 2012). More evidence for parallel activation of the two languages comes from bilinguals' ability to switch from one language to another, as it was argued that bilinguals' language switching abilities, even within the same sentence, serve as evidence that both languages are constantly activated (Kroll et al., 2012). These examples suggest that bilinguals constantly deal with two languages, which compete for selection. Bilinguals show successful language processing while the two languages are competing; this happens phonologically, semantically and lexically (Kroll et al., 2012). In word production, it was found that bilinguals are able to name a picture, in the target language, despite the presence of a distractor word in another language that is semantically related to the picture (Miller & Kroll, 2002). Phonologically, it was found that bilinguals are able to deal with competition when a word is presented and other alternative words also arise, where these alternative words are presentenced in other languages and are similar in sound, such as *marker* in English, and *marka* in Russian (Marian, Spivey, & Hirsch, 2003).

1.3.1. Cognitive control and Executive Functions

Evidence from tasks examining cross-language competition is used to suggest that bilinguals develop cognitive advantage due to the increased cognitive demands of language processing (Blumenfeld & Marian, 2013; Linck, Hoshino, & Kroll, 2008). More explicitly, bilinguals have to constantly focus on the relevant language and ignore the irrelevant one based on the context (Carlson & Meltzoff, 2008). Therefore, it has been generally assumed that controlling when to use these languages entails certain cognitive demands, meaning that bilinguals may need to rely more on their executive control abilities, compared to monolinguals (Kroll & Bialystok, 2013). Executive Functions (EFs) refer to a set of mental abilities that include filtering interference, directing goals and behaviours, resisting temptations and focusing (Ardila, 2008; Diamond, 2013). Further, EFs are responsible for activities of high-level thought, multi-tasking, and sustained attention (Bialystok, Craik, & Luk, 2012). Therefore, EFs are said to be central for academic achievement (Bialystok et al., 2012).

Studies investigating the effects of bilingualism on EFs have focused on three domains: inhibition, the ability to suppress attention to misleading aspects in order to attend to the appropriate stimuli; switching, the ability to switch from one task to another; and working memory, the ability to temporarily hold information for processing (Miyake et al., 2000). It has been strongly suggested that EFs are involved in the process of selecting between languages; this happens when the non-target language is inhibited for the use of the target language (Bialystok et al., 2012). As previously mentioned, a bilingual's mind constantly deals with linguistic conflicts of competing language representations (Grundy, 2020; Kroll et al., 2012), with neuroimaging research suggesting that this process involves domain-general EFs (Green & Abutalebi, 2013). More explicitly, it has been suggested that bilinguals' constant practice of juggling the two languages leads to benefits in non-linguistics tasks. Supporting this prediction, many studies reported a bilingual *advantage* in different tasks measuring the different components of EFs, as bilinguals often show higher performances in EF skills when compared to monolinguals of the same age and the same background (Bialystok et al., 2012). Amongst this body of research is a series of studies by Bialystok et al. (e.g., Bialystok, Craik, Klein, & Viswanathan, 2004; Bialystok, Craik, & Luk, 2008) in which bilinguals outperformed monolinguals in the Simon task that measures inhibition. In this task, participants are asked to respond to stimuli appearing on the screen (e.g., a square) by pressing a key response (a button on a keyboard). The participants have to indicate the colour of the square by pressing the corresponding button (e.g., red or green). In Congruent trials, the key response and the stimuli are located on the same side. In Incongruent trials, the key response and the stimuli are located on different sides. The bilingual advantage in this task is typically found in a smaller Simon effect, that is, a smaller difference between Congruent and Incongruent trials in bilinguals compared to monolinguals. Similarly, there is evidence for a bilingual advantage in the Colour–shape task measuring switching, where participants are asked to indicate if the two pictures that appear on the screen (squares or circles in blue or green) have either the same colour, or the same shape (Gold, Kim, Johnson, Kryscio, & Smith, 2013; Prior & MacWhinney, 2010). If the cue presented is the word *colour*, the participants have to focus on the colour of the pictures and ignore the shape. If the cue presented is the word *shape*, the participants have to focus on the shape of the pictures and ignore the colour. In Stay trials, the participants will match the pictures either on the basis of shape, or colour. In Change trials, the participants will have to switch between colour and shape. The bilingual advantage is found in smaller switching cost, indicated by a smaller difference between Stay and Change trials. Bilinguals also showed advantages in Corsi blocks measuring working memory, where participants are presented with a sequence of boxes; the sequence is simple to begin (e.g., two boxes), and then becomes more difficult (Bialystok et al., 2008; Luo, Craik, Moreno, & Bialystok, 2013). In Forward trials, the participants have to click on the boxes in the same order they appeared. In Backward trials, the participants have to click on the boxes in the reverse order. The bilingual advantage is typically expressed as the ability for bilinguals to recall longer sequences than monolinguals.

While there is literature reporting a bilingual advantage in children, young adults and also older adults (for a review, see Valian, 2015), there is generally less consistent evidence for the bilingual advantage in young adults than in the other two groups (Berkes, Calvo, Anderson, & Bialystok, 2021). The limited evidence for a bilingual advantage amongst young adults has been explained by the Peak Performance Hypothesis. Accordingly, as young adults are at the peak of their cognitive performance, bilingualism does not offer any additional boost (Bialystok et al., 2005). Bialystok et al. (2005) also explained that this particular group are very familiar with computers, therefore performing EF tasks using computers is highly suited to the interest and skills of young adults. This is supported by a number of studies reporting that both bilingual and monolingual young adults exhibited a reaction time advantage (very fast responses), and a very small cognitive cost (the difference between control and challenging conditions) (for a review, see Bialystok et al., 2005). However, Samuel, Roehr-Brackin, Pak, and Kim (2018) noted that the notion that the bilingual advantage is rarely found in this age group remains a hypothesis challenged by a number of studies reporting a bilingual advantage in young adults using different tasks (see Costa, Hernández, & Sebastián-Gallés, 2008; Linck et al., 2008; Prior & MacWhinney, 2010).

The effect of bilingualism on cognition continued to be viewed positively in general, until recently when studies emerged indicating no bilingual advantage in EFs. The lack of the bilingual advantage was reported in a number studies assessing children, young adults and older adults (for a review, see Valian, 2015). According to Paap, Johnson, and Sawi (2015), more than 80% of the bilingual studies conducted after 2011 yielded null results. Not only that, but those studies that indicated a bilingual advantage often had a small sample size, and most of the studies that attempted to replicate the same findings with a larger sample size failed to do so (see Gathercole et al., 2014; Paap et al., 2015). Similarly, in a meta-analysis of 152 studies, including unpublished research, Lehtonen et al. (2018) concluded that there is no evidence for a bilingual advantage in inhibition, switching, or working memory. Furthermore, it was suggested that the bilingual advantage interacts with some life experiences that we, so far, know little about, such as music training and video gaming

(Valian, 2015). Given the increased attention these activities require, it was found that musicians and video game players show enhancement in a variety of EF tasks when compared to non-musicians or non-active video game players (Amer, Kalender, Hasher, Trehub, & Wong, 2013; Green, Li, & Bavelier, 2010). This led many to argue that it is not merely bilingualism, but also other experiences that enhance EFs (Antón et al., 2016; Calvo & Bialystok, 2014). The real challenge in investigating factors, or life experiences, relating to EFs lies in the fact that we have limited exposure to studies that report a lack of a bilingual advantage in comparison to studies that report a bilingual advantage. This is supported by Paap et al. (2015), who reported that only 29% of the published studies are those that report either mixed results or no bilingual advantages. Similarly, after reviewing conference abstracts and published studies, de Bruin and Della Sala (2015) concluded that studies reporting a bilingual advantage are more likely to be published than studies reporting results that challenge the bilingual advantage (see de Bruin & Della Sala, 2015).

Different factors have been investigated as potential moderators of EFs, and amongst these factors is socio-economic status. It was suggested that since socio-economic status correlates with health, education and income, it is logical to assume that it will also correlate with better EFs (Valian, 2015). However, studies that investigated the bilingual advantage and controlled for socio-economic status have reported different results; for instance, after controlling for socio-economic status, Engel de Abreu, Cruz-Santos, Tourinho, Martin, and Bialystok (2012) found a bilingual advantage when comparing Portuguese-Luxembourgish bilinguals to Portuguese monolinguals in inhibitory control tasks. The same, however, was not found in a large study where there was no difference between Basque-Spanish bilingual and Spanish monolingual children in inhibitory control tasks, even after controlling for the socio-economic status

(Duñabeitia et al., 2014). Another factor that has been investigated is immigration status, where it was reported that the bilingual advantage is likely to be found in research that controls for immigration status in comparison to research that does not control for this factor (see Paap et al., 2015). However, Kirk, Fiala, Scott-Brown, and Kempe (2014) found no evidence for a bilingual advantage when comparing immigrant bilinguals (Bengali, Hindi, Malay, Punjabi and Urdu-English), non-immigrant bilinguals (Gaelic–English), and English monolinguals in the Simon task measuring inhibition. The authors concluded that these findings are unrelated to immigration status, and suggested that other factors such as conversational contexts could have influenced the results. These inconsistencies were also linked to different methodological choices (Zhou & Krott, 2016), and how bilinguals are labelled, such as using proficiency measures, language history or schooling (Surrain & Luk, 2019). Surrain and Luk (2019) argued that it is difficult to understand the effects of bilingualism without agreeing how bilingualism should be assessed across all studies. The authors also highlighted the importance of reporting the different sociolinguistic contexts of bilinguals, as this could indicate different language usage that may influence the outcomes. In terms of data trimming choices, Zhou and Krott (2016) analysed the trimming procedure, and the maximum response time per trial allowed in 68 experiments from 33 different articles comparing inhibition abilities in bilinguals versus monolinguals in three commonly used non-verbal interference tasks, namely, Simon, Stroop and Flanker. The authors found that the bilingual advantage is most likely to be found only when slow responses are included in the analyses. The authors concluded that regardless of the specific age group tested, trimming response times is likely to eliminate the bilingual advantage. In an attempt to solve the debate regarding the bilingual advantage on EFs, Donnelly, Brooks and Homer

(2019) analyzed 80 studies that compared the performances of bilinguals and monolinguals in non-verbal interference tasks. The authors concluded that there is a small, but still significant evidence for a bilingual advantage in interreference costs. Interestingly, this advantage was seen in studies involving late bilinguals rather than early bilinguals. In another meta-analysis of 167 studies examining the effects of bilingualism on EFs, Grundy (2020) concluded that even if group differences between bilinguals and monolinguals are rare, these differences always favor bilinguals. Grundy (2020) highlights the need for researcher to focus on when, rather than if, bilinguals outperform monolinguals.

The debate regarding the bilingual advantage has become heated in past years, with mixed results becoming the norm in the field. One way of resolving this is going back to the source of the bilingual advantage. As already mentioned, the root for the suggested bilingual advantage comes from the ability to switch between the two languages, due to the belief that the ability to suppress one language and use the other is a key factor in advanced inhibition (Yang, Hartanto, & Yang, 2016). Therefore, varying levels of language switching could have different impacts on how bilinguals perform on EF tasks. Green and Abutalebi (2013) attempted to address this issue by introducing the Adaptive Control Hypothesis (ACH), which will be central to this thesis.

1.4. The Adaptive Control Hypothesis

In their ACH, Green and Abutalebi (2013) identified three conversational contexts that apply to bilinguals. These contexts impose varying levels of switching, which in turn may impose different control demands, potentially resulting in different types and/or amount of impact on EFs. The contexts are (a) the Single Language Context (SLC), where each language is used in a separate context, allowing for minimal switching between the two languages; (b) the Dual Language Context (DLC), where both languages are used in one context, and switching between the two languages happens between two sentences but not within one sentence; and (c) the Dense code-switching Context, where speakers switch between two languages in one utterance. Green and Abutalebi (2013) also identified eight control processes and the demands imposed on these processes in each context: goal maintenance, conflict monitoring, interference suppression, salient cue detection, selective response inhibition, task disengagement, task engagement, and opportunistic planning. According to Green and Abutalebi (2013), the DLC requires greater interference control than the other two contexts because it does not allow for switching within one utterance, followed by the SLC, and finally the Dense code-switching Context. Therefore, bilinguals in the DLC are predicted to have more enhanced cognitive control compared to bilinguals in other contexts, due to the greater level of interference they need to control (Green & Wei, 2014) (see Table 1.1). This means that bilinguals in the DLC engage and show enhancement in the majority of the control processes, except for opportunistic planning that refers to adapting words from one language into the syntactic structure of another language, which can only be seen when switching happens within one utterance. Furthermore, bilinguals in the SLC are also expected to exhibit enhanced cognitive control compared to bilinguals in the Dense code-switching Context. This is because in the SLC, bilinguals have to constantly avoid switching (Green & Wei, 2014), and as a result, they are expected to show enhancement in tasks that tap into the processes of goal maintenance and conflict monitoring, which according to the ACH are the main processes that seem to be engaged by this context. Finally, for the Dense code-switching Context, individuals are expected to show enhancement only in opportunistic planning, as this is the only control process that is engaged in such environments.

Table 1.1: *Demands on language control processes in the three interactional contexts.*

Control Processes	Single Language Context	Dual Language Context	Dense code-switching Context
Goal maintenance	+	+	=
Interference control: conflict monitoring and interference suppression	+	+	=
Salient cue detection	=	+	=
Selective response inhibition	=	+	=
Task disengagement	=	+	=
Task engagement	=	+	=
Opportunistic planning	=	=	+

Note: Reprint from Green and Abutalebi (2013, p. 519).
Key: + : increased demands, = : neutral effect

It is important to note that many bilingual studies have supported the ACH and its potential role in explaining the inconsistencies found in the literature on bilingual advantages (Hartanto & Yang, 2016; Henrard & van Daele, 2017; Struys, Woumans, Nour, Kepinska, & van den Noort, 2019). A good example is the study by Henrard and van Daele (2017), who assessed 180 participants aged 24–65 years and divided into three groups: bilingual translators, bilingual interpreters, and monolinguals. Computerised tasks were designed to assess different components of EFs: the speed of information processing was assessed using a reaction times task, where participants had to respond to a cross appearing on the screen as soon as they saw it. The participants had to respond to the cross by either using the keyboard, or producing the word *cross* in a voice key. Updating was assessed using the Letter Memory task, where participants were asked to recall the last four letters of a list of letters that was briefly presented. The list of letters could contain either four letters, or twelve letters.

Inhibition of a prepotent response was assessed using the Antisaccade task, where the participants were asked to fixate on a certain target (e.g., a black square). A stimulus (e.g., an arrow) was then presented on either the left or the right side of the square. If the arrow appears on the right side of the square, the participants should avoid looking towards the left side and look towards the right instead. Flexibility was assessed using the Plus–Minus task, where the participants were asked to either add or subtract three numbers of a list of 30 numbers that appeared on the screen. Finally, resistance of proactive inhibition was assessed using the Brown–Peterson task, where the participants had to memorise three consonants, say the consonants in a reverse order, and then repeat the consonants in their original order. The results showed enhanced performances by interpreters and translators compared to monolinguals in the Brown–Peterson and the Plus–Minus tasks, that is, in tasks tapping flexibility and inhibition. According to the authors, the results can be explained by the ACH as both interpreters and translators belong to a DLC. The authors supported the ACH by highlighting the importance of the bilingual experience modulated by context and the amount of switching. Moreover, Henrard and van Daele (2017) noted that the bilingual advantage was not found in young bilinguals (both interpreters and translators), who were in the early stages of their career, suggesting that more experience in switching results in more enhanced EFs. The authors also highlighted that most of the tasks used were verbal tasks, which may have led to interference between the participants' verbal abilities and their performances on EFs. This is supported by studies showing that enhanced verbal abilities lead to enhanced performances in EFs (Bialystok et al., 2004). The authors also found advantages by interpreters in the other tasks when compared to the rest of the groups. They hypothesised that interpreters use different inhibitory control processes in their work activity; unlike translators, under time pressure interpreters have to deliberately and actively ignore less relevant information. This means that interpreters are more trained and have more experience in ignoring irrelevant aspects, which eventually leads to better performances in inhibition tasks. However, Henrard and van Daele's (2017) study lacks the inclusion of a bilingual group that would belong to a different conversational context (e.g., the SLC). This addition would have confirmed if the reported results were influenced by a general bilingual advantage, or by the specific properties of the DLC. In fact, most of the studies assessing the ACH have supported the predictions of the ACH for the DLC in bilingual environments (see Hartanto & Yang, 2016; Henrard & van Daele, 2017; Struys et al., 2019). However, the validity of the ACH also depends on confirming the predictions of the ACH in other contexts, and other language environments, which may impose different EF demands. This thesis aims to test the predictions of the ACH for the SLC, as proposed by Green and Abutalebi (2013). To do this, we have used diglossia as an example of the SLC. According to the ACH, the SLC taps goal maintenance, which means that enhancements are predicted for diglossics in tasks measuring goal maintenance. This is in contrast to the DLC, which taps many processes (goal maintenance, interference control, salient cue detection, selective response inhibition, task engagement and task disengagement), where individuals are expected to show enhancements in tasks measuring these processes. Therefore, if we are able to find enhancements in tasks measuring goal maintenance in diglossia as an example of the SLC, and compare these to that of the DLC, this will provide additional support for the ACH.

1.5. Executive Functions and bidialectalism/diglossia

While a large number of studies is available on the relationship between bilingualism and EFs, the relationship between speaking two varieties of one language (e.g., bidialectalism and diglossia) and EFs is still a growing field with limited studies. Diglossia is a situation where two varieties of one language exist, one of these varieties is known as a high (H) or a Standard variety, used for formal purposes, while the other one is known as a low (L) or colloquial variety, used for informal purposes (Ferguson, 1959). Bidialectalism is when the H and the L of diglossia break into a number of varieties (Rowe & Grohmann, 2013).

While both diglossia and bidialectalism have in common the co-existence of H and L, there are notable differences between the two terms. From a linguistic perspective, in bidialectalism the two varieties are grammatically and phonologically more similar, while in diglossia they are more divergent; this means that the H in diglossia is more complex and highly codified while the L is less complex (Ferguson, 1959). From a social perspective, in diglossia, the H variety is strictly used for formal purposes while the L is used for informal settings. On the other hand, in bidialectalism the two varieties are *overlapping*, this means that both L and H can be used for formal purposes. Finally, in diglossia code-switching depends on activity (e.g., writing or speaking), while in bidialectalism code-switching is based on situational factors, such as if the addressee understands the variety (Masica & Sinha, 1986).

When it comes to bilingualism and bidialectalism/diglossia, it has been suggested that just like speaking two different languages, different varieties of one language also have different lexical and phonemic systems (Ross & Melinger, 2017; Saiegh-Haddad & Joshi, 2014). It was also suggested that just like bilinguals, bidialectals and diglossics practise inhibition, which should translate into enhanced EF abilities for these populations (see Antoniou, Kambanaros, Grohmann, & Katsos, 2016; Scaltritti, Peressotti, & Miozzo, 2017). However, there are also some linguistic and social differences between bilingualism and bidialectalism/diglossia. Linguistically, it is suggested that there are more similarities in terms of grammar, vocabulary and phonology in speaking two varieties than in speaking two distinct languages (Scaltritti et al., 2017). Socially, it has been suggested that in bidialectalism/diglossia there are social norms which impose a separation between each variety in a different context, resulting in less opportunities for code-switching than bilinguals who are expected to code-switch within the same context (Scaltritti et al., 2017). However, it is important to highlight that, at least from a social perspective, it seems that there is generally no clear cut between the three terms bidialectalism, diglossia and bilingualism. This means that not all bilinguals belong to the DLC, in fact bilinguals can be found in all three contexts of the ACH (Green & Abutalebi, 2013). Similarly, not all bidialectals/ diglossics belong to the SLC.

Investigating bidialectalism/diglossia would constitute a fresh and new angle in exploring the potential advantages of dual language use on EFs. Crucially, testing Green and Abutalebi's (2013) ACH on samples speaking two language varieties instead of two languages is appropriate for two reasons. First, the context in which each variety is used is clearer in such environments. Indeed, perhaps the most distinguishing factor between bilingualism and bidialectalism/diglossia is that in the latter situations there is often a Standard and a local or everyday variety, and cultural identities and societal norms often impose a separation between the Standard and the local variety in each context (Rowe & Grohmann, 2013; Scaltritti et al., 2017). Second, the fact that we still have limited studies conducted on bidialectalism and diglossia makes such investigations potentially helpful in drawing a clearer picture of the effects of switching in these environments and the impact on EFs.

From a wider perspective, previous studies investigating the relationship between bilingualism and EFs continue to yield mixed results. There is no doubt that for the ongoing debate to be solved, it needs to be tackled from another perspective. Green and Abutalebi's (2013) ACH provides a different perspective for investigating the cognitive effects of bilingualism in different contexts. Tackling the debate of the bilingual advantage solely on the basis of the amount of switching embedded in contexts resembles a contemporary method that is highly needed. Additionally, the new direction towards investigating the cognitive advantages in diglossic/bidialectal environments makes it appropriate to focus on SLCs, especially since the literature is already starting to show some mixed results. Thus, this thesis aims to explore the relationship between SLCs, found in diglossia and bidialectalism, and EFs. Most importantly, if conversational contexts and the amount of switching prove to be essential in bidialectal and diglossic studies, then this should be an important factor to consider in bilingual studies. Further, this thesis will be the first to compare the predictions of the ACH in two different contexts: the SLC for diglossics and the DLC for bilinguals. This will allow for drawing a clearer picture on the effects of speaking two languages/varieties on cognition as modulated by context, it will also allow for comparing the different control processes to be enhanced in the SLC to that of the DLC.

1.6. This thesis

This thesis comprises three papers testing the role of the SLC in modulating performances in EFs. The first part is a review paper, and the first one to review all available studies that examined the relationship between bidialectalism/diglossia and EFs. Evidence from these studies was viewed in relation to Green and Abutalebi's (2013) ACH. These studies show that bidialectalism does not show consistent advantages in EFs, however, the two available studies on diglossia report a diglossic advantage. In this paper, it is pointed out that the only two studies investigating the effects of diglossia on EFs were conducted in Cyprus, where the diglossic situation was characterised as transitioning into type B diglossia or *diaglossia* (Rowe & Grohmann, 2013). This means that use of the Standard/H is no longer restricted to written purposes, but also extends to oral communications. In diaglossia, code-switching is more related to situations than purposes (speaking/writing) (Auer, 2005; Rowe & Grohmann, 2013). Therefore, we hypothesize that the results of the two studies on diglossia are related to the unique diglossic situation in Cyprus, which may not apply in other diglossic situations. Conversely, there is evidence suggesting that Arabic resembles a typical diglossic situation with a rigid correspondence to the SLC (see Amara & Mar'I, 2002).

The previous observations motivated our second paper, an empirical study conducted to investigate the relationship between diglossia and EFs in young adults in Saudi Arabia. In this study, we take Arabic as an example of the SLC proposed by Green and Abutalebi (2013). We compared the performance of Arabic diglossic young adults to English monolingual young adults in the three components of EFs (Miyake et al., 2000); for inhibition, two tasks were used, Flanker task measuring non-verbal inhibition, and Stroop task measuring verbal inhibition, while for switching the Colour–shape task was used, and finally for working memory the Nback was used. All of these tasks are typical tasks used to measure EFs (see Valian, 2015). We expected enhanced performances by diglossics compared to monolinguals in Flanker and Stroop tasks, expressed as a smaller cognitive cost (smaller difference between challenging and control conditions). This is because the ACH predicts that goal maintenance will be in high demand in the SLC and DLC, which should result in enhanced performances in the Flanker and Stroop tasks. Furthermore, we did not predict any enhanced performances by diglossics in the Colour–shape task tapping the processes of task engagement, task disengagement and selective response inhibition. This is because the ACH predicts enhanced performances in these processes in the DLC only, as speakers in the DLC are trained to speak a certain language (task engagement), and to stop speaking this language (task disengagement). Selective response inhibition is found when speakers in the DLC need to change the goal (selecting one language or the other). Further, we did not predict any advantages by diglossics in the Nback task. This is because the ACH did not predict any processes to be enhanced in the Nback task. We included a working memory task to exclude the possibility of a general cognitive advantage in diglossics. Results showed a diglossic disadvantage in Flanker RTs where the diglossics exhibited a larger Flanker effect than monolinguals, however, no difference in cognitive cost between diglossics and monolinguals was seen in the other tasks. The diglossics also yielded longer reaction times in all of the tasks compared to the monolinguals. We attribute the lack of any diglossic advantage to the rigid correspondence to diglossia in Arabic. However, the ACH doesn't explain the negative Flanker effect, and the slow RTs found in diglossics.

Considering that the bilingual advantage is controversial in young adults and more consistent in older adults (see Berkes et al., 2021; Valian, 2015), the last study was conducted to investigate the diglossic and bilingual advantages in older adults. Here, performances were compared using the same EF tasks in three groups of older adults: Arabic diglossics, English monolinguals and bilinguals. Including a bilingual group in this study allowed us to examine the predictions of the ACH in different contexts: the DLC for bilinguals, and the SLC for diglossics. Based on the predictions of the ACH, for the Flanker and Stroop tasks tapping goal maintenance we predicted enhanced performances by diglossics and bilinguals compared to monolinguals, expressed as a smaller cognitive cost. This is because the ACH predicts enhanced performances in goal maintenance in both SLCs and DLCs. For the Colour–shape task, tapping task engagement, task disengagement and selective response inhibition, we predicted enhanced performances by bilinguals only compared to diglossics and monolinguals, expressed as a smaller switching cost. This is because the ACH predicts enhanced performances in these processes only in the DLC. No enhancements were predicted by any group for the Nback task, as the ACH did not predict any control processes to be enhanced in the Nback task. We included a working memory task to exclude the possibility of a general cognitive advantage. Results revealed a diglossic advantage in Flanker RTs, expressed as a smaller Flanker effect in diglossics compared to bilinguals and a near significant effect when compared to monolinguals. Also, diglossics showed an advantage in Stroop RTs, expressed as a smaller Stroop effect in diglossics compared to monolinguals. However, no bilingual advantage was found in any of the tasks. We attribute the lack of a bilingual advantage to a number of factors such as: age of bilinguals, immigration status and amount of switching. All analyses for both empirical papers were performed using linear mixed models in R.

CHAPTER 2 : THE EFFECTS OF USING TWO VARIATIES OF ONE LANGUAGE ON COGNITION: EVIDENCE FROM BIDIALECTALISM AND DIGLOSSIA

Abstract

Although the question of whether and how bilingualism affects Executive Functions has been extensively debated, less attention has been paid to the cognitive abilities of speakers of different varieties of the same language in linguistic situations such as bidialectalism and diglossia. Similarly to the bilingual situation, in bidialectalism and diglossia speakers have two language varieties that are active at the same time. However, these situations have been argued to potentially provide fewer opportunities for mixing or switching between the varieties, which may in turn lead to different cognitive outcomes than those reported in bilingualism. Here we review the available evidence on the effects of bidialectalism and diglossia on cognition and evaluate it in relation to theories of the effects of bilingualism on cognition. We conclude that investigations of bilingualism, bidialectalism and diglossia must take into account the conversational context and, in particular, the opportunities for language switching that this affords.

2.1. Bilingualism and Executive Functions

The relationship between bilingualism and cognition has been the subject of considerable research for almost two decades. It is generally accepted that, in the bilingual mind, both languages are constantly active (Bialystok et al., 2012); consequently, to use the appropriate (target) language, bilinguals must constantly prevent intrusions from their non-target language according to the context in which they find themselves (Carlson & Meltzoff, 2008). This perpetual cognitive challenge was suggested to enhance inhibition abilities in bilinguals compared to monolinguals, with benefits that extend beyond language control to enhanced domain-general cognitive performance, including executive control (Kroll & Bialystok, 2013).

Inhibition, switching and working memory are a set of cognitive abilities that underlie executive control (Miyake et al., 2000). Each of these abilities is measured with different behavioural tasks. Inhibition, or inhibitory control, is often measured by tasks tapping into the ability to suppress attention to, or ignore, irrelevant or misleading aspects in order to attend to the appropriate stimuli. These include the Flanker (Eriksen & Eriksen, 1974), Simon (Martin-Rhee & Bialystok, 2008), and Stroop tasks (Stroop, 1935), and it has been argued that they may even tap different subcomponents of inhibition (for a discussion, see Poarch & van Hell, 2019), although the validity of such tasks remains controversial (Paap, Anders-Jefferson, Zimiga, Mason, & Mikulinsky, 2020). Switching is often measured using tasks that tap into the ability to switch rapidly from one task to the other, such as the Colour-sorting task (Piper et al., 2012) and the Colour–shape task (Miyake, Emerson, Padilla, & Ahn, 2004). Finally, working memory refers to the ability to temporarily hold information in mind for processing purposes, and is commonly measured using tasks such as the Backward Digit

Span (Wechsler & Psychological Corporation, 1949), and the Backward Dot Matrix (Alloway, 2015) (for a recent comprehensive discussion of the Executive Functions (EFs) tasks used in bilingualism research, see Poarch & Krott, 2019).

In the bilingual literature, all three domains have been tested and, when effects of bilingualism are claimed, these seem to most commonly affect inhibition (Bialystok et al., 2012; Emmorey, Luk, Pyers, & Bialystok, 2008; Luo et al., 2013; Poarch & van Hell, 2012). Specifically, bilingual children (Poulin-Dubois, Blaye, Coutya, & Bialystok, 2011), young adults (Pelham & Abrams, 2014), and older adults (Bialystok et al., 2004) have been shown to outperform monolingual controls in a series of tasks tapping the different domains of EFs (for a review, see Valian, 2015). These effects have been typically called *bilingual advantages*, a term that has received a lot of scrutiny and remains controversial (for a discussion, see Poarch and Krott. 2019). For the purposes of the review, we will follow the authors of the original studies that we review and use the term *advantage* for those cases where bilingual/bidialectal/diglossic groups outperformed monolingual controls in the aforementioned tasks. Notably, while there is evidence for similar advantages in *multilingual* adults when compared to monolingual controls (Limberger & Buchweitz, 2014), such evidence has not been reported for multilingual children (Schroeder & Marian, 2017). Schroeder and Marian (2017) noted that this could be because multilingual children have not fully developed the cognitive advantage of multilingualism, or that multilingualism does not necessarily increase EFs demands beyond the level of bilingualism.

While some studies that reported bilingual advantages highlighted the importance of controlling for factors such as the socio-economic situation (Engel de Abreu et al., 2012), age (Bialystok et al., 2005), and education (Luo et al., 2013), other studies failed to find a link between bilingualism and EFs, sometimes after controlling for these factors (Duñabeitia et al., 2014; Gathercole et al., 2014; Kousaie & Phillips, 2012; Morton & Harper, 2007). This has led to a vivid debate on whether such advantages actually exist (Paap et al., 2015; Valian, 2015), which has also been supported by recent meta-analyses showing that such effects may not be reliable (Gunnerud, ten Braak, Reikerås, Donolato, & Melby-Lervåg, 2020; Lehtonen et al., 2018; Paap, 2019). Several explanations for the discrepancy between studies have been put forward, including how bilingual groups are defined in different studies and how comparable they are in terms of their language and cultural experiences (Calvo & Bialystok, 2014; Pliatsikas, DeLuca, & Voits, 2020; Poarch & Krott, 2019; Surrain & Luk, 2019), and the linguistic distance between the spoken languages (Oschwald, Schättin, von Bastian, & Souza, 2018).

2.2. Bidialectalism and diglossia

It is of particular interest to examine the cognitive abilities of speakers of two varieties of the same language, where the language similarity is much higher than for typical bilingual speakers. The linguistic cases of bidialectalism and diglossia provide such degrees of similarity, yet remain under-researched in terms of their implications for cognition: both are characterised by the coexistence of a high (H) or Standard, and low (L) or social variety of the language. In both diglossia and bidialectalism, the L is used in domains such as the home, with social contacts, when shopping, and sometimes at work, while the H is used in formal situations (Masica & Sinha, 1986; Scaltritti et al., 2017). In both diglossia and bidialectalism, the L is typically used in more contexts than the H (Masica & Sinha, 1986). It has also been suggested that bidialectalism develops from the breakage of the typical H and L of diglossia into a number of varieties. Bidialectalism is also known as social dialectia (Karyolemou, 2006), bidialectalism, Standard with dialect (Papapavlou & Pavlou, 1998), or leaky diglossia (Rowe & Grohmann, 2013).

Despite their similarities, there are notable differences between diglossia and bidialectalism, particularly in terms of the relationship between the two varieties spoken. Bidialectals speak two highly similar varieties of a given language, one of which is the Standard form, and the other often a regional dialect, such as Italian and Venetian (Scaltritti et al., 2017). In diglossia, the two varieties are more divergent. The Standard (H) form used in written literature and learned through formal education is often highly codified and grammatically complex, while the L, used for everyday conversations and learned at home, is often less grammatically complex (Ferguson, 1959). Diglossia also differs from bidialectalism in two *functional characteristics* (Masica & Sinha, 1986). First, in diglossia, the uses of the two varieties are *exclusive*, while in bidialectalism they are *overlapping*. For example, in diglossia the H is strictly used in formal speeches, while the L is only used in informal settings. In bidialectalism, both the high and the low varieties can be used in formal speeches, depending on the audience. The second functional characteristic that distinguishes these two linguistic situations is the criteria for code selection. In diglossia, code selection is based on the activity (e.g., writing vs speaking). In bidialectalism, the variety to use is determined by situational factors, including whether the addressee understands each variety (Masica & Sinha, 1986). Moreover, in diglossia, it is a given that everyone understands the same L, and also the H (assuming a certain level of education has been achieved), while bidialectalism involves two overlapping speech communities, requiring the speaker to assess whether the addressee understands the regional dialect or not. Further, Rowe and Grohmann (2013) identified three criteria that separate diglossia from bidialectalism: (a) Bidialectalism occurs when the H is taking over the L, meaning that the H is likely to be used for formal and informal purposes, whereas in diglossia the H is typically perceived for formal purposes and the L for informal purposes. (b) What Keller (1982) calls a *native speaker test*. First, a typical diglossic situation does not include native H speakers who grow up in a context where the H is used in a typical L context, for example, home. Second, in bidialectalism native speakers do not encourage acquiring the L for outsiders, as this could be regarded as *encroachment* or *intrusive* to a form of solidarity that is specific to a certain group. This is opposite to diglossia, where everyone is expected to acquire both the L and the H. (c) Prestige type: in bidialectalism it is common for parents to avoid teaching their children the L, because the H is known to be a mark of education; conversely, in diglossia everyone is expected to acquire and use the L and the H in their appropriate domains. Moreover, avoiding using the L in diglossia is discouraged as it could be regarded as a sign of *anti-ethnicity* or a denial of *cultural heritage*. This leaves the L in diglossia un-stigmatised, despite the H being associated with prestige (Rowe & Grohmann, 2013). These three elements' criteria enforce the view that bidialectalism is a description of how people behave in a society, rather than a description of the society itself (Papapavlou & Pavlou, 1998). When attempting to distinguish diglossia from bidialectalism, it might be helpful to revisit Ferguson's (1959) main definition, which provides some features of diglossia that help us differentiate between diglossia and other linguistic situations such as bidialectalism or bilingualism (Abutalebi, Canini, Della Rosa, Green, & Weekes, 2015; Tsiplakou, 2020). These are: (a) function: the H is strictly used for formal situations, while the L is used for informal situations; (b) literary heritage: the vast majority of literature is written in the H, which includes religious textbooks; (c) acquisition: the L is naturally acquired, while the H is taught at schools; (d) standardisation: the H only is governed by grammar and a standardised writing system; (e) stability: diglossia often last for centuries, although over time diglossia may extend to *diaglossia*, which is a situation where the H is a mixed system of local and Standard dialects (Auer, 2005); (f) grammar: the H is more morphologically and syntactically complex than the L; (g) lexicon: the H includes all complex, scientific and technical terminology, while the L includes everyday objects (Tsiplakou, 2020); (h) phonology: the H and the L could share the same phonemic systems, or in other cases the L could be a subset of a bigger phonemic system found in the H—these additional phonemic systems may only be written, for example in French the contrast between /ü/ and /i/ in H production is not available for educated Haitian Creole speakers (Tsiplakou, 2020).

2.3. Diglossia/bidialectalism vs bilingualism

There are prominent similarities between bidialectalism/diglossia and bilingualism. Like two distinct languages, different varieties of a language may have different lexical, phonetic and syntactic systems (Ross & Melinger, 2017; Saiegh-Haddad & Joshi, 2014). However, there are both linguistic and socio-cultural differences between these situations. Linguistically, two varieties of one language will always be more similar than two distinct languages in terms of their grammar, vocabulary and phonology (Scaltritti et al., 2017). From a sociocultural perspective, bidialectal/diglossic individuals often view one of the varieties (typically the L) as *socially stigmatised* and the other (typically the H) as *prestigious*. In bilingualism, the two languages are more likely to have the same social status, although in some countries with a colonial history, such as India or some African nations, the use of a second language is associated with prestige (Mejía, 2002). Social stigma can also be found in bilingual settings where some minority languages are perceived as less prestigious such as Spanish among Hispanic populations living in the US (Mejía, 2002).

Perhaps the most important social difference between bidialectalism/diglossia and bilingualism is the nature and amount of code-switching between the two varieties or languages (Masica & Sinha, 1986). Bilinguals were argued to have more opportunities to switch between languages in the same context, because bidialectals and diglossics tend to use each variety in a different context (Scaltritti et al., 2017). In relation to the contexts defined in the Adaptive Control Hypothesis (ACH) (Green & Abutalebi, 2013), bidialectalism and diglossia may be good examples of the Single Language Context (SLC), when speakers use each language/variety in a different context (Masica & Sinha, 1986). It is true that individuals with two varieties typically use one variety in one context (e.g., at work) and another in another context (e.g., at home) (Masica & Sinha, 1986). Further, the Dual Language Context (DLC) and Dense code-switching Context are more likely to apply to bilingualism. In the DLC, speakers switch between the two languages with different speakers, while in the Dense code-switching Context speakers switch between languages within the same utterance. For example, (-ieren) as in *choisieren* is a German particle attached to a French verb (Green & Abutalebi, 2013). However, it is important to highlight that not all bilinguals correspond to the DLC, or the Dense code-switching Context. According to Green and Abutalebi (2013) bilinguals can be found in the three contexts (SLC, DLC and Dense code-switching Context). This means that bilinguals adapt to the different conversational contexts they find themselves in. However, speakers who primarily find themselves in one type of context will adapt to the particular control processes of that context (Green & Wei, 2014).

According to the ACH, of the three interactional contexts, the DLC requires the highest levels of language control due to the complexity of the goal maintenance, conflict monitoring and interference suppression requirements of this context. This was suggested to lead to the enhanced cognitive control skills of bilinguals in DLC compared to those in SLC and Dense code-switching Contexts (Yang et al., 2016). More clearly, in the DLC bilinguals engage in more switching between languages; being constantly exposed to the DLC enhances task switching ability relative to bilinguals in the other two types of context (Green & Abutalebi, 2013), although these effects are likely to interact with other factors related to the bilingual experience, including the age of second language acquisition (Ooi, Goh, Sorace, & Bak, 2018) and language usage (Pot, Keijzer, & de Bot, 2018). Subsequently, bilinguals in the SLC should be expected to demonstrate more enhanced EF skills than bilinguals in the Dense code-switching Context, as the latter are thought to require the least amount of cognitive control, simply because switches are permitted even within single utterances.

Based on this, the ACH can be used to predict that speakers in the DLC will show superior cognitive control to speakers in the SLC, whether in bidialectalism/diglossia or bilingualism. However, it would be wrong to conclude that bidialectals do not practise dialect inhibition, or that these language situations do not require cognitive control. Even an SLC enforces separation between the two varieties of the language, and this may require more control than in the Dense code-switching Context where two languages may be used. It is therefore of value to investigate the effects of bidialectalism and diglossia on domain-general cognition. The unique nature of the bidialectal/diglossic linguistic environments has led to differing, and sometimes contradicting, accounts of their potential effects on EFs. Some authors suggested that the bidialectal/diglossic requirement to acquire two languages that are highly similar in structure, phonology or grammar will lead to stronger demands on EFs (Linck, Kroll, & Hoshino, 2008). Similarly to the case of bilingualism, selection between two similar varieties of a language requires effort to inhibit the interference of the non-target variety, to reduce the cost of switching between the varieties and to reduce the monitoring of working memory content, leading to stronger EF abilities (Barac & Bialystok, 2012; Linck et al., 2008). Others suggested that the shared syntax, grammar and phonology of the two varieties should facilitate lexical access and language comprehension, reducing the need to engage the EFs relative to bilinguals (Oschwald et al., 2018).

In sum, bidialectalism and diglossia present valid test cases of the cognitive effects of juggling two varieties of a language, which can be assumed to be linguistically closer than two separate languages, and whether these depend on the relative usage of each variety, and the amount of switching between them. Crucially, studying bidialectalism/diglossia will add to our understanding of the effects to be expected in SLCs and whether the inconsistencies in the literature on the cognitive effects of bilingualism might be attributed to the different language contexts in which bilingualism occurs. The remainder of this paper will review the empirical evidence on the effects of bidialectalism and diglossia on cognition. In selecting studies to review here, the common denominator was that the speakers in all the studied environments spoke two varieties of the same language. We treated the few studies on diglossia in Cyprus as the only available examples of diglossic environments with an assumed strict separation of the two varieties of Greek (in the absence of evidence from other key environments such as the Arab world). The rest of the linguistic environments were classified as bidialectal ones, where the two varieties are less separated in context. We also chose to include Frisian–Dutch bilingualism in the latter group of studies because of the relative small linguistic distance between the two languages, and also because of the usage patterns that resemble bidialectalism (e.g., frequent switching, use of Frisian orally more than written) (Blom, Boerma, Bosma, Cornips, & Everaert, 2017; Muysken, 2000). Following the pattern of findings in the bilingual literature, evidence from children and from younger and older adults will be presented separately. Bidialectal studies will be presented first, followed by the studies on diglossia. Finally, conclusions will be drawn on how this evidence contributes to theoretical positions on the effects of bilingualism on cognition. We reiterate here that while in the reviewed studies the term *advantage* has been used, it does remain a controversial term that has led to mixed results and has limited implications for real-life experiences, and it was recently suggested that the term should be abandoned (Poarch and Krott, 2019).

Table 2.1: *Studies of the effects of bidialectalism and diglossia on Executive Functions*.

Group	Study	N	Language Pairs	Age (years)	EF	Tasks	Results
Children	Antoniou et al. (2016)	47 MUL 25 MON 64 DI	MULT: CG, SMG, other language MON: SMG DI: CG, SMG	4–12	Inhibition Working memory (WM) Switching	Soccer, Background Digit Span, Corsi block, Colour–shape	In all the tasks, diglossics performed better than monolinguals, but less than multilingual children. EF advantages can be achieved through language varieties.
Children	Blom et al. (2017)	44 BIL 44 MON 44 BID	BIL: Dutch, Polish MON: Dutch BID: Dutch, Frisian BID: Dutch, Limburgish	6–7	Inhibition, WM, Selective attention	Flanker, Backward Digit Span, Backward Dot, visual Sky Search	Sky Search: Frisian–Dutch Bidialectals, and proficient bilinguals, performed better than monolinguals. WM: No between-group differences. Flanker: Monolinguals responded faster to Incongruent trials than Congruent.

Children	Bosma et al. (2017a)	30 balanced BID 30 Dutch dominant BID	Frisian, Dutch	6–7	Inhibition, WM, Attention	Flanker-backward dot, Matrix, Sky Search	Digit Span and Sky Search: balanced bidialectals performed better than dominant bidialectals. Matrix task/Flanker: No between group-differences. Dialects-balance (proficiency) modulates EFs.
Children	Bosma et al. (2017b)	120 BID	Frisian, Dutch	Time1: 5–6 Time2: 6–7 Time3: 7–8	Inhibition, WM, Selective attention	Flanker, Backward Digit Span, Dot Matrix, Sky Search task	Sky Search: degree of bidialectalism predicted performance at time (1) only. Flanker, WM: No effect. The level of exposure to the minority language at home correlates with children's cognitive abilities.
Children	Ross and Melinger (2017)	54 BIL 45 MON 48 BID 49 BIL 21 MON 20 BID	BIL: Gaelic, English MON: English BID: Dundonian Scots, English	6–7	Inhibition, Switching	Simon, Flanker, Dimensional Change Card Sort (DCCS)	No between-group differences except for Simon accuracy, where bilinguals performed better.

							The more distant the two dialects, the higher the EFs.
Young Adults	Antoniou and Spanoudis (2020)	46 MUL 72 DI 47 MON	MUL: CG, SMG, other language DI: CG, SMG MON: SMG	18–30	Inhibition, WM, Switching	Flanker, Stroop, Nback, Cosri block, Rotation Span, Colour–shape, Number–colour	Multilingual and diglossics with high SMG vocabulary perform better than monolinguals. This advantage is not component specific, it is found across all EF components.
Young Adults	Poarch et al. (2019)	34 BID	Swabian, German	18–26	Inhibition	Flanker, Simon	Flanker, Simon: Swabian dominant bidialectals outperformed Swabian-German bidialectals. The level of exposure to the minority language correlates with performances on EFs.
Young Adults	Scaltritti et al. (2017)	55 BID 41 MON 56 BID	BID: Italian, Venetian, other dialects MON: Italian. BID: Italian, Venetian	22–23	Inhibition Inhibition	Simon, Flanker Flanker	Flanker, Simon: No between-group differences. Flanker: No between-group differences.

							Level of familiarity of the dialect does not correlate with higher EFs.
Older Adults	Houtzager et al. (2017)	50 BID 50 MON	BID: Frisian, Dutch MON: German or English	Middle aged: (35–56) Elderly: (65–85)	Switching, Working memory,	Colour-shape switching, Corsi block	Colour-shape switching: Bidialectal advantage in switching costs. Life-long experience of using two dialects leads to enhanced switching.
Older Adults	Hsu (2021)	20 MON 20 BID	MON: Mandarin BID: 10 Minnan, Mandarin 10 Hakka, Mandarin	61–71	Inhibition, Working memory	Nonverbal: Flanker (easy), Simon (easy), Stroop colour–word (intermediate difficulty), One back (intermediate) Verbal: Stroop colour–word (intermediate difficulty), Stroop day–night (intermediate	Nonverbal tasks: The bidialectal advantage is found only in the Stroop colour–word. Verbal tasks: bidialectal advantage in the Stroop colour–word and Stroop day–night. The bilingual advantage extends to bidialectalism only in tasks with high or intermediate level.

						difficulty), Number Stroop (easy), Stroop picture-naming (very difficult)	
Older Adults	Kirk et al. (2014)	23 BIL 32 MON 16 BID	BIL: English, other language MON: English BID: Dundonian Scots, English	80–89	Inhibition	Simon	No between-group differences.

Note: BIL: bilinguals, MUL: multilingual, MON: monolinguals, BID: bidialectals, DI: diglossics, SMG: Standard Modern Greek, CG: Cypriot Greek

2.4. Studies of Executive Functions in bidialectalism

2.4.1. Children

To date, four studies have investigated EFs in bidialectal children (see Table 2.1). Ross and Melinger (2017) tested English monolingual, Gaelic–English bilingual and Southern English bidialectal children speaking Standard English and Dundonian Scots. The children were between the ages of six and nine, and lived in Scotland or England. In experiment one, groups of children were tested using Flanker and Simon tasks. In experiment two, a subset of the same children were tested using an age-appropriate version of the Dimensional Change Card Sort test. The results revealed that the groups performed similarly across tasks, except for the Simon task, where bilingual children showed higher accuracy than the other groups. The study concluded that there was no evidence for a bilingual or bidialectal advantage across the three tasks, and the authors suggested that any advantages may be both task- and age-specific, as others also reported advantages in Simon tasks for bilingual children around five years of age (Morales, Calvo, & Bialystok, 2013). This might explain the very mixed results of studies that have investigated bilingual advantages in childhood. With respect to the group of particular interest here, the authors attributed the null finding of a bidialectal advantage to the close similarity of the two dialects. Although Standard English does differ from the Dundonian dialect, the authors noted that Standard English is not commonly spoken in Scotland. Instead, Scots switch between Dundonian and a form of *Scottish Standard English*, which is more similar to Dundonian Scots. Second, the Dundonian dialect is comprehensible to speakers of non-Scottish dialects. This indicates that the bidialectal situation in this study does not resemble bidialectal situations in countries where the local dialect substantially differs from the Standard dialect. Ross and Melinger (2017) argued that the more different the regional dialect is from the Standard dialect, the more effort that is needed to prevent interference, leading to greater demands on EF abilities. They suggested that future studies should involve bidialectal groups who speak distinctively different dialects.

Using more distant dialect pairs, Blom et al. (2017) investigated the potential cognitive advantages in bidialectal children and how they are modulated by dialect use. Four groups of participants were included: monolingual Dutch, two groups of bidialectal Dutch children who spoke the regional dialects of Frisian or Limburgish, and Dutch bilinguals who were exposed to a migrant language (Polish). All participants were aged six to seven years and were assessed using a battery of EF tasks including working memory, measured by Backward Digit Span and Backward Dot Matrix; inhibition, measured by the Flanker task; and selective attention, measured by the visual Sky Search task. The parents completed the Questionnaire for Parents of Bilingual Children (Tuller, 2015), which asks about parental educational level, language input, and language use at home. The parents of monolingual children completed a short version of the same questionnaire. The results revealed no significant differences between groups on most tasks, except for selective attention measured by the Sky Search task, where Frisian–Dutch bidialectals, and a subgroup of Polish–Dutch proficient bilinguals, outperformed the monolinguals.

Surprisingly, the children in all groups showed a negative Flanker effect, taking longer to respond to the Congruent trials than the Incongruent trials. This effect was significantly larger for the monolingual group than for the other three groups. The Frisian–Dutch bidialectals again showed cognitive benefits relative to the Limburgish–Dutch bidialectals.

The advantages shown by the Frisian–Dutch bidialectals were not modulated by the children's proficiency in their respective dialects. Therefore, Blom et al. (2017)

attributed their findings to the different conversational contexts and language uses of the two bidialectal groups. Specifically, while Dutch is the most important language of instruction for both groups, Frisian is also a language of instruction for Frisian–Dutch children, taught at school for at least one hour per week, whereas Limburgish is the language more widely used in the community by Limburgish–Dutch bidialectals. Thus, it is possible there is clearer language separation in the Frisian–Dutch context and more language mixing in the Limburgish–Dutch context. If contexts that allow frequent code-switching are less associated with cognitive control than those that impose stricter separation between languages, as claimed by Green and Abutalebi (2013), the observed Frisian–Dutch advantage is as it would be predicted under this framework.

Dialect use and its effects on EFs might also be modulated by dialect proficiency. Bosma, Blom and Versloot (2017) examined this by assessing Frisian–Dutch bidialectals in different language domains including receptive and expressive skills. The scores of the language assessments were used to divide the participants into two groups: Dutch-dominant and balanced Frisian–Dutch. Balanced bidialectals performed similarly in Dutch and Frisian across tasks, and Dutch-dominant bidialectals performed better on the Dutch versions of the tasks. As expected, the groups also differed in their exposure to Frisian at home, with Dutch-dominant children having less exposure to Frisian. The two groups were assessed on the Flanker task, a verbal working memory task (Digit Span), a visuospatial working memory task (Backward Dot Matrix), and the Sky Search task measuring selective attention. While balanced bidialectal children significantly outperformed Dutch-dominant bidialectals in the Digit Span task and the Sky Search task, the groups performed similarly in the other tasks. Therefore, Bosma et al. (2017a) suggested that the bidialectal advantage might be task-specific. However, the lack of monolingual or bilingual control groups, to compare bidialectals with, makes it difficult to draw conclusions in regard to the bidialectal advantage.

Using similar methods, Bosma, Hoekstra, Versloot and Blom (2017) went on to investigate firstly whether the degree of bidialectalism, defined as balanced proficiency in the two dialects, can predict children's performances on EF tasks over a three-year period; and secondly, whether home exposure to the regional dialect (Frisian) predicts EF ability, and whether this relationship is modulated by the degree of bidialectalism. The latter question was influenced by previous studies indicating that only children exposed to Frisian at home become proficient in both Frisian and Dutch (Dijkstra, 2013). Frisian–Dutch children were tested annually over three years, starting at age five to six years. The degree of bidialectalism was measured in terms of children's proficiency in receptive vocabulary and expressive morphology in both Frisian and Dutch. Receptive vocabulary was measured using Dutch and Frisian versions of the Peabody Picture Vocabulary Test in Dutch (Dunn & Dunn, 1997). Morphology was measured using the word formation subset of the Language Assessment all Children in both languages (Verhoeven & Vermeer, 2002). EF measures included the Flanker test of inhibition, the Sky Search task for selective attention, and Backward Digit Span and Dot Matrix working memory tasks.

The results revealed a significant correlation between the degree of bidialectalism and performance on the Sky Search task. However, this correlation was found only at the youngest age tested (five to six years), with a borderline significant correlation at age six to seven years, and no correlation at seven to eight years. There were no between-group differences in inhibition or working memory tasks. Bosma et al. (2017b) argued that this difference between age groups could be either due to the introduction of formal literacy in Dutch after the first measurement, which might have affected their performance, or alternatively the children may have become more proficient in both languages as a result of formal education, which may have made bilingual monitoring more automatic. However, the finding that the balance in children's Dutch and Frisian proficiency did not change over the three years of the study (as measured by receptive vocabulary and expressive morphology) undermines this account. The study also showed that both the intensity of exposure to Frisian at home and the degree of bidialectalism predicted EF scores. Intensity of exposure to Frisian predicted the degree of bidialectalism at all three ages, and the intensity of exposure to Frisian at home correlated with performance on the Sky Search task in the younger two age groups. After controlling for the degree of bidialectalism, the results showed no correlation between the intensity of exposure to Frisian at home and performance on the Sky Search task, indicating that bidialectalism mediated this relationship. The authors concluded that the level of exposure to the minority language at home correlates with children's cognitive abilities. The authors also concluded that selective attention, rather than inhibition, is the core skill that benefits from bidialectalism; however, this effect is not long-lasting and is seen only briefly in early childhood.

2.4.2. Young adults

Only two studies looked at cognition in bidialectal young adults (see Table 2.1). Scaltritti et al. (2017) investigated the roles of dialect familiarity and switching on cognition. Experiment 1 involved young adults (mean age= 23 years) who were native speakers of Italian and a Venetian dialect found in Padua and neighbouring regions (some participants also spoke other Italian dialects). The participants' responses to a questionnaire about their exposure to Italian and Venetian in different contexts (e.g., family, school, and friends) were used to compute a dialect familiarity score. These subjective measures of dialect familiarity failed to predict performance in the Flanker and

Simon tasks. Specifically, estimates of daily exposure to dialects failed to predict either the congruency effect, or the global effect (across the Congruent and Incongruent trials).

More objective measurements of dialect familiarity were taken in a second study that compared Italian–Venetian bidialectals to Italian monolinguals. The participants completed the same questionnaire as in Experiment 1, but their proficiency in the Venetian dialect was additionally assessed via a sentence completion (receptive language) task, and a spontaneous speech (expressive) task. EFs were assessed using the Flanker task. There were no between-group differences on the Flanker task, and the dialect familiarity scores failed to predict performance on the Flanker task. The authors attributed the lack of bidialectal advantage in their studies to the limited opportunities for switching between Venetian and Italian, reinforcing the view that bidialectalism in this region corresponds to an SLC.

Poarch, Vanhove and Berthele (2019) tested the hypothesis that more balanced usage of two dialects leads to better inhibitory control in a sample of bidialectal Swabian–German adults (mean age= 22.6 years). Dialect use was assessed using the Bilingual Language Profile (BLP) questionnaire (Birsong, Gertken, & Amengual, 2012), a self-reporting measure of German–English bilingualism adapted to measure bidialectalism. The BLP responses were used to split the participants into two groups according to their dialect use: Swabian-dominant and balanced Swabian–German bidialectals. The participants were assessed using two inhibitory control tasks: Simon and Flanker. Contrary to the authors' predictions, the Swabian-dominant bidialectals showed significantly smaller Flanker and Simon effects than the balanced Swabian–German bidialectals. This finding led Poarch et al. (2019) to conclude that performances on EF tasks are not related so much to a balanced usage of the two dialects, but rather to the amount of exposure to the minority language, a finding that is in line with Bosma et al.

(2017b). Crucially, Poarch et al. (2019) also pointed out that bidialectal children are more likely to be literate in the majority language only, which might have an effect on the patterns of language use and performance, and consequently, any observable effect of these patterns on cognition. From a methodological standpoint, Poarch et al. (2019) also highlighted that different authors take different *arbitrary* statistical decisions, such as whether or not to transform the data, or to include or exclude some data points. In their conclusion, the authors recommend future studies to minimalise these arbitrary decisions, something that could lead to less mixed results.

2.4.3. Older adults

To date, only three studies have investigated the potential cognitive advantages associated with bidialectalism in older adults (Table 2.1). Kirk et al. (2014) compared performance on a Simon task between Gaelic–English bilinguals, bilingual immigrants to the United Kingdom (UK) who were speakers of English and an Asian language (including Bengali, Gujarati, Hindi Malay, Punjabi and Urdu), Dundonian Scots–English bidialectals, and English monolinguals, all over the age of 60 years. The participants completed an adapted version of the LEAP-Q: Language Experience and Proficiency Questionnaire (Marian, Blumenfeld, & Kaushanskaya, 2007) as an assessment of their proficiency in the tested dialects, and the vocabulary subset of the Wechsler Abbreviated Scale of Intelligence (Wechsler & Psychological Corporation, 1949), as an assessment of their English proficiency. The results showed no group differences. Kirk et al. (2014) explained their null finding in terms of the participants' schooling contexts, which they used as a proxy for the interactional contexts defined by Green and Abutalebi (2013). The Gaelic–English bilinguals had been educated only in English, and the Asian language–English bilinguals had completed their education in just their first language, both providing an SLC. Kirk et al. (2014) argued that if the interactional context plays a role in enhancing EFs, SLCs, with their lack of opportunities for dual-language use, might not result in domain-general cognitive advantages. However, the authors did not provide information about the schooling context of bidialectals, or use this to explain the results for this group.

In a different study, Houtzager, Lowie, Sprenger, and de Bot (2017) aimed to answer the question of whether a life-long experience of bidialectalism can result in enhanced switching abilities. Because the authors suspected that an age-related decline in working memory can interact with performances on switching tasks, working memory was assessed and used as a factor in the analysis, along with age. Fifty Frisian–Dutch bidialectals, and 50 German, or English monolinguals were administered in a cued Colour–shape switching task, and a Corsi blocks working memory task. The participants were divided into two age-groups: middle aged (35–56 years), and elderly (65–85 years). The participants were matched on demographical factors such as socio-economic status, as indicated by educational and occupational levels. For the switching cost, known as the difference between repetition and switching trials in the Colour–shape task, bidialectals have exhibited smaller switching costs than monolinguals. The authors argued that their results provide evidence for the bidialectal advantage in task-switching, and that this is most likely to be caused by the life-long experience of using two dialects. The authors also suggested that the inconsistency found between their study and other studies, reporting no advantage, could be related to different task configurations.

More recently, Hsu (2021) investigated whether cognitive advantages, similar to those reported for bilingual older adults, can be found amongst bidialectal older adults, and whether these cognitive advantages will be consistent across verbal and non-verbal tasks with different levels of difficulty. In order to do so, Hsu administered two experiments to 20 Mandarin monolinguals (mean age= 67.7, SD= 4.3), 10 Minnan–

Mandarin bidialectals (mean age= 68, SD= 4.7), and 10 Hakka–Mandarin bidialectals (mean age= 68.7, SD= 4.5). In Experiment 1, four non-verbal tasks were administered with different difficulty levels, including a Flanker task (easy), a Simon Colour–shape task (easy), a spatial One back task (intermediate) and a Stroop colour–word task (difficult). The results showed no bidialectal advantage in either Flanker, Simon or One back tasks. However, a bidialectal advantage was found in the Stroop colour–word task. Hsu (2021) suggested that the advantage in this specific task results from task difficulty, as the Stroop colour–word task is more difficult than the other tasks. This is because, unlike the Flanker and Simon, in the Stroop task both the target and the distractor are merged in one stimulus, which makes it more difficult to avoid interference from the distractor (Chen, 2003; Hsu, 2021). In Experiment 2, the same group of participants were tested in four verbal tasks with varying levels of difficulty: Stroop colour–word (intermediate), Stroop day–night (intermediate), Number Stroop (easy), and Stroop picture-naming (very difficult). A bidialectal advantage was found only in the two intermediate-level tasks. This led to the conclusion that bidialectal advantages will only be found in tasks with appropriate levels of difficulty (not too easy and not excessively difficult). Hsu (2021) concluded that the cognitive advantages of EFs extend beyond bilingualism to bidialectalism. However, this bidialectal advantage is found only in some tasks that include attentional and inhibitory control, with high or intermediate difficulty. Nevertheless, it is worth pointing out that the small sample size of this study, especially of the two bidialectal groups, does not warrant strong conclusions.

2.5. Studies of Executive Functions in diglossia

2.5.1. Children

Only one study has investigated the effects of diglossia on EFs in children. Antoniou et al. (2016) investigated the diglossic situation in the Republic of Cyprus, where Cypriot Greek (CG) is the L and Standard Modern Greek (SMG) is the H. One hundred and thirty-six children were divided into three groups: CG–SMG diglossics recruited from schools that offered traditional Greek-speaking programmes; multilingual CG–SMG diglossics who were also speakers of English (and, in some cases, additional languages), recruited from schools in Cyprus; and monolingual SMG children, who were recruited from schools in Greece. The participants were assessed on measures of working memory (Background Digit Span and Corsi block tasks), inhibition (Soccer task), and switching (Colour–shape task). Multilingual children performed better in the EF tasks than diglossic and monolingual children, which the authors attributed to the bilingual/multilingual's joint activation ability, namely the ability to jointly recruit different executive control components (Green & Abutalebi, 2013). Second, when differences in language proficiency were controlled for, diglossic children were also found to outperform monolingual children in all of the EF tasks. The authors proposed that diglossic children have an advantage in their ability to recruit different EF components, but to a lesser extent than multilinguals. According to that, any advantages afforded by diglossics may be more similar to those reported in bilinguals than in multilinguals. However, as the study did not include a bilingual group, this hypothesis remains untested. The study concluded that cognitive advantages could be achievable through the acquisition and use of language varieties (dialects), as well as through the learning of more than one language.

2.5.2. Young adults

Antoniou and Spanoudis (2020) closely followed the methods of Antoniou et al. (2016) when examining the effects of speaking more than one language or dialect on EFs in young adults. Their study design allowed them to explore whether a bilingual/diglossic advantage affects all, or only some, of the components of executive control. Seven EF tasks were administered to three groups of participants: 46 multilingual participants (speaking CG, SMG and another language), 72 diglossic participants (speaking CG and SMG), and 47 monolingual SMG speakers, with the latter group being Greek citizens who lived in Cyprus but who had worked or studied in Greece. Inhibition was tested using the Stroop and Flanker tasks. Working memory was tested using the Nback, Rotation Span and Corsi Blocks tasks. Switching was assessed using the Colour–shape and Number–colour tasks. All participants completed a Socioeconomic Status and Language Background Questionnaire, developed by the authors for the purpose of the study to establish language use in different domains, along with the socio-economic status and educational level. The participants also completed the Mill Hill Vocabulary Scale test (Raven, Court, & Raven, 1956) as an index of their proficiency in SMG. To explore the bilingual\diglossic advantage, an ANCOVA was performed with the group as a between-subject factor, EF tasks (WM, Inhibition and Switching) as a within-subject factor, and vocabulary as a covariate. The results replicated those reported in Antoniou et al. (2016), whereby multilinguals and diglossics with a high level of SMG proficiency outperformed monolinguals across the various EF tasks. When vocabulary ability was controlled for, there was no group by component interaction, confirming that the multilingual/diglossic advantage is found broadly across the EF sub-domains. The authors indicated that the groups did not differ in age, educational level, or socio-economic status, thus eliminating any concerns that these factors could have influenced the results.

2.6. Bidialectalism and diglossia as Single Language Contexts

As discussed earlier, any effects of using two languages (or two varieties of a language) on domain-general cognition might depend on the opportunities different contexts provide to switch between them. The studies reviewed above provided little evidence for any effects of bidialectalism on cognition. Evidence from diglossic environments remains extremely limited, but suggests some effects that could traditionally be interpreted as advantages; however, we remain cautious to not overinterpret these findings, given the scarcity of the evidence. The common denominator of bidialectalism and diglossia is that they are likely to correspond to SLCs, defined by Green and Abutalebi (2013) as situations where the two varieties of a language are reserved for different contexts, with minimal opportunities for language mixing and/or switching. If a cognitively challenging, long-term experience like controlling two languages that can be used interchangeably can have an effect on EFs, as shown by several studies of bilingualism, this review suggests that these effects should not be expected in SLCs, or Dense code-switching Contexts; this seems to be supported by the majority of studies to date, at least those on bidialectalism: Scaltritti et al. (2017) argued that Venetian–Italian bidialectals engage in much less switching between dialects than Catalan–Spanish bilinguals, and Blom et al. (2017) explained that Limburgish contexts require more code-switching than Frisian, which is in line with Green and Abutalebi (2013) who predicted less EF enhancement in Dense code-switching Contexts.

Few studies have investigated the effects of using dialects equally, or in a *balanced manner*, on EFs. Such contexts may be closer to the DLC as defined by the ACH, assuming that balanced use is a result of more opportunities to use both dialects in various context, and therefore more likely to lead to EF enhancement; some studies showed opposite effects (Bosma et al., 2017b; Poarch et al., 2019), suggesting that further study is warranted.

In contrast to bidialectalism, the two studies that have looked at the effects of diglossia on cognition found advantages in children (Antoniou et al., 2016) and young adults (Antoniou & Spanoudis, 2020). The discrepancy in the reported effects of bidialectalism and diglossia on cognition could be attributed to functional differences between the two situations. Specifically, in diglossia each variety is used in a special context, with the formal (H) variety used for writing purposes and the spoken (L) variety used for spoken language and everyday communication (Masica & Sinha, 1986). It is also important to note that the distinction between writing and speaking can be found in certain bidialectal environments such as Frisian–Dutch and Swabian–German, where bidialectals are likely to only be literate in the majority language (see Bosma et al., 2017a; Poarch et al., 2019). These functional distributions should translate into more rigid application of the SLC in diglossia than is the case in bidialectalism, and as a result, more limited need for language control, and less of a cognitive advantage. However, the results of the two available studies (Antoniou et al., 2016; Antoniou & Spanoudis, 2020) suggest the opposite pattern. This could be explained by the specific linguistic situation of CG, which was identified by Rowe and Grohmann (2013) as diglossic transitioning into type B diglossia or *diaglossia*, where the use of the Standard variety is no longer restricted to written purposes, but rather the use of the H extends to oral communications, and hence, code-switching becomes more related to situations than purposes (speaking/writing) (Auer, 2005), a situation that is more similar to bidialectalism. This tendency to use the H where the L is expected negates the clear separation between the two varieties in typical diglossia, and possibly allows for more switching between the two varieties than one would expect in diglossia. This is supported by the finding that in CG, switching between the two varieties happens frequently and naturally, sometimes even when the speakers do not intend it (Pavlou, 2004). This brings into question whether the language context in Cyprus should even be treated as diglossic, and whether any evidence we have from it can inform our knowledge of the effects of SLC on cognition.

It is important to note that no study to date has explored the differences between diglossia and bidialectalism, or how these impact on EFs (Masica & Sinha, 1986). Our limited knowledge of diglossia is accompanied by only a vague understanding of how speakers in diglossic environments use their H and L, which may vary across contexts. While the two available studies on diglossia reported a diglossic advantage in EFs (Antoniou et al., 2016; Antoniou & Spanoudis, 2020), both studies were conducted in Cyprus. It is important to highlight that speakers across different diglossic societies may vary considerably in terms of their exposure to a particular variety and the criteria they use for switching between the two varieties. Madau et al. (1996) reported that the Telugu community in India uses an H to write poetry and articles, but never for speaking purposes (Madau et al., 1996). In Greece, an H of Greek, *katharevousa*, was used until recently for formal documents and speeches, but now an L, *demotiki*, is used across the board and the H is becoming extinct (Kaye, 2001). In contrast, both the L and the H of Arabic are used for composing poetry in the Arab world (Kaye, 2001). The amount of exposure a speaker has to the H may be an important factor, as it was argued that diglossia can sometimes border on bidialectalism and even bilingualism, depending on how speakers are exposed to the H (Kaye, 2001). This strengthens our hypothesis that not all diglossic environments would produce the same results as Antoniou et al. (2016) or Antoniou and Spanoudis (2020), because exposure to the two varieties differs from one diglossic environment to another. It was argued that less exposure to a certain variety would lead to less switching between the two varieties, which may lead to less executive control ability (Kirk et al., 2014; Scaltritti et al., 2017).

One of the examples of a diglossic society where speakers are not often exposed to the H is the Arab world. It has been suggested that some native speakers of Arabic would find it difficult to understand complicated essays written in the H, and that an illiterate person in the Arab world would barely understand the H. It was also suggested that even an educated Arab would find it hard to carry on a conversation entirely in the H without needing to switch to the L (Kaye, 2001). Therefore, a study investigating the diglossic advantage in the Arab world might not replicate the pattern in Cyprus or Greece (Antoniou et al., 2016; Antoniou & Spanoudis, 2020).

The previously mentioned factors highlight the need for research in diglossic environments to take account of the level of familiarity speakers have with the H and the L, and the conversational contexts in which participants use these dialects. While both bidialectalism and diglossia belong to the SLC, the results of this review are highly suggestive of EF advantages in diglossia that are not seen in bidialectalism. This may be due to the greater syntactic and grammatical separation between the two dialects in diglossia, or to the conversational context in diglossic environments being more similar to the DLC than to the SLC. However, as both studies of diglossia were conducted in Cyprus, we cannot rule out the possibility that Cyprus might present a unique language context, and that the findings of these studies are not representative of diglossia in general. Further research with other dialect pairings is clearly required.

2.7. Implications for theories of cognitive advantages in bilingualism

If the context in which languages are used is key in explaining the lack of cognitive advantages in bidialectal studies, the inconsistent results of studies of bilingual speakers might be explained in a similar way. In fact, similar suggestions have already been put forward. For example, the lack of advantages in bilingual immigrants, especially those who reside in an English-speaking country, was attributed to the lack of switching in their conversational context (Kirk et al., 2014; Scaltritti et al., 2017). Immigrant bilinguals are likely to have acquired their first language from their parents and to use this language exclusively at home but rarely at work or in public, effectively operating in SLCs (Kirk et al., 2014.). This suggests that the SLC, rather than the DLC, applies to many bilingual environments. For example, Gaelic–English bilinguals, who often use English for formal, official and technical subject matters and Gaelic for informal conversations in domestic settings (Lamb, 2008; MacAulay, 1982, 1993) do not show bilingual advantages (Kirk et al., 2014; Ross & Melinger, 2017). The same is true of Sardinian–Italian bilinguals; Sardinian is used only for writing purposes, and Italian for spoken purposes, offering few opportunities for switching between languages, and effectively an SLC. Therefore, it is hardly surprising that studies have failed to find any bilingual advantage in EFs in Sardinian–Italian bilinguals (Garraffa, Beveridge, & Sorace, 2015; Lauchlan, Parisi, & Fadda, 2015). Bilingual situations in which each language is used in a specific context were even regarded as *extended diglossia* (Fishman, 1972). The term extended diglossia includes characteristics of bilingualism and multilingualism in a social community where two languages are used for different purposes. For instance, the situation in Paraguay can be considered diglossic because Spanish is used as the H, for professional or prestigious situations, while Guarani (an American Indian language), is used as the L for everyday communication (Fishman, 1972). It seems important to note that some theorists argued against Fishman's definition of extended diglossia; Hudson (2002), for instance, believed that the extended diglossia proposed by Fishman (1972) should be regarded as a form of *societal bilingualism* rather than diglossia. According to Hudson (2002), the two concepts, societal bilingualism and diglossia, extremely differ in their social origins, their developments, and resolutions. One thing in common between diglossia and extended diglossia or societal bilingualism is the use of each language in a different context (SLC), leading to less enhanced EFs. Whether it is extended diglossia, or societal bilingualism, the previous examples strengthen our argument that the label is not significant in modulating EFs; rather, it is how the speakers of that community use each language/variety.

Studies investigating EFs in bilingualism have also given little attention to the role of balance in the *use* of the bilingual's languages. According to Green and Abutalebi (2013), it is language use that distinguishes the three contexts. Bilinguals with balanced use of their two languages can be assumed to have more opportunities to use both of them, and switch between them, compared to those with imbalanced use, where one of the languages will inevitably be restricted to certain contexts and/or interlocutors, with limited opportunities for code-switching. Indeed, Guerrero et al. (2015) reported that bilingual children who speak their two languages at home in a balanced manner show smaller switching costs in tasks measuring attention and switching, compared to bilingual children who speak one language in a more dominant manner at home (Hartanto & Yang, 2016). Further, bilingual children who live in a home where their parents speak both languages were shown to outperform bilingual children whose parents speak only one language at home on a battery of inhibitory control tasks (Verhagen, Mulder, & Leseman, 2017). This particular finding corroborates the finding by Bosma et al. (2017a) that balanced bidialectal children performed better in the Digit Span task than Dutch-dominant bidialectal children. It was reported in several studies that bilinguals operating in DLCs show smaller switching costs than bilinguals in SLCs (Hartanto & Yang, 2016; Ooi et al., 2018). These studies support the view that balanced language use plays a crucial role in the strengthening of EF abilities. The previously mentioned examples indicate that bilinguals who belong to a DLC are more likely to show a bilingual advantage than bilinguals who belong to an SLC; therefore, language context needs to be taken into account. In sum, our review of the available studies on bidialectalism and diglossia strongly suggests that conversational contexts play an important role in modulating EFs. Most importantly, we recommend that bilingual studies should consider the role of conversational contexts, as this can solve the long-running debate found in the literature regarding the bilingual advantage.

2.8. Conclusion

The aim of this paper was to review the evidence on whether and how context can modulate EFs in bidialectalism and diglossia. We compared these results to bilingual situations where a similar context is used, that is, SLCs. We acknowledge that the very limited studies available on diglossia and bidialectalism do not allow for any sharp conclusions. However, the pattern of results seems to indicate that the conversational context in which speakers use their two languages/varieties modulates the effects of their language status on EFs. Having reviewed the empirical evidence on bidialectal and diglossic advantages in inhibition, working memory and switching, we conclude that bidialectalism does not appear to result in consistent advantages in domain-general cognition, likely due to the SLC of the bidialectal speaker. However, although the evidence is limited, the same conclusion may not apply to the diglossic situation. We argue that the conversational context of a language community may be a crucial factor in determining how speakers perform on EF tasks. This finding has implications not only for the study of bidialectalism/diglossia, but also for interpreting the literature on cognitive advantages in bilingualism, which has yielded mixed results. Future research on bilingualism, bidialectalism and diglossia should take into account the conversational contexts in which languages/varieties are used, the type and amount of code-switching between languages/varieties and the domains in which this is practised, as these can modulate EFs. Detailed descriptions of the participants' language backgrounds are needed to support such investigations. The combination of these measures will result in carefully controlled designs that will further our understanding of the subtleties in the effects of speaking two languages on cognition.

CHAPTER 3 : IS THERE AN EFFECT OF DIGLOSSIA ON COGNITION? AN INVESTIGATION OF THE RELATIONSHIP BETWEEN DIGLOSSIA AND EXECUTIVE FUNCTIONS IN YOUNG ADULTS

Abstract

Recent studies investigating whether bilingualism has effects on cognitive abilities beyond language have produced mixed results, with evidence from young adults typically showing no effects. These inconclusive patterns have been attributed to many uncontrolled factors, including linguistic similarity and the conversational contexts the bilinguals find themselves in, including the opportunities they get to switch between their languages. In this study, we focus on the effects on cognition of diglossia, a linguistic situation where two varieties of the same language are spoken in different and clearly separable contexts. We used linear mixed models to compare 32 Arabic diglossic young adults, and 38 English monolinguals on cognitive tasks assessing the Executive Function domains of inhibition, switching and working memory. The results revealed that despite both groups performing as expected on all tasks, there were no effects of diglossia on their performance in any of these domains. These results are discussed in relation to the Adaptive Control Hypothesis. Considering that this is the first study to investigate the diglossic advantages in Arabic, we propose that any effects on Executive Functions that may be attributed to the use of more than one language or language variety should not be expected when the two are used in exclusive contexts with limited opportunity to switch between them.

3.1. Introduction

The effects of using two languages on cognition have been widely discussed in the psycholinguistic literature on bilingualism. It is widely accepted that the two languages of a bilingual are constantly active and, in order to select the language that is appropriate to a given context, a bilingual must access domain-general mechanisms that are not restricted to language processing (Green & Abutalebi, 2013). These mechanisms are thought to include Executive Functions (EFs) such as inhibition, switching and working memory (Miyake et al., 2000). Significantly better performance for bilinguals compared to monolinguals in non-linguistic tasks tapping into these functions has led several researchers to claim cognitive advantages in bilinguals, which stem from their long-term greater reliance on these EFs; however, this claim remains controversial, especially as a far as young bilinguals are concerned (for a comprehensive review, see Valian, 2015). Much less is known about the effects on cognition of speaking two *varieties* of a single language, in linguistic situations such as bidialectalism and diglossia; indeed, the limited available evidence has only added to the controversy in the field. Many explanations have been put forward to explain the contradictions in the evidence, including some relating to the type and frequency of opportunities for switching between languages/varieties. One of the most prominent proposals is the Adaptive Control Hypothesis (ACH) (Green & Abutalebi, 2013), which predicts that different bilingual conversational contexts require different degrees of reliance on EFs, and as a result, modulate the extent of the relevant effects on cognition (also see Bialystok, Craik, & Ryan, 2006; Costa, Hernández, Costa-Faidella, & Sebastián-Gallés, 2009). One of the contexts that the ACH describes is the Single Language Context (SLC), where limited opportunities for language switching occur, and as a result minimal, if any, effects on cognition should be expected compared to the Dual Language Context (DLC) that allows for more switching. In the present study, we focus on Arabic diglossia as a case for studying the effects of using two varieties of the same language on cognition. Arabic diglossia offers a good example of an SLC that provides limited opportunities for switching between the two varieties, allowing to test the predictions of the ACH for SLCs. The remaining sections of this introduction define diglossia, and summarise the evidence on the effects of two languages, or two varieties of a single language, on cognition in young adults, before outlining the aims of the present study.

3.1.1. Defining diglossia

According to Ferguson (1959), diglossia refers to the coexistence of two or more related varieties of the same language in one community. Ferguson described four linguistic situations as prototypes of diglossia: Standard/Colloquial Arabic (in the Arab world), Katharevousa/Dhimotiki (in Greece), Standard/Swiss German (in Switzerland), and Standard/Creole French (in Haiti). In such situations, one variety functions as the *Standard* formal language, while the other is typically a regional variety. The two varieties are very divergent: the Standard or high variety (H) is highly codified, more grammatically complex, with the language often used for written literature or for educational or religious reasons, and is learned through formal education. As a result, a person speaking the H is often seen as more educated or of higher status. The low variety (L) tends to be less grammatically complex, used for everyday conversation in informal settings, and is learnt at home.

As already mentioned, one of the prototypical diglossic situations is diglossia in Arabic-speaking countries. Modern Standard Arabic is the common H, which is used across Arabic-speaking nations in formal contexts and found in literature, governance, religious discourse and formal speeches. The Ls of Arabic, known as colloquial varieties, vary between countries and are used in informal communication in music, films, sport and everyday conversation. In contrast to the disappearing diglossic situations of other countries (e.g., Greece) (Frangoudaki, 1992), diglossia remains a defining characteristic of the Arab world. This serves to maintain the Islamic heritage and the language of the Qura'an (Amara & Mar'I, 2002), enforces a sense of nationalism and functions as a unifying force amongst Arab countries (Palmer, 2008). Diglossia in the Arab world, therefore, constitutes an ideal candidate for studying the effects of using two varieties of a language on cognition, a phenomenon that remains under-researched (Alrwaita, Houston-Price & Pliatsikas, 2020).

3.1.2. The effects of bilingualism on Executive Functions

Before considering the effects of diglossia on cognition, it is useful to review the evidence relating to bilingualism, which has received greater attention from researchers. As discussed earlier, the juggling of two languages in the bilingual mind is thought to activate domain-general cognitive mechanisms that support EFs. Thus, bilinguals are *trained* to prevent interference from the non-target language in order to use the target language (Bialystok et al., 2012; Carlson & Meltzoff, 2008). The need to constantly inhibit interference is thought to be the origin of the reported enhanced inhibition abilities in bilinguals compared to monolinguals, which are seen even in non-linguistic tasks (Calvo & Bialystok, 2014; Costa et al., 2008; Kroll & Bialystok, 2013; Ross & Melinger, 2017). Inhibition, the ability to suppress attention to, or ignore, misleading information in order to attend to an appropriate target, along with switching, the ability to switch from one task to another, and working memory/updating, the ability to temporarily hold information in mind for processing, are fundamental to EFs (Miyake et al., 2000) and the most commonly investigated domains in bilingual studies.

While the bilingual ability to manage two languages is considered to enhance executive control abilities (Kroll & Bialystok, 2013), only a small number of studies replicated findings of advantages in young adults (Costa et al., 2009; Emmorey et al., 2008). The advantage is found most commonly in older bilinguals (Hilchey & Klein, 2011). For instance, Kousaie and Phillips (2012) reported no bilingual advantages in tasks requiring inhibitory control amongst young adults (also see Paap & Greenberg, 2013; Scaltritti et al., 2017). Similar null findings were reported in studies investigating bilingual advantages in switching tasks (Hernández, Martin, Barceló, & Costa, 2013; Paap & Greenberg, 2013), and working memory tasks (Bialystok et al., 2012). The lack of a consistent advantage for young adults was explained in terms of the Peak Performance Hypothesis, which states that in contrast to children and older adults, young adults are at the peak of their cognitive performance (Bialystok et al., 2005), making it difficult to find evidence of advantages in one group over another (Paap et al., 2015).

Given that bilingual advantages were closely linked to language use (Yang et al., 2016), it is perhaps surprising that the inconsistent findings in the literature have not previously been linked to differences in linguistic context or the amount of language switching of the bilingual participants studied. It has been suggested that there is a need to explore the extent to which bilinguals engage their EFs to resolve conflict between their two languages (Green & Abutalebi, 2013). According to the ACH (Green & Abutalebi, 2013), there are three conversational contexts that vary in the amount of switching between a bilingual's two languages, each impacting on EFs differently: (a) the SLC, where speakers use each language in a different context (e.g., one language at home and another at work); (b) the DLC, where speakers use the two languages in the same context, and switching occurs between sentences but not within sentences; and (c) the Dense code-switching Context, where speakers freely switch between the two languages within the same sentence. According to the ACH, DLCs require the most inhibitory control, followed by SLCs and Dense code-switching Contexts, and DLC should therefore result in particularly enhanced EFs (Green & Abutalebi, 2013). Following the ACH categorisation, diglossia, and Arabic diglossia in particular, is closest to the bilingual SLC, considering the exclusive contexts in which the varieties are used and the minimal switching between the two varieties. Diglossia therefore provides a test case to study the effects on cognition of linguistic contexts where proficient speakers of two language varieties have only minimal need to switch between them.

3.1.3. The effects of speaking two varieties of one language on Executive Functions

Only a few studies have investigated the effects of speaking two varieties of a single language on EFs of young adults. We first review the evidence from bidialectalism, a linguistic situation that is very similar to diglossia but where the typical H and L of diglossia are better represented as a Standard variety and a local variety (Papapavlou & Pavlou, 1998). Scaltritti et al. (2017) investigated whether the amount of exposure to the two varieties of a language relates to bidialectals' performance in inhibitory control tasks. Estimates of daily exposure to Italian and Venetian in speaking and listening in different domains (family, friends, school, hometown) were obtained through a questionnaire. In two experiments, Scaltritti et al. reported no significant correlation between exposure to the two varieties and performance in the Flanker and Simon tasks; moreover, they reported no advantages for bidialectals compared to Italian monolinguals, in line with studies that reported no bilingual advantage in young adults (Kousaie & Phillips, 2012; Paap & Greenberg, 2013). Scaltritti et al. (2017) argued that the lack of switching between dialects in the Italian–Venetian context explains the lack of the bidialectal advantage in this study. Poarch et al. (2019) investigated whether balanced usage of the Swabian–German dialect and Standard German enhances bidialectals' performance in Simon and Flanker tasks. Poarch et al. compared balanced Swabian–German and Swabian-dominant bidialectals aged 18 to 26 years and reported smaller Flanker and Simon effects in the

Swabian-dominant group, which they interpreted as an advantage. The authors suggested that using the non-Standard dialect more than the Standard language dialect enhances inhibitory control over equal use of the two dialects. This conclusion is against the general prediction that balance usage of two languages/ varieties leads to more EF advantages, it also contradicts the findings of Scaltritti et al. (2017), and others. For example, Bosma et al. (2017a) suggested that Frisian–Dutch children who are more balanced in proficiency, perform better in EF tasks than unbalanced children (Bosma et al., 2017a).

To date, only one study has investigated the effects of diglossia on EFs in young adults (Antoniou & Spanoudis, 2020). This study was conducted in Cyprus, where Standard Modern Greek (SMG) functions as the H and Cypriot Greek (CG) the L (Antoniou et al., 2016). Diglossic and multilingual advantages were explored across the EF domains of inhibition, switching and updating (Miyake, 2000) by comparing diglossics (speakers of CG and SMG), multilingual participants (speakers of CG, SMG and another language) and monolingual speakers of SMG on the Stroop, Flankers, Colour–shape, N-back and Corsi block tasks. Antoniou and Spanoudis (2020) reported both multilingual and diglossic advantages across all EF components. Notably, while these findings contradict the results of studies in bilinguals and bidialectals of a similar age, they corroborate those of Antoniou et al. (2016), who found diglossic advantages in CG children.

The discrepancy between the evidence from diglossia and bidialectalism, two very similar linguistic situations, is intriguing, and is potentially related to the different usage of the two language varieties in bidialectal and diglossic settings. Most importantly, Antoniou and Spanoudis's (2020) findings don't support the ACH, the findings contradict the prediction that executive control demands should be low in SLCs found in diglossia, at least for tasks that don't measure goal maintenance, this is due to the clear separation between the contexts in which each variety is used (H for writing, L for speaking). However, there remains the assumption that the situation in Cyprus doesn't resemble the pure SLC found in diglossia and it is more similar to a DLC.

3.1.4. The role of context and switching

As mentioned, both diglossia and bidialectalism constitute SLCs in the ACH terms (Green & Abutalebi, 2013); both have been suggested to offer limited opportunities for switching between the two varieties, which are used in a specific context (Rowe & Grohmann, 2013; Scaltritti et al., 2017).

For these reasons, the ACH predicts that SLCs have minimal effects on EFs compared to DLCs with their greater language switching requirements. The predictions of the ACH are supported by studies highlighting the role of language switching in modulating performances in EF tasks (Bialystok et al., 2006; Costa et al., 2009), and by the observation that the bilingual advantage is more likely to be found in tasks that require more switching (Bialystok et al., 2006; Costa et al., 2009). It is therefore important to consider why, in conditions where we would expect to see minimal or no advantages (diglossic and bidialectal environments), contradictory results have been found in the only available study of diglossia (Antoniou & Spanoudis, 2020).

While the bidialectal and diglossic situations appear to be similar, it is worthwhile considering the differences in how the H and the L function in each case, and how often speakers switch between them. First, bidialectalism develops in diglossic situations when the H takes over the L, meaning that the H is used for both formal and informal purposes (Rowe & Grohmann, 2013). Second, diglossic native speakers are raised in homes where only the L is used (Keller, 1982). Finally, in bidialectalism the H is seen as the more prestigious variety and learning it is considered more important than learning the L, while in diglossia both varieties are expected to be learned (Rowe & Grohmann, 2013).

Linguistically, in bidialectalism the H and the L are similar in complexity, while in diglossia the H is syntactically and grammatically more complex than the L (Ferguson, 1959).

There are also some differences in the functional uses of bidialectalism and diglossia, which suggest that diglossia better corresponds to the SLC than bidialectalism. In diglossia, switching between the two varieties depends entirely on the activity, as all users understand both varieties, although the level of understating of the H can vary with education. However, in bidialectalism the use of the two varieties overlaps (Masica & Sinha, 1986), which means that both the H and the L can be used for formal purposes. It follows that we should be less likely to observe cognitive advantages in diglossia than in bidialectalism. As described above, the limited available evidence points in the opposite direction, suggesting that broad brush categorisations of environments as diglossic or bidialectal might not necessarily describe the important characteristics of those environments. For example, in diglossia, exposure to and usage of the two varieties might vary considerably across different languages (Kaye, 2001). Given that lower exposure to one variety results in less switching between the two varieties, and therefore to less enhancement of executive control abilities (Kirk et al., 2014; Scaltritti et al., 2017), relative use of the two varieties in diglossia is likely to be an important factor to consider. Interestingly, the diglossic situation in Cyprus has been recently characterised as diglossic transitioning into type B diglossia or *diaglossia*, where the use of the Standard or H variety. is no longer restricted to written purposes, but also extends to oral communication. In such cases, the extent of code-switching depends more on the situation than on the activity (speaking/writing) (Auer, 2005; Rowe & Grohmann, 2013). This issue highlights the need for studies of diglossia in environments other than Cyprus.

Arabic offers the ideal test case for investigating the effects of diglossia on EFs. First, in typical diglossia there is a clear separation between the contexts in which each variety is used, which should limit enhancements to EFs (Costa et al., 2009). This separation is strongly enforced in Arabic diglossia, where there is rigid use of the H for formal purposes and the L for informal purposes (Albirini, 2016), ruling out the possibility of an overlap in their use (Kaye, 2001). According to Albirini (2016), even the most educated Arabs do not use the formal variety (H) for informal purposes, or vice versa; doing so would be a clear violation of sociolinguistic norms (Albirini, 2016). In contrast, switching between the H and the L is very frequent in Cyprus, even when the speaker does not intend to switch (Pavlou, 2004). Second, some Arabic speakers are rarely exposed to the H; even educated Arabs would find it difficult to hold conversations entirely in the H, and understanding it is even more difficult for uneducated Arabs (Kaye, 2001). Again, this implies less switching between the two varieties and, as a result, less enhanced EFs. Arabic therefore offers an example of diglossia in which two language varieties are used in an SLC.

3.1.5. This study

To investigate whether Arabic diglossia has an effect on EF abilities, we compared young Arab diglossics to English-speaking monolinguals of the same age in a series of tasks tapping into the three domains of EFs (Miyake et al., 2000), namely, Flanker, Stroop, Colour–shape switching and Nback. If our results replicate the findings by Antoniou and Spanoudis (2020), this would suggest that diglossic situations, in general, enhance performances in EF tasks, irrespective of the amount of language switching (which, as discussed, differs between Cyprus and the Arab world). If we fail to report a diglossic advantage, this could be attributed to the specific properties of diglossic Arabic and its rigid correspondence to an SLC as defined by the ACH.

3.2. Methods

3.2.1. Participants

Seventy young adults participated, 32 Arabic speaking diglossic young adults (22 females: age 18-37, mean age= 29.6, SD= 5.6), and 38 English speaking monolinguals (34 females: age 18-36, mean age= 21.6, SD= 5.6). Arabic speaking adults were recruited from Prince Sultan University in Riyadh, Saudi Arabia. English speaking adults were recruited from the School of Psychology and Clinical Language Sciences at the University of Reading. One English-speaking individual was excluded for having bilingual parents and scoring significantly higher than other monolinguals in the Language and Social Background Questionnaire (LSBQ) (Anderson, Mak, Keyvani Chahi, & Bialystok, 2018).

3.2.2. Language background and proficiency measures

Prior to the study, our monolingual participants were assessed using the LSBQ (Anderson et al., 2018). The LSBQ examines the degree to which, and the domains in which, participants use English, and other languages (if applicable), in their daily lives. To measure proficiency, the questionnaire includes self-rating questions about reading, writing and listening skills in English/other languages. Factor scores were calculated for each participant for three domains: English proficiency, non-English social use and non-English home use. A composite *bilingualism score* was computed by summing the factor scores weighted by the variance in each factor. Of the three-factor scores (English proficiency, non-English social use and non-English home use and proficiency), non-English home use and proficiency contributes the highest to the composite score (0.33), followed by the non-English social use (0.30). Finally, English proficiency has the least contribution to the composite score (0.11). Non-English home use is calculated using participants answers for questions assessing the frequency of using non-English in different stages (infancy, preschool, high school), and with different people (grandparents, parents, siblings). Non-English social use score is calculated using participants answers for questions assessing non-English use in different domains (friends, school, work…etc), as well as switching frequency in social media and with friends. Finally, English proficiency score is calculated using participants answers for self-rating questions assessing English understanding, speaking, reading and writing. According to Anderson et al. (2018), those with composite scores below -3.13 should be classified as monolinguals, while composite scores above 1.23 indicate bilinguals. Our monolingual young adults had an average composite score of -8.18 (SD=1.2), these composite scores range between -4.911 to -9.66, meaning that all monolinguals are classed as monolinguals according to the LSBQ. Monolinguals have scored low in the three domains of switching found in the LSBQ. For switching with family monolinguals scored between 0.27 to -1.11, for switching with friends monolinguals scored between -0.54 to -0.43, and for switching in social media monolinguals scored between -0.46 to -0.46. These scores mean that monolinguals mostly reported 0 switching in these domains.

To ensure that our diglossic group were indeed diglossics (knowing both the Standard and the spoken dialect), we adapted the LSBQ to investigate the degree of dialect use, and the domains in which each dialect was used (Appendix A). Arabic-speaking diglossics were asked to complete the adapted version of the LSBQ, in which they achieved an average composite score of -0.21 with a standard deviation of 2.6. According to Anderson et al. (2018), this score lies in the grey area between bilingualism and monolingualism. Diglossics' Composite scores range between 4.91 to -6.62. Scores from the LSBQ show that diglossics reported little switching. For switching with family diglossics scored between 0.96 to -1.11, for switching with friends diglossics scored between 0.71 to -0.43, and for switching in social media diglossics scored between 1.20 to -0.46. Most importantly, results from the LSBQ show that diglossics and monolinguals have different composite scores with little or no overlapping.

Because the level of knowledge of Standard Arabic differs according to the level of education and exposure to the Standard dialect (Kaye, 2001), proficiency in Standard Arabic was measured using a vocabulary test designed by Masrai and Milton (2019). This test is administered using a pen and a paper and it comprises a checklist of the most common Arabic words generated from the web-based corpus of Arabic (Sharoff, Umanskaya, & Wilson, 2013). The test is divided into two parts, each comprises 120 items which include both real words and non-words intermixed. The participants indicate if they recognise each word by responding either yes or no to each word. The duration of the test is between 10 and 15 minutes. According to Masrai and Milton (2019), a native Arabic speaker around the age of 20 would have acquire 20,000 words, and this would increase with age. To make a calculation out of 50,000 words of each participant's vocabulary size, all yes answers to real words are given a score of 500 to form an unadjusted vocabulary score, and each false yes answer to a false word deducts 2500 points from the unadjusted score to form an adjusted vocabulary score. The final adjusted score gives the participants total vocabulary knowledge. Based on this, our diglossic group had an average of 87.59 (SD=12.17) of yes responses to real words, an average of 5.25 (SD= 3.69) to yes responses to non-words, and an estimated average of 30,671.87 (SD= 732.2) words. Based on their performances in the vocabulary test, no one was excluded from the diglossic group.

3.2.3. Executive Functions tasks

The battery of EF tasks included tasks measuring inhibition, switching and working memory. Flanker and Stroop tasks were administered to measure inhibition, the Colour–shape task was administered to measure switching, and finally the Nback task was administered to measure working memory. The inclusion of a working memory task serves to rule out the possibility of a general cognitive advantage in diglossics; as the ACH did not predict any enhancements in a working memory task by speakers of any domain. The tasks were delivered using the E-prime 2.0 software (Psychology Software Tools, PA), all the tasks were taken from Kendrick, Robson, & Meteyard (2019), there were no changes in terms of stimuli or how the tasks were delivered. All tasks were presented in a 15.6 inch computer screen, and all participants were tested in private rooms. Instructions and texts were changed to Arabic for the diglossic group.

3.2.3.1. Inhibition

Two inhibition tasks were used, Flanker testing non-verbal inhibition and Stroop testing verbal inhibition.

3.2.3.1.1. Flanker

This task had three conditions: Congruent, Incongruent and Neutral. In all conditions, a central arrow appeared on the screen and the participants were asked to indicate if the arrow pointed to the right or left by pressing either the (<) or (>) button on the keyboard. The participants were instructed to respond as fast and accurately as possible. In the Congruent condition, there were surrounding (flanking) arrows, which pointed in the same direction as the target central arrow (<<<<<). In the Neutral condition, the target central arrow appeared with dashes on the left and the right sides (--<--). In the Incongruent condition, there were surrounding arrows pointing in the opposite direction to the target central arrow (>><>>). Forty-four trials of each type were distributed across four blocks, each including 33 trials, 11 per condition, presented in a random order. Each trial began with a 250 ms fixation cross, followed by a stimulus lasting for 5,000 ms, or until a response was provided. The trials were separated by a blank screen, which appeared for 250 ms.

3.2.3.1.2. Stroop

In this task, a single word appeared on the screen and the participants were asked to decide the colour in which a word was written. The task consisted of three conditions: Congruent, Incongruent and Neutral. In the Congruent trials, the target word was consistent with the ink colour; for example, the word *green* was presented in green ink. In the Neutral trials, neutral words were written in different ink colours (red, green or blue). In the Incongruent trials, names of colours were presented that were inconsistent with the ink colour; for example, the word *green* in red ink. The three different colours (red, green and blue) were assigned to three adjacent keyboard buttons and the participants responded by clicking the corresponding button (see Fig. 3.1).

Forty-eight trials of each type were distributed across three blocks, each consisting of 48 trials in random order, with a total of 144 trials. Each trial began with a 250 ms fixation cross, followed by the presentation of the word for a maximum of 5,000 ms, or until a response was provided.

For Arabic-speaking participants, the same task was administrated translated in Arabic.

3.2.3.2. Switching

3.2.3.2.1. Colour–shape task

In this task, the participants were presented with three possible patterns in either blue, green or red. There were three blocks. First, in the blocked colour task, two patterns appeared on the screen and the participants had to decide if the patterns were the same or different colours. Second, in the blocked pattern task, the participants were presented with two patterns and were asked to decide if the pattern was the same or different. Third, in the switching task, the participants had to switch between attending to the colour or the pattern. In each trial, including single task blocks, a word (colour/pattern) was presented at the top of the screen, indicating whether the colour or pattern should be responded to. To respond, the participants had to press the S button on the keyboard for *same*, or the D button for *different* (see Fig. 3.1).

There was a total of 124 trials. The blocked colour task and blocked pattern task each included 31 trials. The switching block included 62 randomised trials consisting of 31 Stay trials, where the participants were asked to attend to the same property (colour/pattern) as the previous trial, and 31 Change trials, where the participants had to switch to attending to the other property. Each trial began with a 100 ms central fixation cross, followed by a stimulus presentation until a response was detected. There was a 250 ms blank screen between trials.

3.2.3.3. Working memory

3.2.3.3.1. Nback

This task included two versions with increasing working memory load: One back and Two back. In both, a single number between 1 and 9 appeared on the screen. In the One back version, the participants were asked to decide if the number they saw on the screen was the same as the number that had appeared one trial before. In the Two back version, the participants were asked to decide if the number they saw on the screen was the same as the number that had appeared two trials before. If the answer was yes, participants were asked to press a key; if the answer was no, the participants were asked not to respond (see Fig. 3.1).

The task included 117 trials, of which 36 were target (yes) trials. These trials were distributed across four blocks, each containing nine targets. The paradigm for this task was similar to other Nback tasks, with a trial-to-target ratio of 31% for the One back condition and 32% for the Two back. Each stimulus was presented for 500 ms, after which a black screen appeared for 1,500 ms to allow the participant to make a decision and respond before the next number appeared. In each task, no more than two target trials appeared consecutively.

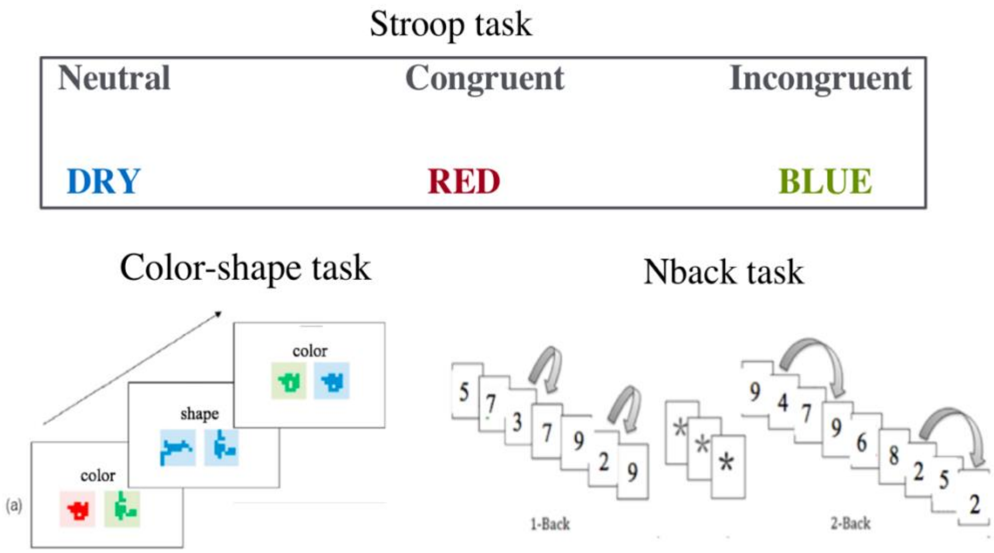

Figure 3.1: Stroop task, Colour–shape task and Nback task (Kendrick et al., 2019).

3.3. Results

Analyses of accuracy and reaction time (RT) data were run using generalised linear mixed-effects models from the statistical package Ime4 (Bates, Kliegl, Vasishth, & Baayen, 2018), in R studio (version 4.0.3). Because the RTs were not normally distributed, they were log-transformed prior to the analysis. We included treatment coded fixed effects of group (diglossics, monolinguals), condition (Congruent, Incongruent, Neutral) and interactions between group and condition. The reference level for group was diglossics and the reference level for condition was Congruent. For condition, we compensated for the third missing comparison between Incongruent and Neutral by using relevel. Incongruent was then used as the reference level to get coefficients for the Incongruent vs. Neutral comparisons.

3.3.1. Flanker

The RTs from both groups were screened for extreme values, defined as anything that exceeded 2,500 ms, or was less than 200 ms. These values were excluded, affecting 1.7% of the Diglossic data, and 3.7% of the Monolingual data. These outliers were removed for analysis of accuracy and RTs.

3.3.1.1. Accuracy

Table 3.1: *Mean accuracy (SD) per Group and per Condition for the Flanker task.*

	Congruent	Incongruent	Neutral
Diglossics	99% (12)	97% (18)	98% (13)
Monolinguals	98% (12)	94% (24)	98% (15)

Table 3.1 illustrates the accuracy data for the Flanker task. As the optimisation requires more than 10,000 iterations, and to avoid convergence errors, we increased the amount of iterations to 100,000. A maximal model with random intercepts for subject and a random slope for Condition did not converge. We removed the random slope for Condition and the model converged (for the results see, Table 3.2).

The model coefficients revealed that Incongruent (M *correct responses*= 95%, SD(21)) was significantly less accurate than both Congruent (M *correct responses*= 98%, SD(12)) (β=-0.839,SE=0.288,t(.)=-2.910,p=0.003) and Neutral (M *correct responses*=

98%, SD(14)) (β=-0.916,SE=0.176,t(.)=-5.219,p<0.001). There was no significant difference between Congruent and Neutral.

There was no significant difference between the Diglossics (M *correct responses*= 97%, SD(14)) and the Monolinguals (M *correct responses*= 96%, SD(17)). There was no significant interaction between Group and Condition.

Table 3.2: *Generalised linear mixed effects model results for Flanker accuracy.*

Fixed Effects				
	Est/Beta	SE	t value	p value
Intercept:	5.014	0.372	13.473	p<0.001*
Condition:				
Congruent vs Incongruent	0.839	0.288	-2.910	p=0.003*
Congruent vs Neutral	0.145	0.322	0.459	p=0.652
Incongruent vs Neutral	-0.916	0.176	-5.219	p<0.001*
Group:	-0.299	0.477	-0.627	p=0.530
Group interaction:				
Congruent x Incongruent	-0.663	0.378	-1.753	p=0.079
Congruent x Neutral	-0.219	0.430	-0.510	p=0.609
Incongruent x Neutral	0.444	0.350	1.266	p=0.205
Random Effects				
		Variance		S.D.
Subject (Intercept)		1.636		1.727
Model fit				
R^2		Marginal		Conditional
		0.07		0.38

Key: p-values for fixed effects calculated using Satterthwaite approximation, and the Tukey method.
The random effect variance for Incongruent versus Neutral was calculated using a maximal mo
that includes a relevel of the missing factor: Incongruent.
Model equation: glmer(Accuracy ~ Condition * Group +(1|Subject), data=Flanker, family="binomial")

3.3.1.2. Reaction Times

For the RT analysis, all incorrect trials were removed. For the Diglossics, incorrect trials comprised 86 out of 3,689 trials (7%), while for the Monolinguals, incorrect trials comprised 150 out of 4,434 trials (4%).

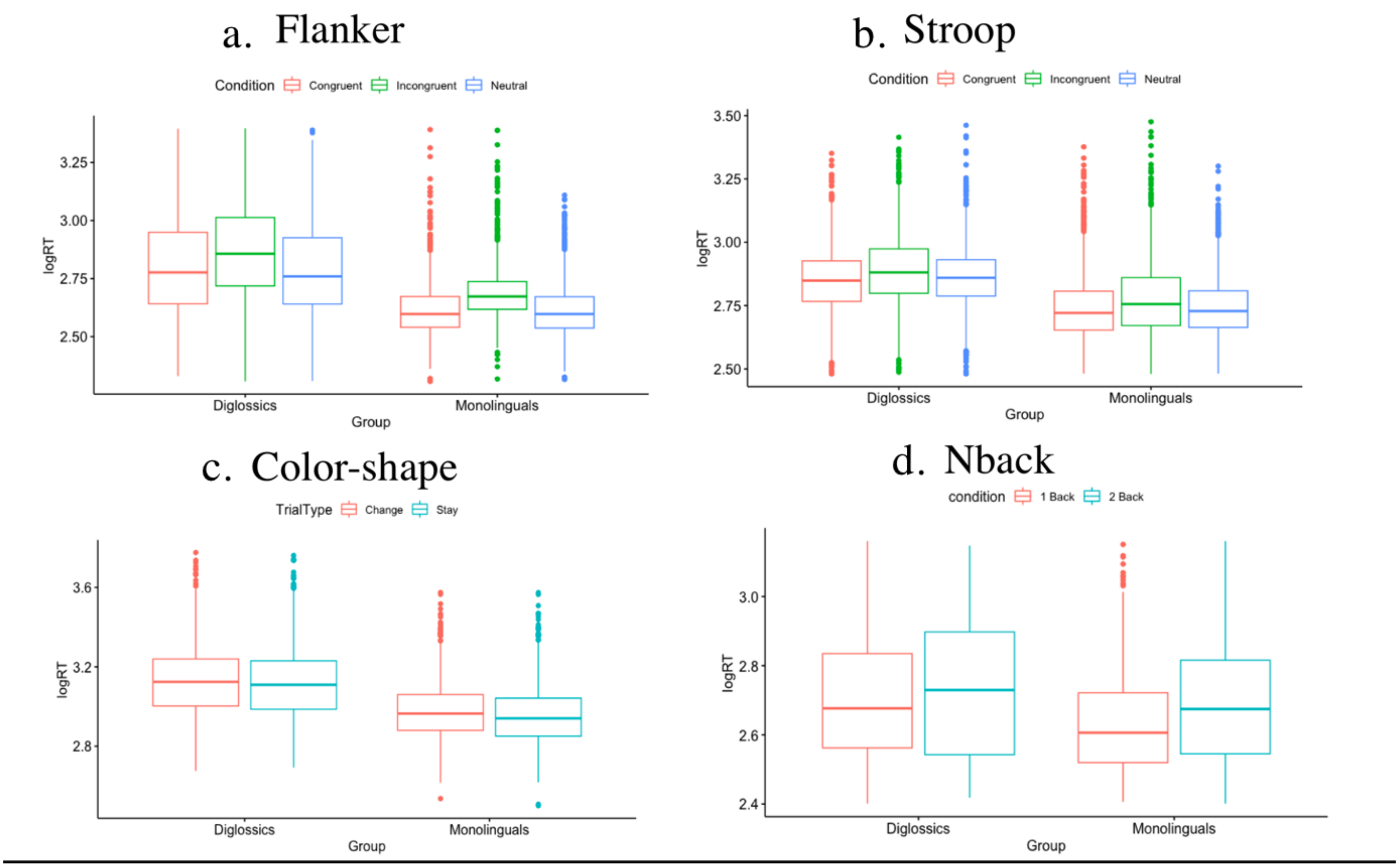

Figure 3.2: Reaction Times for Diglossics and Monolinguals across conditions for Flanker, Stroop, Colour–shape and Nback.

Figure 3.2a illustrates the RT data for the Flanker task. A maximal model with random intercepts for subject and a random slope for Condition did not converge. We removed the random slope for Condition and the model converged (for the results, see Table 3.3).

The model coefficients revealed a significant difference between the Congruent and Incongruent trials, with Incongruent (M *RTs*= 2.77 sec, SD(0.10)) being significantly slower than both Congruent (M *RTs*= 2.70 sec, SD(0.18)) ($\beta=0.082$,$SE=0.004$,$t(782)=18.714$,$p<0.001$) and Neutral (M *RTs*= 2.69 sec, SD(0.175)) ($\beta=-0.095$,$SE=0.004$,$t(782)=-21.652$,$p<0.000$). There was also a significant difference between the Congruent and Neutral trials, with Neutral (M *RTs*= 2.69 sec, SD(0.175)) being faster than Congruent (M *RTs*= 2.70 sec, SD(0.18)) ($\beta=-0.012$,$SE=0.004$,$t(782)=-2.976$, $p<0.01$).

There was a significant difference between the Diglossics and Monolinguals, where the Diglossics (M *RTs*= 2.8 sec, SD(0.20)) were significantly slower than the Monolinguals (M *RTs*= 2.63 sec, SD(00.11)) ($\beta=-0.171$,$SE=0.028$,$t(67.78)=-5.946$,$p<0.001$).

There was a significant Group and Condition interaction, where the Monolinguals showed a smaller difference than the Diglossics in Congruent and Incongruent ($\beta=-0.012$,$SE=0.003$,$t(7829)=-2.004$,$p=0.045$), in Incongruent and Neutral ($\beta=0.022$,$SE=0.006$,$t(7829)=3.746$,$p=0.000$), and also in Congruent and Neutral ($\beta=0.010$, $SE=0.005$,$t(782)=1.765$,$p=0.007$).

Table 3.3: *Linear mixed effect model results for the Flanker reaction times.*

Fixed Effects				
	Est/Beta	SE	t value	p value
Intercept:	2788	0.020	133.196	p<0.001
Condition:				
Congruent vs Incongruent	0.082	0.004	18.714	p<0.001*
Congruent vs Neutral	-0.012	0.004	-2.976	p<0.01*
Incongruent vs Neutral	-0.095	0.004	-21.652	p<0.000*
Group:	-0.171	0.028	-5.946	p<0.001*
Group interactions:				
Congruent x Incongruent	-0.012	0.003	-2.004	p=0.045*
Congruent x Neutral	0.010	0.005	1.765	p=0.007*
Incongruent x Neutral	0.022	0.006	3.746	p=0.000*

Random Effects		
	Variance	S.D.
Subject (Intercept)	0.013	0.117
Model fit		
R^2	Marginal	Conditional
	0.26	0.65

Key: p-values for fixed effects calculated using Satterthwaite approximation, and the Tukey method.
The random effect variance for Incongruent versus Neutral was calculated using a maximal model that includes a relevel of the missing factor: Incongruent.
Model equation: lmer(logRT ~ Condition * Group + (1|Subject), data=Flanker)

3.3.2. Stroop

The RTs from both Groups were screened for extreme values, defined as anything exceeding 2,500 ms, or less than 200 ms. These values were excluded, affecting 1.4% of the Diglossic data, and 3% of the Monolingual data. These outliers were removed for analysis of accuracy and RTs.

3.3.2.1. Accuracy

Table 3.4: Mean accuracy (SD) per Group and per Condition for the Stroop task.

	Congruent	Incongruent	Neutral
Diglossics	99% (9)	98% (13)	99% (10)
Monolinguals	98% (13)	96% (19)	97% (17)

Table 3.4 presents the accuracy data for the Stroop task. As the optimisation requires more than 10,000 iterations, and to avoid convergence errors, we increased the amount of iterations to 100,000. A maximal model with random intercepts for subject and a random slope for Condition did not converge. We removed the random slope for Condition and the model converged (for the results, see Table 3.5).

The model coefficients revealed that Incongruent (M *correct responses*= 97%, SD(16)) was significantly less accurate than both Congruent (M *correct responses*= 98%, SD(16)) (β=-0.789,SE=0.343,t(.)=-2.300,p=0.021) and Neutral (M *correct responses*= 97%, SD(14)) (β=0.029,SE=0.004,t(.)=6.837,p<0.001). There was no significant difference between Neutral and Congruent.

There was also a significant difference between the Monolinguals and Diglossics, with the Diglossics (M *correct responses*= 98%, SD(10)) being more accurate than the Monolinguals (M *correct responses*= 97%, SD(16)) (β=-0.807,SE=0.385,t(.)=-

2.094,p=0.036). The model coefficients revealed that there was no significant interaction between Groups and Condition.

Table 3.5: *Generalised linear mixed effects model results for Stroop accuracy.*

Fixed Effects				
	Est/Beta	SE	z value	p value
Intercept:	5.117	0.324	15.776	p<0.001*
Condition:				
Congruent vs Incongruent	-0.789	0.343	-2.300	p=0.021*
Congruent vs Neutral	-0.288	0.374	0.769	p=0.442
Incongruent vs Neutral	0.029	0.004	6.837	p<0.001*
Group:	-0.807	0.385	-2.094	p=0.036*
Group interaction:				
Congruent x Incongruent	-0.055	0.408	0.136	p=0.891
Incongruent x Neutral	-0.288	0.440	-0.655	p=0.512
Incongruent x Neutral	-0.232	0.364	-0.639	p=0.522

Random Effects		
	Variance	S.D.
Subject (Intercept)	0.4957	0.7041
Model fit		
R^2	Marginal	Conditional
	0.08	0.20

Key: p-values for fixed effects calculated using Satterthwaite approximation, and the Tukey method. Confidence intervals calculated manually.
The random effect variance for Incongruent versus Neutral was calculated using a maximal model that includes a relevel of the missing factor: Incongruent.
Model equation: glmer(Accuracy ~ Condition * Group +(1|Subject), data=Stroop, family="binomial”)

3.3.2.2. Reaction Times

All incorrect trials were removed. This affected 56 out of 4,600 trials (2%) of the Diglossic group, and 152 out of 5,614 trials (3%) of the Monolingual group.

Figure 3.2b illustrates the RT data for the Stroop task, which suggests that the Monolinguals were faster. A maximal model with random intercepts for subject and a random slope for Condition converged (for the results, see Table 3.6).

The model coefficients showed that the Incongruent trials (M *RTs*= 2.82 sec, SD(0.15)) were significantly slower than both the Congruent trials (M *RTs*= 2.78 sec, SD(0.141)) (β=-0.039,SE=0.005,t(67.28)=7.384,$p<0.001$), and the Neutral trials (M *RTs*= 2.79 sec, SD(0.13)) (β=0.0265,SE=0.006,t(67.28)=-4.182,$p<0.001$). There was also a significant difference between Congruent and Neutral, with Neutral being significantly slower (β=0.013,SE=0.004,t(67.69)=2.740,$p<0.01$).

There was also a significant difference between Diglossics and Monolinguals, where the Diglossics (M *RTs*= 2.86 sec, SD(0.137)) were significantly slower than the Monolinguals (M *RTs*= 2.75 sec, SD(0.13)) (β=-0.107,SE=0.017,t(67,97)=-6.232,$p<0.001$). There was no significant interaction between Group and Condition.

Table 3.6: *Linear mixed effects model results for the Stroop reaction times.*

Fixed Effects						
	Est/Beta	SE	t value	p value		
Intercept:	2.846	0.012	224.60	p<0.001*		
Condition:						
Congruent vs Incongruent	-0.039	0.005	7.384	p<0.001*		
Congruent vs Neutral	0.013	0.004	2.740	p<0.01*		
Incongruent vs Neutral	0.026	0.006	-4.182	p<0.001*		
Group:	-0.107	0.017	-6.232	p<0.001*		
Group interaction:						
Congruent x Incongruent	-0.003	0.007	-0.459	p=0.647		
Congruent x Neutral	-0.009	0.006	-1.430	p=0.157		
Incongruent x Neutral	-0.005	0.008	-0.686	p=0.495		
Random Effects						
		Variance	S.D.	Correlation matrix		
Subject (Intercept)		0.004	0.069	Subject (intercept)	Congruent vs Incongruent	Congruent vs Neutral
Condition (Slope):						
Congruent vs Incongruent		0.000	0.019	-0.62		
Congruent vs Neutral		0.000	0.013	-0.33	-0.36	
Incongruent vs Neutral		0.000	0.023	-0.76	0.10	0.76
Residual		0.012	0.113			
Model fit						
R^2		Marginal	Conditional			
		0.15	0.40			

Key: p-values for fixed effects calculated using Satterthwaite approximation, and the Tukey method.
The random effect variance for Incongruent versus Neutral was calculated using a maximal model that includes a relevel of the missing factor: Incongruent.
Model equation: lmer(logRT ~ Condition * Group +(1+Condition|Subject), data= Stroop)

3.3.3. Switching

The RTs from both groups were screened for extreme values, defined as anything that exceeded 6,000 ms, or was less than 300 ms. Extreme values were excluded, affecting 2.3% of the Diglossic data and 0.1% of the Monolingual data. These outliers were removed for analysis of accuracy and RTs.

3.3.3.1. Accuracy

Table 3.7: *Mean accuracy (SD) per Group and per Condition for the Colour–shape task.*

	Change	Stay
Diglossics	96% (19)	98% (13)
Monolinguals	92% (25)	95% (20)

Table 3.7 presents the accuracy data for the Switching task. As the optimisation requires more than 10,000 iterations, and to avoid convergence errors, we increased the amount of iterations to 100,000. A maximal model with random intercepts for subject and a random slope for Condition did not converge. We removed the random slope for Condition and the model converged (for the results, see Table 3.8).

The model coefficients showed a significant effect of Condition, where Change (M *correct responses*= 94%, SD(23)) is less accurate than Stay (M *correct responses*= 96%, SD(17)) (β=0.835,SE=0.261,t(.)=3.197,p=0.001).

There was also a significant difference between Diglossics and Monolinguals, where the Diglossics (M *correct responses*= 97%, SD(0.166)) were more accurate than the Monolinguals (M *correct response*= 94%, SD(0.233)) (β=-0.602,SE=0.244,t(.)=-2.467,p=0.013). There was no significant interaction between Group and Condition.

Table 3.8: *Generalised linear mixed effects model results for the Colour–shape accuracy.*

Fixed Effects				
	Est/Beta	SE	z value	p value
Intercept:	3.366	0.195	17.261	p<0.001*
Condition: Stay vs Change	0.835	0.261	3.197	p=0.001*
Group:	-0.602	0.244	-2.467	p=0.013*
Group x Condition interaction:	-0.322	0.310	-1.038	p=0.299

Random Effects		
	Variance	S.D.
Subject (Intercept)	0.420	0.648
Model fit		
R^2	Marginal	Conditional
	0.07	0.17

Key: p-values for fixed effects calculated using Satterthwaite approximation.
Model equation: glmer(Accuracy ~ Condition * Group +(1|Subject), data=Switch, family="binomial")

3.3.3.2. Reaction times

Along with extreme values, all incorrect trials were removed. For the Diglossics, incorrect trials comprised 65 out of 2,298 trials, while for the Monolinguals, incorrect trials comprised 180 out of 2,037 trials. Removing incorrect trials affected 3% of the Diglossic group, and 6% of the Monolingual group.

Figure 3.2c illustrates the RT data for the Switching task, which suggests that the Monolinguals were faster. A maximal model with random intercepts for subject and a random slope for Condition did not converge. We removed the random slope for Condition and the model converged (for the results, see Table 3.9).

The model coefficients revealed that there was a significant difference between Conditions, where Change (M *RTs*= 3.05 sec, SD(0.17)) was slower than Stay (M *RTs*= 3.03 sec, SD(0.18)) (β=-0.012,SE=0.005,t(0.004)=-2.459,p=0.014).

There was also a significant difference between Diglossics and Monolinguals, where the Diglossics (M *RTs*= 3.124 sec, SD(0.180)) were significantly slower than the Monolinguals (M *RTs*= 2.969 sec, SD(0.147)) (β=-0.146,SE=0.025,t(7.083)=-5.702,p<0.001). There was no significant interaction between Group and Condition.

Table 3.9: *Linear mixed effects model results for the Colour–shape reaction times.*

Fixed Effects				
	Est/Beta	SE	z value	p value
Intercept:	312.5	0.018	70.67	p<0.001*
Condition: Stay vs Change	-0.012	0.005	-2.459	p=0.014*
Group:	-0.146	0.025	-5.702	p<0.001*
Group x Condition interaction:	-0.007	0.007	-1.090	p=0.275

Random Effects		
	Variance	S.D.
Subject (Intercept)	0.011	0.105
Residual	0.015	0.125
Model fit		
R^2	Marginal	Conditional
	0.07	0.17

Key: p-values for fixed effects calculated using Satterthwaite approximation.
Model equation: lmer(logRT ~ Condition * Group + (1|Subject), data= Switch)

3.3.4. Nback

For the One back task, the RTs from both groups were screened for extreme values, defined as anything that exceeded 1,200 ms, or was less than 250 ms. Extremes values were excluded, affecting 1% of the Diglossic data and 1.3% of the Monolingual data.

For the Two back task, the RTs from both groups were screened for extreme values, defined as anything that exceeded 1,500 ms, or was less than 250 ms. Extreme values were excluded, affecting 2% of the Diglossic data and 4% of the Monolingual data. These outliers were removed for analysis of accuracy and RTs.

3.3.4.1. Accuracy

Removing upper cut-off and lower cut-off points resulted in no inaccurate results. Therefore, we did not run an accuracy analysis for this task, as all our participants were at the ceiling.

3.3.4.2. Reaction Times

Figure 3.2d illustrates the RT data for the Nback task, which suggests that the Monolinguals were faster. A maximal model with random intercepts for subject and a random slope for Condition converged (for the results, see Table 3.10).

The model coefficients revealed that there was a significant effect of Condition, where Two back (M *RTs*= 2.69 sec, SD(0.174)) was significantly slower than One back (M *RTs*= 2.66 sec, SD(0.151)) (β=-0.061,SE=0.025,t(51.61)=2.394,p=0.020).

There was a significant difference between the Diglossics and Monolinguals, where the Diglossics (M *RTs*= 2.70 sec, SD(0.167)) were significantly slower than the

Monolinguals (M *RTs*= 2.657 sec, SD(0.15)) (β=-0.070,SE=0.024,t(66.818)=-2.839,p=0.005). There was no significant interaction between Group and Condition.

Table 3.10: *Linear mixed effects model results for the Nback reaction times.*

Fixed Effects				
	Est/Beta	SE	t value	p value
Intercept:	2.709	0.018	184.65	p<0.001*
Condition: One back vs Two back	-0.061	0.025	2.394	p=0.020*
Group:	-0.070	0.024	-2.839	p=0.005*
Group x Condition interaction:	-0.004	0.029	-0.162	p=0.872

Random Effects			
	Variance	S.D.	Correlation
Subject (Intercept)	0.010130	0.10065	
Condition (Slope)	0.005953	0.07716	-0.38
Residual	0.015288	0.12365	
Model fit			
R^2	Marginal	Conditional	
	0.05	0.40	

Key: p-values for fixed effects calculated using Satterthwaite approximation.
Model equation: lmer(logRT ~ Condition * Group +(1+Condition|Subject), data=Nback)

3.4. Discussion

Following suggestions that conversational contexts requiring different levels of switching affect EFs differently (Green & Abutalebi, 2013), this study examined whether diglossic participants (who with minimal opportunities for code-switching between their two language varieties correspond to Green and Abutalebi's SLC) perform similarly to monolinguals. We compared the performance of Arabic speaking young adults to English speaking monolinguals of a similar age on four tasks, Flanker, Stroop, Colour–shape and Nback, that cover Miyake's (2000) three domains of EFs: inhibition, working memory and switching. In each task, we compared performance between cognitively challenging and control conditions, namely, between Congruent and Incongruent trials for the Flanker and Stroop tasks, between Stay and Change trials for the Colour–shape task, and between One back and Two back trials for the Nback task. All of our tasks yielded the expected pattern (i.e., lower accuracy and slower RTs for the more cognitively challenging conditions). However, diglossics were slower than monolinguals in all the tasks. Specifically, in the Colour-shape task diglossics were slower but more accurate than monolinguals, suggesting a possible speed-accuracy trade-off. In the Flanker RTs, monolinguals showed a smaller difference between all conditions compared to diglossics. The difference between Congruent vs Incongruent is generally considered of most theoretical contribution (Valian, 2015). Based on this, our results show a diglossic disadvantage in Flanker RTs where diglossics exhibited a larger Flanker effect (a larger difference between Congruent vs Incongruent) than monolinguals. For the other tasks, there was no difference in performance between the two groups in terms of cognitive cost. These findings will be discussed with reference to previous studies and theoretical proposals for the effect of using two languages on cognition.

Groups were not matched in variables such as education, IQ or computer usage. Despite the fact that the monolingual group had fewer males than the diglossic group, and that the diglossics (M age= 29.6) were slightly older than the monolinguals (M age= 21.6), we have not included either gender or age as covariates in our main/initial analysis. First, to our knowledge gender was not discussed in the bilingual literature as a modulator for EFs. Second, both groups still lie within the young group category; mostly defined between 18 and 40 years (Donnelly, Brooks, & Homer, 2019).

It is worth noting that the monolingual group had shorter RTs than the diglossic group across all tasks ($p<0.001$ in all cases). While a bilingual advantage in global RTs was linked to the high monitoring skills of bilinguals compared to monolinguals (Hilchey & Klein, 2011), our study fails to replicate these effects in a diglossic population; rather, our findings point towards a global disadvantage for the diglossic group. It is important to note that bilingual advantages in overall RTs were not replicated in all studies (Antón, Carreiras, & Duñabeitia, 2019; Kirk et al., 2014). In order to explain this discrepancy, some rejected bilingualism as a factor leading to faster RTs, and attributed the faster RTs sometimes found in this group to unmatched external factors such as socio-economic status (Antón et al., 2019). Since the monolinguals in our study demonstrated faster RTs than the diglossics, we cannot readily attribute this seeming diglossic disadvantage to the two groups' language experiences; indeed, we had no grounds to predict it, nor has it been reported previously. As suggested by Antón et al. (2019), this finding might be related to external factors that warrant further investigation. One candidate is task familiarity; our monolingual group were psychology students recruited for course credit who may have been familiar with the classic cognitive tasks we employed. In contrast, our diglossics were not recruited from a psychology department. Prior training was shown to result in better performance in inhibition, switching and working memory tasks (Chevalier et al., 2012; Hughes, Ensor, Wilson, & Graham, 2009; Salminen, Strobach, & Schubert, 2012) and increased processing speed (Dux et al., 2009), and this suggestion might explain our overall RT patterns. Another possible reason that could explain the longest RTs by the diglossics is that while both groups still lie within the grey area of young adults as defined by bilingual studies (Donnelly et al., 2019), the diglossics were slightly older than the monolinguals, and it was suggested that processing speed and RTs decline with age (Ferreira, Correia, & Nieto, 2015). Moreover, to ensure that there were no effects of age, also given the wide age range of our sample, in a follow up analysis we compared the maximal model with and without age. This showed no significant contribution of age in any of the tasks ($p>0.05$).

With respect to overall accuracy, a general observation in all the tasks was the high accuracy for both diglossics and monolinguals in all tasks. This suggests that the tasks could be too easy to perform. It is possible to consider then, that the obtained null results could have stemmed from using relatively easy tasks. However, RTs results still show speed differences suggesting that the tasks function properly. Further, there was no significant difference between the two groups in accuracy except in the Colour–shape switching task, where the diglossics demonstrated significantly greater accuracy than the monolinguals (although the monolingual group showed shorter RTs on the same task). This suggests a possible speed-accuracy trade-off for the diglossic group. In other words, the diglossic group were slower but more accurate than the monolingual group in deploying their switching abilities, possibly suggesting that their language experiences have made them more successful in suppressing irrelevant information, albeit at a cost in terms of speed. While an accuracy advantage is achieved by diglossics in this task, it seems logical to consider that the slow RTs by diglossics could be attributed to uncontrolled factors, such as education, IQ or the use of video games. However, this remains an uncommon finding, so we interpret it with caution.

To our knowledge, this is the first study that reports no EF advantages across the board in diglossics. Our study contradicts previous studies by Antoniou et al. (2016), who found a diglossic advantage in children, and Antoniou and Spanoudis (2020), who found a diglossic advantage in young adults. The contradiction between our and previous results might be explained in light of the amount of switching required by our diglossic group. In Arabic, the Standard dialect and regional varieties are clearly separated by context, and orally switching between the two varieties is very unlikely (Albirini, 2016). In this respect, Arabic is a good example of an SLC as described by the ACH (Green & Abutalebi, 2013), where each language/dialect is used in a specific context and switching between them rarely occurs. This contrasts with the diglossic situation in Cyprus, where switching between the two varieties occurs frequently (Pavlou, 2004), as the two varieties are not restricted to a specific context (Rowe & Grohmann, 2013). Therefore, we suggest that the diglossic advantage found in other studies (Antoniou & Spanoudis, 2020; Antoniou et al., 2016) is due to the diglossic situation in Cyprus allowing for switching between the two varieties. Importantly, our results are in line with Scaltritti et al. (2017), who reported no bidialectal advantage in EFs amongst young adults. This pattern of findings across studies calls for careful attention to the context in which each language is used in each environment, whether the case at hand is diglossia, bidialectalism or bilingualism. As discussed previously, the type and amount of code-switching cannot be assumed to be constant in each of these situations. Together, these findings suggest that it is overly simplistic to label a diglossic environment as an SLC, or a bilingual environment as a DLC, based on narrow linguistic criteria. Strong predictions about the effects of multiple language use on cognition should not be drawn based on these crude categories alone; instead, the everyday linguistic experiences of the user should be central to the formulation of predictions.

Indeed, careful examination of the context of each bilingual/bidialectal/diglossic situation may be key in solving the long-running debate regarding the existence of a bilingual advantage. The mixed results reported in the literature led some to conclude that bilingualism does not facilitate EFs, and that other factors such as cultural differences or the statistical methods used explain reports of a bilingual advantage (Paap et al., 2015). Others investigated potential alternative moderators of EFs, such as socio-economic status (Morton & Harper, 2007) and the age of second language acquisition (Kapa & Colombo, 2013; Pelham & Abrams, 2014). To date, the role of context as defined by the ACH as a mediator remains underexamined, despite studies showing the impact of the DLC in facilitating EFs relative to the SLC (Wu & Thierry, 2013; Yang et al., 2016). Similar conclusions were drawn from bidialectal studies (Kirk et al., 2014; Scaltritti et al., 2017). The relationship between language and cognition is a complex one, involving heterogeneous populations, sociocultural contexts and individual experiences. While it has been suggested that rejecting the bilingual/bidialectal or diglossic advantage altogether may be premature, researchers are also encouraged to avoid overgeneralising any discovered advantages to new populations in differing social contexts (Yang et al., 2016).

Finally, it is worth mentioning that the existence of a bilingual advantage is typically contested in the age group tested in this study. Unlike children and older adults, a bilingual advantage in EFs has rarely been reported in young adults. Thus, it is possible that the lack of diglossic advantage in our study is attributed to the age group studied. However, Antoniou and Spanoudis's (2020) discovery of a diglossic advantage in the same age group gives more strength to our argument for the importance of considering the context of language use. Nevertheless, future studies might seek evidence from older diglossics to establish whether the age differences seen in studies of bilingualism also apply to diglossia.

3.5. Conclusion

Despite the wealth of studies exploring the effect of speaking two or more languages on EFs, little research has investigated the effects of speaking two language varieties on EFs. In this study we assessed diglossic and monolingual young adults on the three components of EFs: inhibition, working memory and switching (Miyake, 2000). Our study found no diglossic advantage on these tasks, in contrast with previous findings (Antoniou & Spanoudis, 2020). Our findings show a lack of a diglossic advantage (expressed as a smaller cognitive cost) by diglossics compared to monolinguals in most of the tasks, we attribute this to the limited chances for code-switching found in the SLC. Moreover, the ACH doesn't explain the disadvantage found in diglossics in Flanker RTs where diglossics exhibited a larger Flanker effect than monolinguals. Similarly, the ACH doesn't explain overall group differences in terms of RTs or accuracy. We argue that examining the language context, in terms of the amount of code-switching employed, is essential to understanding the relationship between languages/language variations and cognition. However, context alone as described by the ACH can't explain all differences found in performance between groups. Further, we argue that no contextual assumptions should be ascribed to all bilingual or diglossic situations. Rather, careful attention should be paid to the specific code-switching requirements of each language environment.

CHAPTER 4 : EXECUTIVE FUNCTIONS ARE MODULATED BY THE CONTEXT OF DUAL LANGUAGE USE: COMPARING DIGLOSSIC AND BILINGUAL OLDER ADULTS

Abstract

Studies investigating the role of dual language use in modulating Executive Functions (EFs) have reported mixed results, with some reporting advantages in older adults. The focus of these studies has typically been on bilingual settings, while the role of dual language use in diglossic settings has been rarely investigated. In diglossia, the two language varieties are separated by context, making it an ideal test case for the Single Language Context, as defined by the Adaptive Control Hypothesis (Green & Abutalebi, 2013). However, different effects may be observed in different diglossic settings, depending on the relative language switching and use (Alrwaita, Houston-Price, & Pliatsikas, 2020). In this study, we compare the performances of three groups of older adults: Arab diglossics in the Single Language Context (n=28), bilinguals in the Dual Language Context (n=29), and monolinguals (n=41). The participants were tested using different tasks that tap into Miyake's (2000) three domains of EFs: inhibition, measured with the Flanker and Stroop tasks; switching, measured with the Colour–shape task; and working memory, measured with the Nback task. We found a diglossic advantage in the Flanker task only, while the bilinguals showed no advantages in any task. These findings are discussed with reference to theoretical proposals about how different contexts may have differential effects on EFs.

4.1. Introduction

Cognitive decline with age is a normal stage of human development. While older adults in general are expected to suffer deterioration in a variety of cognitive abilities (Salthouse, 2000), cognitive decline is particularly observed in Executive Functions (EFs) (Basak, Boot, Voss, & Kramer, 2008), usually expressed as difficulties in the speed of processing, inhibition and working memory (Nyberg, Lövdén, Riklund, Lindenberger, & Bäckman, 2012; Potter & Grealy, 2008; Salthouse, 2000). As a consequence, a considerable amount of research has been conducted to investigate whether, and how, cognitive decline can be postponed, counteracted or even reversed (Reijnders, van Heugten, & van Boxtel, 2013). Studies suggested that cognitive training programmes enhance cognitive functioning and delay cognitive decline in healthy ageing adults, and also in adults with cognitive impairments (Lustig, Shah, Seidler, & Reuter-Lorenz, 2009; Valenzuela & Sachdev, 2006). For instance, it was suggested that cognitive training using video games enhances inhibition, working memory and switching (Basak et al., 2008). However, other studies have discussed some limitations of training using computer tasks. For instance, Owen et al. (2010) observed improvements on the tasks themselves; however, they noted that these advantages are not global and do not transfer to untrained tasks. More persistent results in cognitive reserve are found in life-long experiences, including years of education, occupational attainments and leisure activities (Stern, 2012).

Similarly, the life-long experience of bilingualism has been suggested to be one of those challenging experiences that may bring about modulations in cognition (Anderson et al., 2018; Bialystok et al., 2004) and the brain (DeLuca, Rothman, Bialystok, & Pliatsikas, 2019; Pliatsikas, 2019), and lead to enhanced cognitive abilities in older adults (Bialystok et al., 2004; Samuel et al., 2018). It has even been suggested that the benefits of bilingualism in older age extend to increased cognitive flexibility and delay the onset of dementia symptoms (Bialystok, 2021; Craik, Bialystok, & Freedman, 2010). It was shown that both languages are constantly active, and competing, in the bilingual mind (Bialystok et al., 2012; Carlson & Meltzoff, 2008). This requires bilinguals to inhibit the non-target language and use the target language, leading several researchers to suggest that the bilingual cognitive system develops an advantage in executive control abilities that is not found in monolinguals (Kroll, Bobb, Misra, & Guo, 2008). Studies that investigate the bilingual advantage often focus on the three domains of EFs identified by Miyake et al. (2000): inhibitory control, switching and working memory. These studies linked bilinguals' ability to maintain attention to one language, and suppress interference from the non-target language, to their superior performances in working memory and inhibition tasks (Hoshino & Thierry, 2011; Kroll et al., 2008). Further, bilinguals' ability to switch from one language to another was linked to increased language control and monitoring skills (Bialystok, 2011; Kroll & Bialystok, 2013). Crucially, the bilingual advantage in these domains was reported more in older adults than in young adults (Paap & Greenberg, 2013), which led many to argue that it is caused by the life-long experience of frequently juggling the two languages (Kirk et al., 2014). However, other studies reported no bilingual advantage in older adults (Gathercole et al., 2014; Kirk et al., 2014; Kousaie & Phillips, 2012).

The focus has recently shifted to examining similar effects in two very common linguistic situations that are similar to bilingualism, *bidialectalism* and *diglossia*, where speakers typically use two *varieties* of the same language; however, the evidence from such situations remains limited (for a review, see Alrwaita, Houston-Price, & Pliatsikas, 2020). While the bilingual advantage remains most pronounced amongst older adults (Berkes et al., 2021), there are only a few studies that investigated whether bidialectal older adults exhibit an advantage in EFs, and these studies provide mixed results (see Houtzager et al., 2017; Hsu, 2021; Kirk et al., 2014). It has been previously argued that bidialectalism and diglossia both correspond to Single Language Contexts (SLCs) with minimal opportunities for switching between the two varieties, which might explain the lack of effects (Alrwaita et al., 2020). This is because in both diglossia and bidialectalism, there are social norms that impose a separation between the two varieties (Rowe & Grohmann, 2013; Scaltritti et al., 2017). Diglossia in the Arab world provides an ideal test case for investigating the effects such contexts have on cognition. This is due to more rigid separation between the two varieties in different contexts compared to other diglossic situations (Kaye, 2001). Specifically, in Arabic the high variety (H) is strictly used for formal purposes, and the low variety (L) is strictly used for informal purposes. Switching between these two varieties is generally unaccepted and regarded as a violation of social norms (Albirini, 2016).

In this study, we investigate whether there are effects of diglossia on EF abilities in older adults. To that end, we compare the performance of Arabic speaking older adults in the three most investigated EF domains (inhibition, switching and working memory), to that of age-matched bilinguals and monolinguals. The remainder of this introduction reviews the available evidence on the effects of using more than one language on EFs, with particular focus on the limited available evidence from bidialectalism and diglossia.

4.1.1. Bilingualism and Executive Functions

EFs are generally defined as the ability to consciously control thoughts and actions. Miyake et al. (2000) defined three main components of EFs: inhibition is the ability to suppress attention to misleading aspects and focus on a certain target, switching is the ability to switch from one task to another, and working memory/updating is the ability to temporarily hold information for processing. General cognitive abilities, including EFs, tend to decline with age (Nyberg et al., 2012). Many studies have investigated whether the decline in EFs in older age can be reduced or even prevented. One form of mental exercise that has been recently suggested to enhance EFs in older adults is bilingualism. Indeed, it has been reported that individuals speaking two or more languages have enhanced EF abilities compared to monolinguals, or that they exhibit *bilingual advantages* as expressed in smaller differences between more challenging and less challenging conditions in tasks that measure different components of EFs (for a review, see Valian, 2015). Specifically, bilinguals were reported to perform better than monolinguals in tasks measuring inhibition (Carlson & Meltzoff, 2008), switching (Prior & MacWhinney, 2010), and working memory (Luo et al., 2013). The premises behind the Bilingual Advantage Hypothesis stem from the assumption that the two languages in the bilingual mind are constantly active, and therefore bilinguals are *trained* to resist interference from one language to another (Prior & MacWhinney, 2010). The increased cognitive control in bilinguals is derived from their efficient ability to separate the two languages, which is underlined by enhanced EFs. While early studies, in general, reported bilingual advantages (Portes & Schauffler, 1994), these findings have been famously difficult to replicate, even across the same age groups and by using the same tasks (see Valian, 2015). The majority of mixed results are found across young adults, while studies with children and older adults, in particular, tend to show more consistency in reporting bilingual advantages (Berkes et al., 2021). One possible explanation is that cognitive abilities, including EFs, are in general at their peak during young adulthood, which makes it difficult to find differences between groups (Bialystok et al., 2005). As already mentioned, evidence from older adults appears more consistent (Berkes et al., 2021). It is suggested that the life-long training of older bilinguals in managing the two languages leads to improved EFs. Older bilinguals were reported to perform better than aged-matched monolinguals in inhibition, switching and working memory tasks (Bialystok et al., 2004; Gold et al., 2013; Luo et al., 2013).

In a seminal paper, Green and Abutalebi (2013) introduced the Adaptive Control Hypothesis (ACH), which claims that language control processes themselves adapt to the demands imposed on them by the particular interactional language context. Green and Abutalebi (2013) described a set of language control processes that underlie EFs and support conversations in different contexts: (a) goal maintenance, which involves maintaining a goal as speaking one language while ignoring the other; the processes of goal maintenance require (b) interference control, which encompasses the two processes of conflict monitoring, which is responsible for monitoring conflict, and interference suppression, which is responsible for suppressing interference; (c) salient cue detection, which entails detecting cues requiring speakers to switch from one language to another; (d) selective response inhibition, which involves inhibiting speaking the current language to speak the other; (e) task disengagement, which involves stopping the use of one language in conversations; (f) ask engagement, which entails engaging in the other language; and (g) opportunistic planning, which involves adapting words from one language to fit the structure of another language. The ACH focuses on the different contexts in which bilinguals use their languages, and how this can affect EFs differently. According to the ACH, three main conversational contexts can be defined: (a) the SLC, in which bilinguals use each language in a separate context (e.g., work or home), and each language is reserved for a specific context, leading to less switching between them; (b) the Dual Language Context (DLC), in which bilinguals use both languages in one context (e.g., home), whereby in this situation switching between the languages happens more frequently than in the SLC; and (c) the Dense code-switching Context, which refers to switching between the two languages within one utterance. According to Green and

Abutalebi (2013), because the DLC does not allow for switching within one utterance, it requires higher levels of language control than the other two contexts, followed by the SLC and finally, the Dense code-switching Context. Crucially, the higher needs of control in the DLC should be expected to impose higher demands on EFs than the other two contexts. As a result, bilinguals in the DLC are expected to engage with, and show related enhancements in, most of the language control processes that are listed above. Similarly, bilinguals in the SLC, who constantly need to avoid switching, should be expected to mostly engage with, and enhance, goal maintenance, but not the rest of the control skills; in any case, they should be expected to show more enhanced cognitive control than bilinguals in Dense code-switching Contexts, who have limited needs for language control. Indeed, several studies reported results supporting the predictions of the ACH; for instance, Kirk et al. (2014) argued that bilingual older adults in DLCs show more enhanced inhibition than older adults in SLCs.

4.1.2. Bidialectalism/diglossia and Executive Functions

Diglossia and bidialectalism provide good examples of SLCs, as they usually feature a clear separation of use between two varieties of the same language, with minimal opportunities for switching (Alrwaita et al., 2020; Kirk et al., 2014). Consequently, if there is any enhancement in EFs by diglossics and bidialectals, this should be detected in tasks such as Flankers and Stroop that tap the relevant process of goal maintenance, but not across the board, as you would expect from populations in DLCs. However, it was argued that diglossic environments impose more rigid rules for reserving each variety in its specific context (Alrwaita et al., 2020), which makes them more representative examples of SLCs compared to bidialectal environments. Diglossia is characterised by the co-existence of an H (Standard), which is used for formal purposes, and an L (colloquial dialect), which is used for informal purposes and everyday communications

(Ferguson, 1959). On the other hand, bidialectalism is known as the breakage of the typical H and L found in diglossia into a continuum of dialect usage (Rowe & Grohmann, 2013). In bidialectalism, speakers shift from one language variety to the other depending on the particular sociolinguistic situations; for instance, whether the addressee understands that variety or not (Masica & Sinha, 1986).

Recently, a few studies investigated EF abilities in bidialectalism and diglossia (for a review, see Alrwaita et al., 2020). Amongst them only three studies investigated bidialectal advantages in older adults. Kirk et al. (2014) used the Simon task to compare the inhibitory control abilities of Dundonian Scots–English bidialectals, Gaelic–English bilinguals, bilingual immigrants residing in the United Kingdom (UK) who spoke English and another language (Bengali, Gujarati, Hindi Malay, Punjabi and Urdu), and English monolinguals, all over the age of 60. The results revealed the expected Simon effect, that is, longer reaction times (RTs) for the more cognitively challenging Incongruent trials (when the response key is located on the opposite side of the target stimuli), compared to Congruent trials (when the response key and the target stimuli are on the same side). However, there was no significant effect of Group and also no significant interaction between Group and Condition; in other words, none of the groups showed a reduced Simon effect that would suggest enhanced EFs (Bialystok et al., 2004). The authors referred to the ACH to explain the observed null results. Specifically, they used the schooling contexts of their participants to argue for the possibility that most bilinguals were in SLCs rather than the DLCs, because Gaelic–English bilinguals were educated only in English but not in Gaelic, whereas bilingual immigrants had been educated only in their first language. However, the authors did not provide information about the schooling contexts and language switching patterns for bidialectal Dundonian Scots–English, to compare them to the other groups. Therefore, there remains the possibility that bidialectals, along with some bilinguals, could have been in DLC or Dense code-switching contexts. Perhaps most importantly, given that the participants were older adults, using the schooling context does not provide information about recent language use and switching, which may have been limited and, as a result, may have not led to any measurable cognitive effects.

In another study, Houtzager et al. (2017) investigated bidialectal advantages in switching abilities amongst 50 Frisian–Dutch bidialectals, and 50 German monolinguals who were divided into two groups, a middle-aged group (35–56 years), and an older adults' group (65–85 years). The participants' switching ability was tested using the Colour–shape task, and working memory was tested using the Corsi block task. After taking into account the effects of age and working memory, the authors reported a bidialectal advantage in switching cost, as the difference between repetition and switching trials in the Colour–shape task was smaller for the bidialectals compared to the monolinguals. Additionally, it was found that older bidialectals were less affected by an age-related increase in switching costs than the monolinguals. The authors concluded that the life-long experience of using two dialects leads to enhanced switching abilities in older age. More recently, Hsu (2021) investigated whether there is a bidialectal advantage amongst Hakka–Mandarin and Minnan–Mandarin bidialectal older adults (Mean age= 68.7), when compared to age-matched Mandarin monolinguals, and whether this advantage was consistent across verbal and non-verbal tasks with different difficulty levels. Their first experiment included four non-verbal tasks: Stroop and Flanker (easy), Spatial One back (intermediate) and Stroop colour–word (difficult). The bidialectals showed an advantage only in the Stroop task, where unlike the other tasks the target itself also contains the distraction, making it relatively more difficult to avoid interference. The second experiment included four verbal tasks: Number Stroop (easy), Stroop colour–

word (intermediate), Stroop day–night (intermediate), and Stroop picture-naming (very difficult). The results suggest a bidialectal advantage only in tasks with intermediate difficulty (Stroop colour–word, Stroop day–night). Hsu (2021) concluded that the cognitive advantages of EFs extend beyond bilingualism to bidialectalism. However, this bidialectal advantage will only be found in tasks with appropriate levels of difficulty (not too easy and not excessively difficult).

The limited evidence from studies on bidialectalism suggests that bilingual advantages in EFs might extend to situations where two varieties of the same language are spoken. However, as already mentioned, bidialectalism may not be a strong example of an SLC, at least in comparison to diglossia, which is generally thought to impose strict separation in the use of the two varieties (Kaye, 2001; Rowe & Grohmann, 2013). To date, there are no studies investigating the potential diglossic advantages in older adults, and the two studies conducted with young adults (aged 20–30) provide contradicting evidence. Specifically, Antoniou and Spanoudis (2020) tested multilingual speakers of Standard Modern Greek (SMG), Cypriot–Greek (CG) and other languages, CG–SMG diglossics, and SMG monolinguals. The participants' inhibition, working memory, and switching were measured. The results indicated that multilinguals and diglossics with high proficiency in SMG outperformed monolinguals in all EF domains. However, these results were not replicated in a recent study where Arabic diglossic young adults (aged 21–29) did not show an advantage over monolinguals in any domain of EFs (Alrwaita, Meteyard, Houston-Price, & Pliatsikas, 2021). In order to explain the contradiction between the two studies, Alrwaita et al. (2021) argued that Cypriot–Greek diglossia is amongst many diglossic situations that are transitioning into a type B diglossia, or *diaglossia*: a state in which the Standard variety is used for spoken purposes, negating the clear separation of the two varieties in typical diglossia (Auer, 2005; Rowe & Grohmann, 2013). Therefore, the environment in Cyprus allows for more switching than typical diglossic environments, such as those in Arabic-speaking countries (Kaye, 2001; Pavlou, 2004). However, the possibility remains that the lack of advantage found in Alrwaita et al. (2021) is due to testing young adults, which rarely leads to a reported advantage, even in bilingual studies (Bialystok et al., 2005). This warrants further investigation on an age group that has more consistently reported bilingual advantages in similar tasks (Berkes et al., 2021).

4.1.3. This study

To date, there is no study that investigated the effects of diglossia on EFs amongst older adults, and the two available studies on the effects of diglossia in young adults provide contradicting results (Alrwaita et al., 2021; Antoniou & Spanoudis, 2020); Considering that Arabic provides a clear separation between the two varieties, which may not apply to diglossia in Cyprus (Pavlou, 2004; Rowe & Grohmann, 2013), and considering that the expected advantages are more likely to be reported in older participants (Berkes et al., 2021), further research focusing on older diglossics is warranted. The present study follows up on Alrwaita et al. (2021) by using the same methods but with a different age group, namely, Arabic diglossic older adults aged 50–78 years. Moreover, this study directly compares the performance of bilinguals and diglossics, which will allow for the examination of the predictions of the ACH in different conversational contexts, as provided by bilingualism and diglossia, respectively (Green & Abutalebi, 2013). The participants will be tested in tasks that tap the three components of EFs: inhibition (Flanker and Stroop tasks), switching (Colour-shape task) and working memory (Nback task) (Miyake et al., 2000). Based on the predictions of the ACH, and presuming that the diglossics belong to an SLC, and that the bilinguals belong to a DLC, we predicted the following patterns for our tasks: for the Flanker and Stroop tasks, which are thought to tap goal maintenance and interference control, we predicted that both the diglossics and bilinguals will show enhanced performance compared to the monolinguals, expressed as smaller cognitive cost, as increased demands on these processes are expected in both SLCs and DLCs. Further, including two inhibition tasks, Flanker measuring non-verbal inhibition and Stroop measuring verbal inhibition, will allow for testing the effect of verbal load on performances on inhibition tasks, as it has been suggested that bilinguals show disadvantage in verbal inhibition tasks (Hsu, 2017). The rationale behind this claim is that bilinguals have significantly bigger vocabulary size, which makes accessing and retrieving words in verbal inhibition tasks difficult (Hsu, 2017). For the Colour–shape task, which taps the processes of selective response inhibition, task engagement, and task disengagement, we expected enhanced performance by the bilinguals compared to both other groups, expressed as smaller switching costs. This is because DLCs are expected to create increased demands for these particular processes, as DLC speakers are trained to speak one language (task engagement), and switch to the other language (task disengagement). Selective response inhibition is required when speakers need to change the goal (speaking one language or the other). Finally, considering that in their original paper Green and Abutalebi (2013) did not indicate any control processes to be facilitated by a working memory task, we expected no enhanced performance in the Nback task, expressed as a small difference between One back and Two back conditions, by either the diglossics or the bilinguals. However, we included a working memory task to exclude any possibility of a general cognitive advantage.

4.2. Methods

4.2.1. Participants

Ninety-eight older adults participated in this study, consisting of 28 Arabic speaking diglossics (22 females: age 50–78, mean age= 58.3, SD= 7.08), 41 English speaking monolinguals (25 females: age 51–84, mean age= 66.6, SD= 11.4), and 29 Language two (L2) English bilinguals (21 females: age 50–72, mean age= 59.6, SD= 7.2). Prior to testing, all participants gave written consent for their participation. The Arabic speaking adults were recruited from educational sectors in Riyadh, Saudi Arabia. The English speaking monolinguals and bilinguals were recruited online and were tested at the department of Psychology and Clinical Language Sciences, the University of Reading.

The diglossics lived in Saudi Arabia at the time of testing. The diglossic group reported the acquisition of Standard Arabic through formal education, starting at the age of six to seven years. The majority of the diglossic group were born in Saudi Arabia, whereas two were born in Lebanon and had lived in Saudi Arabia for more than 25 years. All of the diglossic group reported Arabic as their first and only proficient language. Most of this group reported some exposure to English, mostly at school, while four participants reported occasional exposure to English when traveling abroad. None of the diglossic group reported a daily exposure to English or any other languages. Diglossics reported using Arabic inside and outside home.

The bilingual participants lived in the UK at the time of testing. The bilinguals used English for everyday communication and were native speakers of a variety of languages, including German, Dutch, French, Polish, Swedish, Danish, Catalan and Ukrainian. In addition to speaking English and their native language, 22 of the bilingual participants also reported speaking an additional language. Most of this group were not born in the UK, but had moved there at different ages. Only two participants of this group were born in the UK; however, they reported that English was not used at home. One participant reported that they were born in the Netherlands and grew up in a home where both Dutch and English were spoken. The majority of the bilingual group learned English through formal education (M age of acquisition= 10.64; SD= 5.98). Further, the bilingual participants were immersed in their L2 environment for a long period (M of residence in the UK= 27.1 years; SD= 16.52), suggesting they were long-term active users of their L2. Bilinguals had jobs in the UK requiring daily exposure to English; such as teachers, engineers, and professors. All bilinguals also reported active usage of English outside home.

The monolingual participants lived in the UK at the time of testing. Thirteen of the monolingual participants reported some exposure to an additional language, mostly at school. However, no one in the monolingual group reported a present exposure to any additional language. Any active communication in L2 that was reported had taken place decades before testing.

4.2.2. Background and proficiency measures

To measure the language experience of our bilingual and monolingual groups, and to ensure correct group membership, both groups were tested using the Language and Social Background Questionnaire (LSBQ) (Anderson et al., 2018). The LSBQ is a self-rating questionnaire examining the level of language use and exposure to one or more languages. The LSBQ asks questions about the domains in which each language is used, and the participants are also asked to rate their language skills in reading, writing and listening. The LSBQ showed that monolinguals use only English in different activities such as reading, chatting and watching TV. Further, the LSBQ produces a composite score that reflects the participants' level of bilingual engagement. The composite score is computed by summing the factor scores weighted by the variance in each factor scores (English proficiency, non-English social use and non-English home use and proficiency). Non-English home use and proficiency contributes the highest to the composite score (0.33), while English proficiency contributes the least to the composite score (0.11). The contribution of the non-English social use is (0.30). Questions assessing the frequency of using non-English during different life stages, and with different speakers are used to calculate non-English home use scores. Questions assessing non-English use in different domains are used to calculate non-English social use scores. Finally, self-rating questions assessing English understanding, speaking, reading and writing are used to calculate scores for English proficiency. According to Anderson et al., (2018), participants scoring -3.13 or below are classified as monolinguals, while participants scoring 1.23 or above are classified as bilinguals (Anderson et al., 2018). The monolinguals in our study had a mean score of -5.6981 (SD=3.65), with composite scores ranging between -6.83 to -7.28, meaning that all monolinguals are classed as monolinguals according to the LSBQ. Monolinguals reported no, or rare switching in the three switching domains. For switching with family monolinguals scored between 0.27 to -1.11, for switching with friends monolinguals scored between 0.32 to -0.43, and for switching in social media monolinguals scored between -0.46 to -0.46.

On the other hand, bilinguals have reported active usage of the both languages in activities such as shopping, sending emails, reading, chatting with friends, watching TV, using the internet and texting. LSBQ composite scores show that the bilinguals had a mean score of 17.368 (SD=1.36), with composite scores ranging between 24.93 to 10.40, meaning that all bilinguals are classed as bilinguals according to the LSBQ. Bilinguals have scored higher than monolinguals and diglossics in the three switching domains. For switching with family, bilinguals scored between 1.65 to -1.11. For switching with friends, bilinguals scored between 1.09 to -0.43. Finally, for switching in social media bilinguals scored between 1.76 to -0.46.

To ensure that our diglossic group had sufficient use of both the Standard and the spoken varieties, we created a version of the LSBQ that investigated the degree of dialect use, and the domains in which these dialects were used (Appendix A). The Arabic speaking diglossics were asked to fill only the adapted version of the LSBQ. In our version of the LSBQ, our diglossic group have achieved generally lower scores in the factor scores (L2 social use and L2 home use and proficiency) than bilinguals, resulting in a mean composite score of -0.21 (SD=2.6). According to Anderson et al. (2018), indviduals scoring between 1.23 and -3.13 are those with ambiguous language backgrounds, and are in a grey area between monolingualism and bilingualism. Diglossics composite scores range between 11.46 to -2.13. Further, for switching with friends diglossics scored between 0.71 to -0.43, for switching with family diglossics scored between 0.96 to -1.11, and for switching on social media diglossics scored between 1.20 to -0.46. While it can be argued that diglossics acheived relatively lower scores than bilinguals in the domians of switching, the difference between the two groups in switching scores is still quite small. Most importantly, results from the LSBQ show that the three groups (bilinguals, monolinguals and diglossics) have different composite scores which don't overlap.

Because both the level of education, and exposure to the Standard variety, add to the knowledge of Standard Arabic (Kaye, 2001), a vocabulary test was used to assess the proficiency in Standard Arabic of all the diglossic participants. This was designed by Masrai and Milton (2019) in the form of a checklist, which includes words from those most frequently used in Arabic. A native Arabic speaker of around 20 years old is expected to have knowledge of 20,000 words, and this number is expected to increase with age (Masrai & Milton, 2019). The test comprises 120 items, containing real words, and non-real words intermixed. In order to make a calculation of 50,000 words of individuals vocabulary score, each yes answer to real words is given a score of 500, this is to form an unadjusted vocabulary score. Also, each false yes answer to a false word deducts 2500 points from the unadjusted score given to the adjusted vocabulary score. According to Masri and Milton (2019), the final adjusted score reflects the total vocabulary knowledge. Our diglossic group had an average of 89 (SD=9.82) of yes responses to real words, an average of 5.42 (SD= 3.06) to yes responses to non-words, and an estimated average of 30,928.57 (SD=678) words. No participant was excluded based on performances in the vocabulary test.

4.2.3. Executive Functions tasks

To measure inhibition, two tasks were used these are Flanker and Stroop. To measure switching, the Colour-shape task was used. Finally, to measure Working memory the Nback task was used. All of the tasks were delivered using E-prime 2.0 software (Psychology Software Tools, PA). We used the same tasks as Kendrick et al (2019) with no changes in stimuli or how tasks are delivered. A 15.6-inch computer screen was used to present all the tasks. All participants were tested in private rooms. For the diglossic group, instructions and texts were changed to Arabic.

4.2.3.1. Inhibition

Inhibition was measured using two tasks, Flanker to test non-verbal inhibition and Stroop to test verbal inhibition.

4.2.3.1.1. Flanker

This task included three conditions. In all conditions, a central arrow appeared on the screen and the participants had to indicate the direction of this arrow using either (<) or (>) buttons on the keyboard. The participants had to respond as fast and as accurate as possible. First, in the Congruent condition, there were surrounding (flanking) arrows which appeared on the same direction as the target central arrow (<<<<<). Second, in the Neutral condition, the target central arrow appeared with dashes on both sides (--**<** --). Finally, in the Incongruent condition, the surrounding arrows pointed to the opposite direction of the target central arrow (>> **<** >>). Each condition included forty-four trials that were distributed in four blocks which included 33 trials each, 11 per condition, appearing in a random order. Each trial began with a 250 ms fixation cross, followed by a stimulus which lasted for 5000 ms, or until a response was detected. A blank screen appearing for 250 ms separated trials from each other.

4.2.3.1.2. Stroop

A single word appeared on the screen and participants had to decide the ink colour of the word presented. The task included three conditions. First, in the Congruent trial, the word presented was consistent with the ink colour, for example the word *red* was presented in a red ink. Second, in the Neutral trials, neutral words were presented in different ink colours. Finally, the Incongruent trials consisted of colour words which were inconsistent with the ink colour, for example; the word *red* appeared in a blue ink. The three different colours (blue, green and red) were assigned to three adjacent keyboard buttons, and the participants were asked to respond by clicking the corresponding button.

Forty-eight trials of the three conditions were distributed in three blocks, each condition consisted of 48 randomized trials, with a total of 144 trials. Each trial began with a 250 ms fixation cross, followed by a stimulus which stayed on the screen for a maximum of 5,000 ms, or as soon as a response was provided. The same task was translated to Arabic for the diglossic group.

4.2.3.2. Switching

4.2.3.2.1. Colour–shape task

Three different patterns were presented to the participants in either red, green or blue. There were three blocks of the task; first, in the blocked colour task; two patterns were presented on the screen and the participants were asked to decide if the patterns had the same or different colours. Second, in the blocked pattern task, two patterns were presented on the screen and the participants had to decide if the pattern was different or the same. Third, in the switching task, the participants had to switch between colour or pattern. In each trial, the word colour or pattern was presented on the top of the screen indicating if the participants should respond to colour or pattern. The participants were asked to press either the S button on the keyboard for "same", or the D button on the keyboard for "different".

The task included a total of 124 trials. The blocked colour task and the blocked pattern task each included a total of 31 trials. As for the switching block, it included a total of 62 randomized trials consisting of 31 Stay trials, where the participants had to carry out the same task as the previous trial, and 31 Change trials, where the participants had to change to another task compared to the previous trial. Each trial began with a 100 ms central fixation cross, followed by a stimulus presentation until a response was detected. The trials were separated by a 250 ms blank screen.

4.2.3.3. Working memory

4.2.3.3.1. Nback

This task included two conditions with different working memory load; One back and Two back. In both conditions, a number between 1 to 9 was presented on the screen. In the One back condition, the participants had to decide if the number which appeared on the screen was the same as the number which appeared one trial before. In the Two back condition, the participants had to decide if the number which appeared on the screen was the same as the number which appeared two trials before. The participants were asked to press a key if the answer was yes, and to not press anything if the answer was no.

There was a total of 117 trials, of which 36 were target trials. The trials were distributed in four blocks, each containing nine targets. The ratio of trial to target was 31% for the One back and 32% for the Two back. At the beginning of each trial, a stimulus was presented for 500 ms. After that, a blank screen appeared for 1,500 ms. This allowed a 2,000 ms for the participant to make a decision before another trial appeared. No more than two trials with targets appeared consecutively.

4.3. Results

All data were analysed by running generalised linear mixed-effects models with the statistical package Ime4 (Bates et al., 2018) on R studio (version 4.0.3). The RTs were not normally distributed, so they were log-transformed for use as the dependent variable in a mixed-effects model. Age was included as a covariate in all analyses. We included treatment coded fixed effects of group (bilinguals, diglossics, monolinguals), condition (Congruent, Incongruent, Neutral) and interactions between group and condition. The reference level for group was bilinguals and the reference level for condition was Congruent. For condition, we compensated for the third missing comparison between

Incongruent and Neutral by using relevel. Incongruent was also used as the reference level to get coefficients for the Incongruent vs. Neutral comparisons. For group, we compensate for the third missing comparison between monolinguals and diglossics by using relevel. We then used monolinguals as the reference level to get coefficients for monolinguals vs diglossics.

4.3.1. Flanker

The RTs from all groups were screened for extreme values, defined as anything that exceeded 2,500 ms, or was less than 200 ms. Extremes values were excluded. This affected 4% of the Diglossic data, 1.2% of the Monolingual data, and 1.6% of the Bilingual data. These outliers were removed for analysis of accuracy and RTs.

4.3.1.1. Accuracy

Table 4.1: *Mean accuracy (SD) per Group and per Condition for the Flanker task.*

	Congruent	Incongruent	Neutral
Bilinguals	99% (0.07)	96% (0.19)	99% (0.10)
Monolinguals	100% (0.06)	97% (0.15)	99% (0.71)
Diglossics	95% (0.22)	94% (0.23)	95% (0.22)

Table 4.1 presents the accuracy data for the Flanker task. Optimisation for the mixed model required more than 10,000 iterations, and to avoid warnings, we increased the number of iterations to 100,000. A maximal model with random intercepts for subject and a random slope for Condition did not converge. We removed the random slope for Condition and the model converged, this model is reported in Table 4.2.

The model coefficients showed that the Diglossics (M *correct responses*= 0.945, SD(0.227)) were significantly less accurate than both the Bilinguals (M *correct responses*= 0.981, SD(0.136)) (β=-3.973,SE=0.917,t(.)=-4.331,p<0.001), and the Monolinguals (M *correct responses*= 0.988, SD(0.107)) (β=-1.638,SE=0.788,t(.)=-

2.077,p=0.037). However, there was no significant difference between the Monolinguals and Bilinguals.

Results also revealed that Incongruent (M *correct responses*= 96%, SD(0.194)) was significantly less accurate than both Congruent (M *correct responses*= 98%, SD(0.134)) (β=-2.827,SE=0.518,t(.)=5.251,p<0.001) and Neutral (M *correct responses*= 97%, SD(0.143)) (β=2.300,SE=0.438,t(.)=5.240,p<0.001). However, there was no difference between Congruent and Neutral.

There was a significant interaction between Group and Condition in Congruent and Incongruent, where the Diglossics showed a smaller difference between the two Conditions than the Bilinguals (β=2.445,SE=0.579,t(.)=4.218,p<0.001) and the Monolinguals (β=1.795,SE=0.525,t(.)=3.414,p=0.000). Also, there was a significant interaction between Incongruent and Neutral, where the Diglossics showed a smaller difference between the two Conditions than the Bilinguals (β=-1.654,SE=0.516,t(.)=-3.203,p=0.001) and the Monolinguals (β=-1.231,SE=0.491,t(.)=-2.505,p=0.012).

Finally, the effect of age was not significant (β=0.007,SE=0.032,t(.)=0.227,p=0.820).

Table 4.2: *Generalised linear mixed effects model results for Flanker accuracy.*

Fixed Effects				
	Est/Beta	SE	t value	p value
Intercept	7.877	2.114	3.725	p<0.001
Condition:				
Congruent vs Incongruent	-2.827	0.518	-5.415	p<0.001*
Congruent vs Neutral	-0.527	0.591	-0.891	p=0.372
Incongruent vs Neutral	2.300	0.438	5.240	p<0.001*
Group:				
BI vs DI	-3.973	0.917	-4.331	p<0.001*
BI vs MONO	-0.538	1.001	-0.538	p=0.590
DI vs MONO	-1.638	0.788	-2.077	p=0.037*
Age:	0.007	0.032	0.227	p=0.820
Group x Condition interaction:				
Congruent vs Incongruent				
BI vs DI	2.445	0.579	4.218	p<0.001*
DI vs MONO	1.795	0.525	3.415	p=0.000*
BI vs MONO	0.649	0.691	0.940	p=0.347
Congruent vs Neutral				
BI vs DI	0.791	0.656	1.205	p=0.228
DI vs MONO	0.564	0.622	0.908	p=0.364
BI vs MONO	0.226	0.809	0.280	p=0.779
Incongruent vs Neutral				
BI vs DI	-1.654	0.516	-3.203	p=0.001*
DI vs MONO	-1.231	0.491	-2.505	p=0.012*
BI vs MONO	0.423	0.600	-0.706	p=0.480

Random Effects		
	Variance	S.D.
Subject (Intercept)	5.387	2.231
Model fit		
R^2	Marginal	Conditional
	0.22	0.70

Key: p-values for fixed effects calculated using Satterthwaite approximation, and the Tukey method.
Model equation: glmer(Accuracy ~ Condition * Group+(1 |Subject), data=Flanker, family="binomial")

4.3.1.2. Reaction Times

For the analysis of the RTs, all incorrect trials were removed. This affected 5% of the Diglossic data, 1% of the Monolingual data and 2% of the Bilingual data.

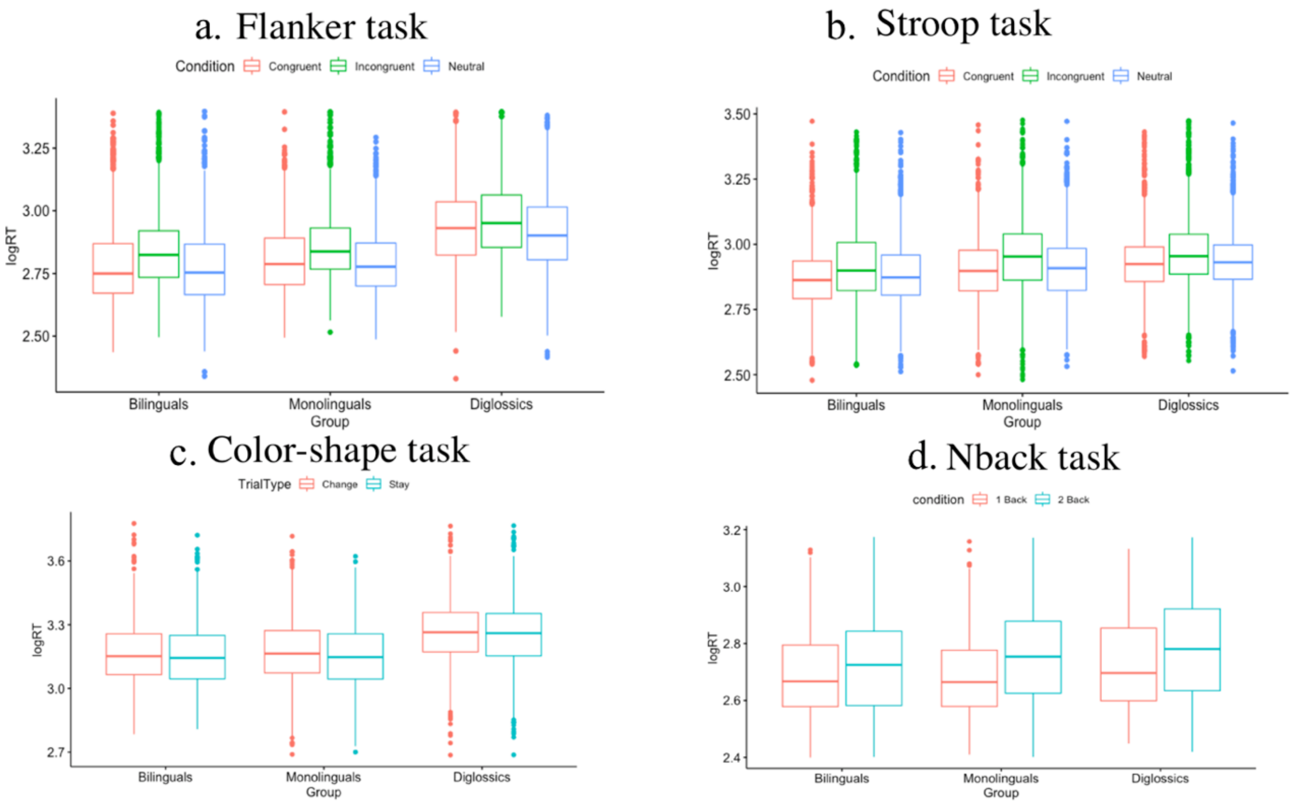

Figure 4.1: Reaction Times for Diglossics, Monolinguals and Bilinguals across conditions for Flanker, Stroop, Colour–shape and Nback.

Figure 4.1a illustrates the RT data for the Flanker task. A maximal model with random intercepts for subject and a random slope for Condition converged without errors (for the results, see Table 4.3).

The model coefficients showed that the Diglossics (M *RTs*= 2.936 sec, SD(0.168)) were significantly slower than both the Bilinguals (M *RTs*= 2.801 sec, SD(0.158)) (β=0.169,SE=0.032,t(90.47)=5.207,p<0.001), and the Monolinguals (M *RTs*= 2.818 sec, SD(0.134)) (β= 0.163,SE=0.032,t(91.79)=4.992, p<0.001). There was no significant difference between the Bilinguals and Monolinguals.

The Incongruent trials (Mean *RTs*= 2.88 sec, SD(0.15)) were significantly slower than both the Congruent trials (M *RTs*= 2.833 sec, SD(0.163)) (β=0.070,SE=0.007,t(87.02)= 9.648,p<0.001), and the Neutral trials (M *RTs*= 2.822, SD(0.159)) (β=-0.073,SE=0.007,t(87.48)=-9.918,p<0.001). There was no difference between the Neutral and Congruent trials.

For the Congruent and Incongruent trials there was a significant interaction between Group and Condition. While the Incongruent trials were slower than the Congruent trials, the Diglossics showed a smaller Flanker effect than the Bilinguals (β=-0.031,SE=0.010,t(88.12)=-2.995,p=0.003), and a near significant difference between the Diglossics and Monolinguals, where the Diglossics showed a smaller Flanker effect (β=-0.017,SE=0.009,t(88.14)=-1.802,p=0.074). There was no significant difference between the Bilinguals and Monolinguals.

For Congruent versus Neutral, there was a significant interaction. While the Congruent trials were overall slower than the Neutral trials, the Bilinguals showed a smaller difference between the two conditions than the Diglossics (β=-0.015,SE=0.005,t(88.70)=-2.585,p=0.011) and the Monolinguals, with the latter effect only approaching significance (β=-0.010,SE=0.005,t(85.95)=-1.910,p=0.059).

For Incongruent versus Neutral, there was a near significant interaction. While the Incongruent trials were overall slower than the Neutral trials, the Diglossics showed a smaller difference between the two conditions than the Monolinguals ($\beta=0.017, SE=0.005, t(88.14)=1.802, p=0.075$).

Finally, the effect of age was significant ($\beta=0.002, SE=0.001, t(89.85)=1.053, p=0.042$), indicating a positive correlation between age and RTs.

Table 4.3: *Linear mixed effects model results for the Flanker reaction times.*

Fixed Effects	Est/Beta	SE	t value	p value		
Intercept:	2.6118	0.0843	30.954	p<0.001*		
Condition:						
Congruent vs Incongruent	0.070	0.007	9.648	p<0.001*		
Congruent vs Neutral	-0.003	0.004	-0.842	p=0.402		
Incongruent vs Neutral	-0.073	0.007	-9.918	p<0.001*		
Group:						
BI vs DI	0.169	0.032	5.207	p<0.001*		
BI vs MONO	0.006	0.031	0.210	p=0.834		
DI vs MONO	0.163	0.032	4.992	p<0.001*		
Age:	0.002	0.001	1.053	p=0.042*		
Group x Condition interaction:						
Congruent vs Incongruent						
DI vs BI	-0.031	0.010	-2.995	p=0.003*		
DI vs MONO	-0.017	0.009	-1.802	p=0.074		
BI vs MONO	-0.013	0.009	-1.453	p=0.149		
Congruent vs Neutral						
BI vs DI	-0.015	0.005	-2.585	p=0.011*		
DI vs MONO	-0.004	0.005	-0.913	p=0.363		
BI vs MONO	-0.010	0.005	-1.190	p=0.059		
Incongruent vs Neutral						
BI vs DI	0.016	0.010	1.517	p=0.132		
DI vs MONO	0.017	0.005	1.802	p=0.075		
BI vs MONO	0.003	0.009	0.382	p=0.703		
Random Effects						
		Variance	S.D.	Correlation matrix		
Subject (Intercept)		0.01452	2.149	Subject (intercept)	Congruent vs Incongruent	Congruent vs Neutral
Condition (Slope):						
Congruent vs Incongruent		0.001	2.025	-0.09		
Congruent vs Neutral		0.000	0.164	-0.63	-0.09	
Incongruent vs Neutral		0.001	2.042	-0.27	0.99	0.25
Residual		0.008	0.092			
Model fit						
R^2		Marginal	Conditional			
		0.19	0.69			

Key: DI: Diglossics, BI: Bilinguals, MONO: Monolinguals
P-values for fixed effects calculated using Satterthwaite approximation, and the Tukey method.
Model equation: lmer(logRT ~ Condition * Group + Age + (1+Condition|Subject), data=Flanker)

4.3.2. Stroop

The RTs from both groups were screened for extreme values, defined as anything that exceeded 2500 ms, or was less than 200 ms. Extreme values were excluded, affecting 1.2% of the Diglossic data, 1.2% of the Monolingual data, and 0.6% of the Bilingual data. These outliers were removed for analysis of accuracy and RTs.

4.3.2.1. Accuracy

Table 4.4: Mean accuracy (SD) per group and per condition for the Stroop task.

	Congruent	Incongruent	Neutral
Bilinguals	100% (0.06)	99% (0.08)	99% (0.07)
Monolinguals	100% (0.05)	99% (0.09)	100% (0.07)
Diglossics	99% (0.10)	98% (0.13)	99% (0.07)

Table 4.4 presents the accuracy data for the Stroop task. Model optimisation required more than 10,000 iterations, and to avoid warnings, we increased the amount of iterations to 100,000. A maximal model with random intercepts for subject and a random slope for Condition converged without errors (for the results, see Table 4.5).

The model coefficients showed that the Bilinguals (M *correct responses*= 0.994, SD(0.07)) were not significantly different than the Diglossics (M *correct responses*= 0.988, SD(0.107)), or Monolinguals (M *correct responses*= 0.993, SD(0.077)). There was also no significant difference between the Monolinguals and Diglossics.

Similarly accuracy in the Congruent trials (M *correct responses*= 94%, SD(0.075)), was not significantly different to the Incongruent trials (M *correct responses*= 98%, SD(0.106)) or the Neutral trials (M *correct responses*= 99%, SD(0.07)). There was no significant difference for accuracy when comparing Incongruent and Neutral conditions.

The model coefficients also showed that there were no significant interactions between Groups and Conditions.

Finally, the effect of age was not significant (β=0.016,SE=0.018,t(.)=0.905,p=0.365).

Table 4.5: Generalised linear mixed effects model results for Stroop accuracy.

Fixed Effects						
	Est/Beta	SE	z value	p value		
Intercept	5.456	1.336	4.083	p<0.001*		
Condition:						
Congruent vs Incongruent	-1.003	0.894	-1.122	p=0.262		
Congruent vs Neutral	0.143	1.002	0.143	p=0.886		
Incongruent vs Neutral	1.154	1.056	1.091	p=0.275		
Group:						
BI vs DI	-1.108	0.717	-1.545	p=0.122		
BI vs MONO	-0.052	0.782	-0.067	p=0.947		
DI vs MONO	-1.055	0.669	-1.577	p=0.114		
Age:	0.016	0.018	0.905	p=0.365		
Group x Condition interaction						
Congruent vs Incongruent						
BI vs DI	0.285	0.875	0.326	p=0.744		
DI vs MONO	-0.738	0.774	-0.953	p=0.340		
BI vs MONO	-0.452	0.919	-0.492	p=0.623		
Congruent vs Neutral						
BI vs DI	1.060	0.889	1.192	p=0.233		
DI vs MONO	0.958	0.788	1.215	p=0.224		
BI vs MONO	0.101	0.914	0.111	p=0.912		
Incongruent vs Neutral						
BI vs DI	0.766	1.195	0.641	p=0.521		
DI vs MONO	0.738	0.774	0.953	p=0.340		
BI vs MONO	0.549	0.942	0.583	p=0.559		
Random Effects						
		Variance	S.D.	Correlation matrix		
Subject (Intercept)		1.865	1.365	Subject (intercept)	Congruent vs Incongruent	Congruent vs Neutral
Condition (Slope):						
Congruent vs Incongruent		2.829	1.682	-0.77		
Congruent vs Neutral		0.781	0.886	-0.29	0.34	
Incongruent vs Neutral		2.606	1.614	-0.11	0.86	0.20
Model fit						
R^2		Marginal	Conditional			
		0.10	0.45			

Key: DI: Diglossics, BI: Bilinguals, MONO: Monolinguals
P-values for fixed effects calculated using Satterthwaite approximation, and the Tukey method.
Model equation: glmer(Accuracy ~ Condition * Group +(1+Condition|Subject), data= Stroop, family="binomial"

4.3.2.2. Reaction Times

Along with extreme values, all incorrect trials were removed. This affected 1.2% of the Diglossic group, 1% of the Monolingual group and 1% of the Bilingual data.

Figure 4.1b illustrates the RT data for the Stroop task. A maximal model with random intercepts for subject and a random slope for Condition did not converge. We removed the random slope for Condition and the model converged (this model is presented in Table 4.6).

The model coefficients showed that the Diglossics (M *RTs*= 2.94 sec, SD(0.133)) were slower than both the Bilinguals (M *RTs*= 2.89 sec, SD(0.138)) (β=0.069,SE=0.022,t(93.20)=3.142,p=0.002) and the Monolinguals (M *RTs*= 2.92 sec, SD(0.131)) (β=0.049,SE=0.022,t(92.56)=2.215,p=0.029).

The model coefficients also showed that Incongruent (M *RTs*= 2.94, SD(0.14)) was significantly slower than both Congruent (M *RTs*= 2.90 sec, SD(0.12)) (β=0.048, SE=0.004,t(1315)=11.713,p<0.001) and Neutral (M *RTs*= 2.91, SD(0.12)) (β=-0.032, SE=0.004,t(1315)=-7.765,p<0.001). There was also a significant difference between Congruent and Neutral, where Neutral was significantly slower: Congruent (M *RTs*= 2.90 sec, SD(0.12)), Neutral (M *RTs* = 2.91 sec, SD(0,12)) (β=0.016,SE=0.004,t(1315)=3.953,p<0.001).

There was a significant interaction in Congruent and Incongruent, where the Diglossics showed smaller difference between the two Conditions than the Monolinguals (β=-0.013,SE=0.005,t(1315)=-2.449,p=0.014).

There was also a significant interaction in the Congruent and Neutral, where the Diglossics showed smaller difference between the two Conditions than the Bilinguals (β=-0.012,SE=0.005,t(1329)=-2.227,p=0.025).

There was also a significant interaction in the Incongruent and Neutral, where the Bilinguals showed a smaller difference between the two Conditions than the Monolinguals (β=-0.011,SE=0.005,t(1329)=-2.083,p=0.037).

Finally, The effect of age was significant (β=0.002,SE=0.0009,t(88.99)=2.276,p=0.025), indicating a positive correlation.

Table 4.6: *Linear mixed effects model results for the Stroop reaction times.*

Fixed Effects				
	Est/Beta	SE	t value	p value
Intercept:	273.7	0.058	46.623	p<0.001*
Condition:				
Congruent vs Incongruent	0.048	0.004	11.713	p<0.001*
Congruent vs Neutral	0.016	0.004	3.953	p<0.001*
Incongruent vs Neutral	-0.032	0.004	-7.765	p<0.001*
Group:				
BI vs DI	0.069	0.022	3.142	p=0.002*
BI vs MONO	0.020	0.021	0.951	p=0.344
DI vs MONO	0.049	0.022	2.215	p=0.029*
Age:	0.002	0.000	2.276	p=0.025*
Group x Condition interaction:				
Congruent vs Incongruent				
BI vs DI	-0.008	0.005	-1.541	p=0.123
DI vs MONO	-0.013	0.005	-2.449	p=0.014*
BI vs MONO	0.004	0.005	0.775	p=0.438
Congruent vs Neutral				
BI vs DI	-0.012	0.005	-2.227	p=0.025*
DI vs MONO	-0.005	0.005	-1.090	p=0.275
BI vs MONO	-0.007	0.005	-1.310	p=0.190
Incongruent vs Neutral				
BI vs DI	-0.003	0.005	-0.680	p=0.496
DI vs MONO	0.007	0.005	1.362	p=0.172
BI vs MONO	-0.011	0.005	-2.083	p=0.037*

Random Effects		
	Variance	S.D.
Subject (Intercept)	0.006	0.080
Residual	0.011	0.105
Model fit	Marginal	Conditional
R^2	0.069	0.41

Key: p-values for fixed effects calculated using Satterthwaite approximation, and the Tukey method.
Model equation: lmer(logRT ~ Condition * Group + (1|Subject), data= Stroop)

4.3.3. Switching

The RTs from both groups were screened for extreme values, defined as anything that exceeded 6,000 ms, or was less than 300 ms. Extreme values were excluded, affecting 2.9% of the Diglossic data, 2.4 of the Monolingual data, and 2.1% of the Bilingual data. These outliers were removed for analysis of accuracy and RTs.

4.3.3.1. Accuracy

Table 4.7: *Mean accuracy (SD) per Group and per Condition for the Colour–shape task.*

	Change	Stay
Bilinguals	97% (0.17)	99% (0.10)
Monolinguals	97% (0.17)	97% (0.17)
Diglossics	96% (0.18)	98% (0.14)

Table 4.7 presents the accuracy data for the Switching task. Optimisation required more than 10,000 iterations, and to avoid warnings we increased the amount of iterations to 100,000.

A maximal model with random intercepts for subject and a random slope for Condition did not converge. We removed the random slope for Condition and the model converged (for the results, see Table 4.8).

The model coefficients showed that the Diglossics (M *correct responses*= 97%, SD(0.16)) did not significantly differ from the Bilinguals (M *correct responses*= 97%, SD(0.14)) or the Monolinguals (M *correct responses*= 96%, SD(0.17)). There was also no significant difference between the Monolinguals and Bilinguals.

The model coefficients also showed that the accuracy was lower in the Change trials (M *correct responses*= 96%, SD(0.17)) than the Stay trials (M *correct responses*= 97%, SD(0.14)) (β=1.087,SE=0.358,t(.)=3.035,p=0.002).

While the Change trials were overall less accurate than the Stay trials, the Monolinguals showed a smaller difference between the two conditions than the Bilinguals (β=-1.140,SE=0.425,t(.)=-2.681,p=0.007). No other significant effects were found.

Finally, the effect of age was not significant (β=-0.015,SE=0.017,t(.)=-0.877,p=0.380).

Table 4.8: *Generalised linear mixed effects model results for the Colour–shape accuracy.*

Fixed Effects				
	Est/Beta	SE	z value	p value
Intercept:	4.960	1.100	4.507	p<0.001*
Condition: Stay vs Change	1.087	0.358	3.035	p=0.002*
Group:				
BI vs DI	-0.169	0.444	-0.381	p=0.702
BI vs MONO	0.355	0.442	0.804	p=0.421
DI vs MONO	-0.525	0.445	-1.180	p=0.238
Age:	-0.015	0.017	-0.877	p=0.380
Group x Condition interaction:				
BI vs DI	-0.556	0.454	-1.224	p=0.220
DI vs MONO	0.583	0.361	1.612	p=0.106
BI vs MONO	-1.140	0.425	-2.681	p=0.007*

Random Effects		
	Variance	S.D.
Subject (Intercept)	1.46	1.208
Model fit		
R^2	Marginal	Conditional
	0.03	0.32

Key: DI: Diglossics, BI: Bilinguals, MONO: Monolinguals
P-values for fixed effects calculated using Satterthwaite approximation.
Model equation: glmer(Accuracy ~ Condition * Group + Age +(1|Subject), data= Switch, family="binomial"))

4.3.3.2. Reaction Times

Along with the extreme values, all incorrect trials were removed. This affected 3.2% of the Diglossic data, 3% of the Monolingual data and 2.8% of the Bilingual data. Figure 4.1c illustrates the RT data for the Switching task. A maximal model with random intercepts for subject and a random slope for Condition converged (for the results, see Table 4.9).

The model coefficients revealed that the Diglossics (M *RTs*= 3.257 sec, SD(0.15)) were significantly slower than both the Bilinguals (M *RTs*= 3.160 sec, SD(0.150) (β=0.109 1,SE=0.026,t(91.04)=4.145,p<0.001), and the Monolinguals (M *RTs*= 3.167 sec, SD(0.153) (β=0.125,SE=0.026,t(92.19)=4.702,p<0.001). However, there was no significant difference between the Bilinguals and Monolinguals.

The model coefficients also revealed that the Change trials (M *RTs*= 3.200 sec, SD(0.155)) were significantly slower than the Stay trials (M *RTs*= 3.183 sec, SD(0.161) (β=-0.013,SE=0.005,t(91.80)=-2.578,p=0.011).

The model coefficients revealed that there were no significant interactions between Groups and Conditions in the model coefficients.

Finally, the effect age was significant (β=0.003,SE=0.001,t(90.99)=3.309,p=0.001). There was a positive correlation between age and RTs.

Table 4.9: *Linear mixed effects model results for the Colour–shape reaction times.*

Fixed Effects				
	Est/Beta	SE	t value	p value
Intercept:	2.941	0.069	42.53	p<0.001*
Condition: Stay vs Change	-0.013	0.005	-2.578	p=0.011*
Group:				
DI vs BI	0.109	0.026	4.145	p<0.001*
BI vs MONO	-0.015	0.025	-0.598	p=0.551
DI vs MONO	0.125	0.026	4.702	p<0.001*
Age:	0.003	0.001	3.309	p=0.001*
Group x Condition interaction:				
BI vs DI	-0.000	0.001	-0.068	p=0.945
DI vs MONO	0.005	0.007	0.732	p=0.465
BI vs MONO	-0.005	0.006	-0.806	p=0.422

Random Effects			
	Variance	S.D.	Correlation
Subject (Intercept)	0.009	0.097	
Condition	0.000	0.007	-0.37
Residual	0.013	0.116	
Model fit			
R^2	Marginal	Conditional	
	0.12	0.40	

Key: DI: Diglossics, BI: Bilinguals, MONO: Monolinguals
P-values for fixed effects calculated using Satterthwaite approximation, and the Tukey method.
Model equation: lmer(logRT ~ Condition * Group + Age + (1+ Condition |Subject), data= Switch)

4.3.4. Nback

One back: the RTs from both groups were screened for extreme values, defined as anything that exceeded 1,200 ms, or was less than 250 ms. Extreme values were excluded, affecting 0.3% of the Diglossic data, 0.1% of the Monolingual data, and 0.4% of the Bilingual data.

Two back: the RTs from both groups were screened for extreme values, defined as anything that exceeded 1,500 ms, or was less than 250 ms. Extreme values were excluded, affecting 1.8% of the Diglossic data, 1.4% of the Monolingual data, and 0.2% of the Bilingual data. These outliers were removed for analysis of accuracy and RTs.

4.3.4.1. Accuracy

The values removed as part of our trimming process also included all incorrect data, so accuracy was 100% in the trimmed data and was not analysed further.

4.3.4.2. Reaction times

Figure 4.1d illustrates the RT data for the Nback task. A maximal model with random intercepts for subject and a random slope for Condition converged (for the results, see Table 4.10).

The model coefficients revealed that the Two back trials (M *RTs*= 2.75 sec, SD(0.16)) were significantly slower than the One back trials (M *RTs*= 2.96 sec, SD(0.14) (β=0.039,SE=0.015,t(78.40)=2.494,p=0.014).

The model coefficients also revealed that there were no significant differences between the groups. Also, there were no significant Groups and Conditions interaction.

Finally, the effect of age was not significant (β=0.001,SE=0.001,t(87.83)=1.388,p=0.168).

Table 4.10: *Linear mixed effects model results for the Nback reaction times.*

Fixed Effects				
	Est/Beta	SE	t value	p value
Intercept:	2.604	0.066	39.236	p<0.001*
Condition: One back vs Two back	0.039	0.015	2.494	p=0.014*
Group:				
BI vs DI	0.029	0.030	0.955	p=0.341
BI vs MONO	-0.016	0.026	-0.635	p=0.527
DI vs MONO	0.046	0.030	1.511	p=0.134
Age:	0.001	0.001	1.388	p=0.168
Group x Condition interaction:				
BI vs DI	0.024	0.026	0.918	p=0.361
DI vs MONO	-0.006	0.025	-0.246	p=0.807
BI vs MONO	0.030	0.020	1.501	p=0.137
Random Effects				
		Variance	S.D.	Correlation
Subject (Intercept)		0.009	0.098	
Condition		0.005	0.076	-0.41
Residual		0.014	0.122	
Model fit				
R^2		Marginal	Conditional	
		0.05	0.42	

Key: DI: Diglossics, BI: Bilinguals, MONO: Monolinguals
P-values for fixed effects calculated using Satterthwaite approximation, and the Tukey method.
Model equation: lmer(logRT ~ Condition * Group + Age +(1+Condition|Subject), data= Nback)

4.4. Discussion

The effects of diglossia on cognition, in general, have been rarely investigated, with the only two studies that investigated the effects of diglossia on EFs in young adults providing contradictory results (Alrwaita et al., 2021; Antoniou & Spanoudis, 2020). It was suggested that investigating the cognitive effects in young adults is challenging due to peak cognitive performance during this age (Bialystok et al., 2005). Therefore, testing older adults should provide a clearer view on how diglossia affects EFs. In this study, we investigated whether and how diglossia has measurable effects on cognition in older age, and whether these effects are comparable to those reported for bilingualism. This also allowed us to test the predictions of how SLCs affect EFs, and how these differ to the equivalent effects of DLCs, as proposed by the ACH (Green & Abutalebi, 2013). In doing so, we compared the performance of monolingual, diglossic and bilingual older adults on tasks tapping the three EF domains: inhibition, switching and working memory (Miyake et al., 2000). Specifically, inhibition was measured using the Flanker and Stroop tasks, switching was measured using the Colour–shape task, and working memory was measured using the Nback task. In all of the tasks, we looked at global RTs and accuracy, and also, crucially for the current investigation, at the cognitive load, measured as the difference between high and low challenging conditions, specifically the Incongruent versus Congruent trials in both the Flanker and Stroop tasks, the Change versus Stay trials in the Colour–shape task, and the Two back versus One back trials in the Nback task, for both accuracy and RTs.

In all of our tasks, cognitively challenging conditions yielded the expected longer RTs across all of our groups, compared to the less challenging conditions. In terms of accuracy, challenging conditions yielded lower accuracy in the Flanker and Colour–shape tasks. For RTs, age had a significant effect on Flanker and Colour–shape and Stroop, with slower RTs with increasing age.

Crucially, some significant differences emerged between our groups. In terms of RTs and accuracy, our results showed that the Diglossics were overall significantly slower than both other groups in all tasks except the Nback, and were significantly less accurate than both other groups in the Flanker task. Interestingly, all groups have demonstrated high accuracy in all of the tasks, suggesting that the tasks were relatively easy to perform.

In terms of interactions between Group and Condition, for inhibition we predicted enhanced performances by bilinguals and diglossics in the Flanker and the Stroop task as well. Green and Abutalebi (2013) highlighted that both speakers of the DLC and the SLC can exhibit enhanced interference suppression in inhibition tasks such as Flanker and Stroop. Despite slow RTs by diglossics in both inhibition tasks, we found enhanced performances for the diglossic group in the Flanker RTs, expressed in a smaller Flanker effect, when compared to bilinguals, and a near significant effect when compared to monolinguals. A diglossic advantage was also seen in the Stroop RTs task, expressed in a smaller Stroop effect, when compared to monolinguals, partially confirming the predictions of the ACH for the SLC, which predicted enhanced performances by speakers in the SLC in tasks measuring goal maintenance. However, the ACH doesn't explain slow RTs by diglossics in most of the tasks, or the low accuracy by diglossics in the Flanker task. Most importantly, the ACH has predicted that speakers in the DLC will show similar, or better performances in tasks measuring goal maintenance compared to speakers in the SLC. Our results contradict this prediction by showing enhanced performances by diglossics in the Flanker task, expressed as a smaller Flanker effect, compared to bilinguals. Further, we failed to find any inhibition advantages, in either Flanker or Stroop for the bilingual group, therefore negating the predictions of the ACH for the DLC.

Specifically, in the Flanker RTs, the diglossics experienced reduced cognitive load compared to the bilinguals, demonstrated as a smaller difference between Congruent and Incongruent conditions, and the same difference between diglossics and monolinguals only approached significance. Also, in the Flanker RTs, the bilinguals showed a smaller difference between Congruent and Neutral conditions than the diglossics, while a similar effect between the bilinguals and monolinguals only approached significance; this difference suggests some facilitatory effect from the Congruent trials for bilinguals, compared to the other two groups. In Flanker accuracy, the diglossics showed a smaller difference between Congruent and Incongruent than both the bilinguals and monolinguals. Diglossics also showed a smaller difference between Incongruent and Neutral conditions compared to both groups. For the Stroop task, also measuring inhibition, diglossics showed a smaller difference between Congruent and Incongruent than monolingual in Stroop RTs. Diglossics also showed a smaller difference between Congruent and Neutral compared to bilinguals. Finally, bilinguals showed a smaller difference between Incongruent and Neutral than monolinguals. For Stroop accuracy, there was no significant interaction between Group and Condition. Generally, the focus in bilingual literature is in the difference between Congruent vs Incongruent measured by RTs, as it is regarded as of most theoretical contribution (Valian, 2015). Accordingly, our results show a diglossic advantage in Flanker RTs when compared to bilinguals only, and a diglossic advantage in Stroop RTs when compared to monolinguals.

For the Colour–shape task, we predicted enhanced performance by the bilingual group only. According to the ACH, bilinguals in the DLC are expected to have enhanced cognitive control in tasks tapping the processes of task engagement, task disengagement and selective response inhibition, all of which can be measured through the Colour–shape task. However, we failed to find any bilingual advantage in this task. Further, it emerged that in terms of accuracy only, the monolinguals had a smaller switching cost than the bilinguals, suggesting that the latter found the Change conditions more challenging. Finally, for the Nback task we predicted no enhanced performance by any group. This is because the Nback task does not involve any of the processes described by the ACH. The results confirm our prediction by showing no group effects or interactions between Groups and Conditions for the Nback task.

Our results contradict the previous studies by showing a diglossic advantage in the Flanker task, as expressed in a smaller difference between Congruent and Incongruent trials, in diglossics compared to bilinguals, and a near significant effect when compared to monolinguals. We also found a diglossic advantage in Stroop, as expressed in a smaller difference between Congruent and Incongruent trials, in diglossics compared to monolinguals. While our results can't be used to fully support the ACH, as a diglossics advantage in Flanker effect was only seen when diglossics are compared to bilinguals, our results of the observed Stroop effect can be used to support the predictions of the ACH for SLC. One possible explanation for finding a smaller Stroop effect by diglossics compared to monolinguals is that in Arabic diglossia, each variety is strictly used in a specific environment, eliminating chances for switching between the two varieties in one context (Albirini, 2016; Kaye, 2001). This clear separation of the two varieties makes Arabic diglossia a good example of the SLC, where enhancement is predicted in tasks measuring goal maintenance. According to Green and Abutalebi (2013), speakers in the

SLC will constantly need to avoid switching which results in enhanced performances in goal maintenance tasks.

Recall that the diglossics were overall slower than both groups in most of the tasks, and they were also less accurate than both groups in the Flanker task. While a bilingual advantage in global RTs was often reported (Hilchey & Klein, 2011), this was not found in our diglossic group, where our results actually suggest a diglossic *disadvantage* in global RTs. A similar pattern of slower RTs was also reported in Alrwaita et al. (2021), where Arabic diglossic young adults had significantly slower RTs than English monolinguals in all tasks, except the Nback. One uncontrolled factor in our study which can explain this pattern of results is computer literacy. It is possible that diglossics in this study have less experience in using computers than bilinguals and monolinguals which could have resulted in slower RTs. This is supported by studies reporting a link between using computers and increased processing speed in various EF tasks (see Simpson, Camfield, Pipingas, Macpherson, & Stough, 2012). In fact, using computers has been proven to be a successful training method to increase processing speed in healthy older adults (Basak et al., 2008), as well as older adults with speed processing impairments (see Vance, Dawson, Wadley, Edwards, Roenker, Rizzo, & Ball, 2007).

Turning to the performance in our bilingual group, recall that it is often suggested that bilingual advantages are most commonly found in older adults (Berkes et al., 2021); however, this was not found in our study. Our results are in line with several other studies reporting no bilingual advantage in older adults across any EF domains (see Gathercole et al., 2014; Kirk et al., 2014; Kousaie & Phillips, 2012). We also failed to find a bilingual advantage in global RTs when compared to monolinguals, as previously suggested (see Hilchey & Klein, 2011). The same finding was reported by Kirk et al. (2014), where no bilingual advantages were found in global RTs in bilinguals. Notably, it also appears that the predictions for the DLC were not met by our bilingual group. More clearly, while Green and Abutalebi (2013) suggested that bilinguals in the DLC should have enhanced performance in inhibition and switching tasks compared to monolinguals, we have failed to show this. Furthermore, there was no difference in performance by bilinguals in verbal and non-verbal inhibition tasks. This finding is in line with Kendrick et al., (2019) who concluded that verbal load doesn't affect performances on EFs. One possible explanation for the lack of a bilingual advantage in our group, in any domain, is the age of our bilingual group (*M* age= 59.6, (7.2)), which is low in comparison to studies reporting a bilingual advantage in older adults. For instance, Bialystok et al. (2004) reported a bilingual advantage in working memory and inhibition amongst bilingual older adults who were older than our bilingual group (M age= 72.3(8.7)). Similarly, bilingual advantages were reported in older samples than ours for working memory (M age= 67.8 (4.4)) (Luo et al., 2013) and switching (M age= 64 (4.4)) (Gold et al., 2013). If the life-long frequent experience of using two languages leads to enhanced EFs (Kirk et al., 2014), it is reasonable to assume that the older the group, the more experience of juggling the two languages they will have, which will lead to more enhanced EF abilities. It is also important to note that the relationship between bilingualism and EFs is complex, and it could involve factors such as culture and socio-economic status that we have not accounted for. One crucial factor could be the daily demands for language switching. Henrard and van Daele (2017) reported enhanced EFs as predicted by the DLC amongst bilinguals with professions that require daily and constant switching, such as language translators and interpreters. Most of the bilinguals in our study were retired, others reported to be employed as teachers, health care professionals, business analysts and so forth. While we have no estimates of the switching requirements of these domains, at least we have not included translators or interpreters that have well established switching needs.

It is also important to note that the bilinguals in our study were immigrants, as many studies reported a lack of advantage in bilingual immigrants (see Kirk et al., 2014; Scaltritti et al., 2017). According to Kirk et al. (2014), bilingual immigrants mostly use their first language at home with their family, and rarely use it in other contexts; subsequently, bilingual immigrants operate in the SLC (Kirk et al., 2014). Similarly, Paap et al. (2015) found that the bilingual advantage is reported more in studies where immigrant status is matched (see Bialystok et al., 2008; Gold et al., 2013; Lee Salvatierra & Rosselli, 2011; Schroeder & Marian, 2017) compared to studies where this factor is not controlled for (see Kirk et al., 2014; Kousaie & Phillips, 2012). Further, the difference in switching scores between bilinguals and diglossics in our study was very small, confirming Green and Abutalebi (2013) who argued that bilinguals can be found in the three contexts (SLC, DLC and Dense code-switching context). However, if we are to consider bilingual immigrants as SLC speakers, this still does not explain why we failed to find a bilingual advantage, even in tasks measuring goal maintenance. Most importantly, all of our bilinguals have scored within the respective area of bilingualism in the LSBQ, while diglossics have scored in the gray area between bilingualism and monolingualism. This confirms that the two groups belong to different contexts which don't overlap. Furthermore, according to Anderson et al., (2018) individuals scoring within the bilingualism category are most likely to belong to the DLC, this is because the LSBQ takes into account the different domains in which the two languages are used, proficiency, and the amount of switching in different domains, this again suggests that our bilinguals belong to the DLC. Thus, the explanation regarding the younger age of our bilingual sample remains more plausible. It is also important to note that groups were not matched in variables such as education and IQ.

In sum, our pattern of results from the bilingual group appears supportive of the conclusions by Calvo and Bialystok (2014) and Samuel et al. (2018) that the bilingual advantage interplays with some life experiences that, so far, remain under-explored. The lack of a bilingual advantage in our study could be related to uncontrolled factors such as the daily demands for switching and immigration status. We also attribute the lack of a bilingual advantage to the young age of the bilinguals in comparison to other studies reporting a bilingual advantage amongst older adults.

4.5. Conclusion

Generally, studies investigating the role of dual language use in modulating EFs have been conducted in bilingual environments (see Hartanto & Yang, 2016; Struys et al., 2019), while little is known about the role of dual language use in other language environments such as diglossia. In diglossia, two varieties of the same language are spoken by the same person; however, these varieties are separately by context (Ferguson, 1959). Specifically, Arabic diglossia is known for its rigid separation of the two varieties, whereby the H is strictly used for formal purposes, while the L is strictly used for informal purposes (Kaye, 2001). These factors make Arabic diglossia an ideal case for testing the predictions of the ACH for the SLC, where each language is used in a separate context. In this study, we compared the performance of bilingual, diglossic and monolingual older adults in the three domains of EFs: inhibition, working memory and switching (Miyake et al., 2000). To test the predictions of the ACH (Green & Abutalebi, 2013), we used Arabic diglossia as an example of the SLC, and bilingualism as an example of the DLC.

While some of the predictions of the ACH for the SLC were met in our study, with the diglossics showing enhanced performance in the Flanker RTs, expressed as a smaller Flanker effect compared to bilinguals, and enhanced performance in Stroop RTs, expressed as a smaller Stroop effect compared to monolinguals, similar effects were not found for the DLC, where we failed to report any bilingual advantage in any domain. We attribute the diglossic advantage found to the correspondence of Arabic diglossia to the SLC, where enhancements are predicted in tasks measuring goal maintenance. Further, we attribute the lack of a bilingual advantage in our study to the young age of our participants, and to several factors that we did not account for, such as the daily demands for switching, and the immigration status. Future studies, particularly investigating the relationship between language varieties and EFs, should consider the control demands imposed by different conversational contexts, as described by the ACH.

CHAPTER 5 : GENERAL DISCUSSION AND CONCLUSION

5.1. General discussion

It is intriguing that even after a decade of intensive investigation of the bilingual advantage in Executive Functions (EFs), it is still unclear whether and how bilingualism affects EFs. Poarch and Krott (2019) argued that the number of studies reporting a bilingual advantage should not be disregarded; when the bilingual advantage is found this should not be dismissed as a *false positive*. Therefore, it is more reasonable to assume that we still do not have a full understanding of which bilinguals may possess this advantage (Poarch & Krott, 2019). This thesis attempted to investigate context as a potential modulator of EFs in diglossics and bilinguals. Precisely, this thesis investigated the role of the conversational context and the amount of language switching, as predicted by the Adaptive Control Hypothesis (ACH) (Green & Abutalebi, 2013).

The first paper is a review paper. In this paper we examined all studies conducted to investigate the diglossic and bidialectal advantage in EFs in relation to the ACH. Both bidialectalism and diglossia, situations where two varieties of one language are spoken by the same person, seem to correspond to the Single Language Context (SLC) in terms of the ACH, by having minimal opportunities for switching and less enhanced EFs (Green & Abutalebi, 2013). However, in bidialectalism it is more acceptable to switch between the varieties in speaking, while in typical diglossia, the high variety (H) is strictly used for formal purposes and the low variety (L) is strictly used for informal purposes (Masica & Sinha, 1986). The reviewed studies show that bidialectalism does not appear to result in consistent advantages in EFs, while the two studies conducted on diglossia reported a diglossic advantage across the board of EF domains. We hypothesised that the diglossic advantage found in these studies could be related to the specific diglossic situation in which the two studies were conducted, namely, in Cyprus. The diglossic situation in Cyprus is moving into type B diaglossia; allowing for more switching between the two varieties than a typical diglossic environment (Rowe & Grohmann, 2013). This negates the separation of each variety in a specific context, which defines typical diglossia, and increases the opportunities for switching between the varieties. It is possible to assume, then, that more chances for switching leads to more enhanced EFs (Kirk et al., 2014). However, the limited studies on diglossia do not provide sufficient answers to the effects of diglossia on EFs, thus warranting further investigation. It also seems reasonable to investigate the diglossic advantage in environments other than Cyprus, and especially in environments with more rigid application of the SLC, such as in the Arab world (Albirini, 2016; Kaye, 2001).

These observations motivated our second paper, which focuses on investigating the diglossic advantage in an environment with more rigid application of the SLC: Arabic. In this paper, Arabic-speaking young adults were compared to English monolingual young adults on their performance in four tasks that cover the three domains of EFs (Miyake et al., 2000): inhibition measured by the Flanker and Stroop tasks, switching measured by the Colour–shape task, and working memory measured by the Nback task. We expected enhanced performances by diglossics only in the Flanker and Stroop tasks as they tap goal maintenance, which is predicted to be enhanced in the SLC (Green & Abutalebi, 2013). According to the ACH, speakers in the SLC constantly avoid switching; therefore, they are expected to show enhancement in tasks that tap into goal maintenance. We did not predict any enhanced performances by diglossics in Colour–shape switching. This is because speakers in the DLC only are expected to show enhancement in tasks that tap the processes of task engagement, task disengagement, and selective response inhibition, all of which can be measured using the Colour–shape task. According to the

ACH, only speakers in the DLC are trained to speak one language (task engagement), stop using that language (task disengagement), and change the goal such as speaking one language or the other (selective response inhibition). The ACH did not predict any control processes to be enhanced in the Nback; therefore, we predicted no enhanced performances in the Nback by diglossics. Specifically, the Nback task was included to rule out the possibility of a general cognitive advantage in diglossics. The results revealed a smaller cognitive cost in the Flanker task, that is, smaller differences between challenging and control conditions, in the monolinguals compared to the diglossics. Further, the diglossics yielded longer overall reaction times (RTs) than the monolinguals in all of these tasks, suggesting slower processing speed. We concluded that the rigid correspondence of Arabic to the SLC is responsible for the lack of a diglossic advantage, at least as far as the Stroop, Colour–shape and Nback tasks are concerned. The ACH predicted an enhancement in the goal maintenance in the SLC, which can be found using the Flanker task, however, the ACH does not explain the diglossic disadvantage found the Flanker task. The lack of advantages in the other tasks could be related to the specific age group, considering that advantages in young adults have been rarely reported in the bilingual literature (Berkes et al., 2021).

This is because young adults are at the peak levels of their cognitive performance, making it more difficult to find effects for bilingualism specifically, as both bilingual and monolingual young adults tend to exhibit fast RTs, and small cognitive costs (smaller difference between challenging and control conditions) (see Bialystok et al., 2005). Another limitation is the lack of a bilingual group, which would allow for comparing the predictions of the ACH in different contexts. Unlike diglossia, bilingualism is often regarded as a DLC, which affects more cognitive processes than the SLC (Green & Abutalebi, 2013). Therefore, comparing the SLC (diglossics) to the DLC (bilinguals) will give a clearer idea of the different processes that each of the contexts is predicted to show enhancement in.

These factors motivated the third study, in which three groups of older adults were tested: bilinguals, diglossics, and monolinguals. The same tasks as in the previous study were used. Presuming that diglossics belong to the SLC, and based on the predictions of the ACH, we predicted enhanced performances by this group in the Flanker and Stroop tasks tapping goal maintenance. Further, presuming that bilinguals belong to the DLC, and based on the predictions of the ACH, we also predicted enhanced performance by bilinguals in the Flanker and Stroop tasks, tapping goal maintenance, in the Colour–shape switching task, tapping selective response inhibition, task engagement and task disengagement. We did not predict any enhancement in the Nback task by any group, as the ACH did not predict any control processes to be facilitated by a working memory task. We expected advantages to be found in older adults, as evidence for the bilingual advantage appears to be more consistent in older adults compared to young adults (Berkes et al., 2021). The results revealed a smaller Flanker effect in diglossics compared to bilinguals, and a near significant effect when compared to monolinguals. Similarly, diglossics showed a smaller Stroop effect when compared to monolinguals. While these results can be used, at least partially, to confirm the predictions of the ACH for the SLC, as speakers of the SLC are expected to show enhanced performance in tasks tapping goal maintenance (Green & Abutalebi, 2013), it remains unclear why a smaller Flanker effect only appears when diglossics are compared to bilinguals, and the same finding does not reach significance when compared to monolinguals. According to the ACH, speakers in the DLC are expected to preform similarly or better, but certainly not worse, than speakers in the SLC in tasks that tap into goal maintenance. This was not met in our study where bilinguals performed worse than diglossics in the Flanker task by exhibiting a larger

Flanker effect. While context seems to be an important factor that modulates EFs, we argue that the ACH lacks taking into account other variables that could correxplain such differences in performance. Furthermore, no bilingual advantages were found, potentially owing to some factors that were not accounted for, such as the age of the bilingual group and their immigration status. More explicitly, the bilinguals in our study were younger than the bilinguals in other studies, where a bilingual advantage was reported (Bialystok et al., 2004; Gold et al., 2013; Luo et al., 2013). It is possible then to assume that the lack of a bilingual advantage in this study is caused by testing relatively young bilinguals, this is supported by studies suggesting that the bilingual advantage is more likely to increase with age (Berkes et al., 2021). Further, many studies reported a lack of advantage in bilingual immigrants (see Kirk et al., 2014; Paap et al., 2015), possibly relating to fewer opportunities for switching as immigrants are likely to use one language at home and another outside of home. This thesis provides good insight into the role of switching in modulating EFs in diglossia and bidialectalism that future studies can benefit from. This thesis provides some evidence supporting the prediction of the SLC in typical diglossic settings amongst older adults. However, the ACH doesn't explain the lack of advantage in the bilingual group, or the short RTs by diglossics in most of the tasks. This thesis also highlights the role of different contexts in imposing different demands on EFs. The role of context can also be seen in how the different cognitive processes of EFs are enhanced based on context.

While the only two previous studies conducted to investigate the diglossic advantage in EFs reported a diglossic advantage in inhibition, working memory and switching (see Antoniou et al., 2016; Antoniou & Spanoudis, 2020), this thesis failed to report the same in young adults, while advantages in the Flanker task when compared to bilinguals, and in the Stroop when compared to monolinguals, were found in older adults.

Specifically, predictions for the SLC include enhanced performances in the Flanker and Stroop tasks. This thesis failed to find the expected predictions in young adults, and the lack of advantages was attributed to the specific age group, as bilingual advatages were rarely reported in young adults (Bialystok et al., 2005). The predictions of the ACH for the SLC are only partitially met in diglossic older adults. While both Cypriot-Greek and Arabic are characterised as diglossic environments, it seems that social norms that either impose a clear separation between the two varieties, or allow more switching between the two varieties, lead to different performance on EF tasks. Therefore, careful attention to the context and amount of switching should be given to each language environment.

Recently, the linguistic similarity of the bilingual's two languages has been suggested to modulate the effect of bilingualism on cognition. Oschwald et al. (2018) argue that language similarity modulates the executive control demands for bilinguals, but highlight that this might work in two opposing directions. On the one hand, if two languages are very similar the cross-language interference might be stronger, meaning that executive functions are more heavily taxed; on the other, two languages that share elements of grammar, phonology and lexicality might facilitate each other, meaning that more dissimilar languages would tax the executive system to a greater extent. Despite these arguments, the empirical literature to date has largely failed to acknowledge the issue of linguistic similarity, despite some of them having looked at linguistically close language pairs, such as Italian and Sardinian (Garraffa et al. 2015), while others have examined more distant language pairs, such as English and Korean or Mandarin (Oh & Lewis 2008; Prior & Macwhinney 2010). The linguistic similarity in diglossia where individuals use two varieties of the same language is closer than speaking two distinct languages such as in bilingualism. The findings from this thesis could be used to suggest that language similarity results in cognitive advantages which are more likely to be seen in tasks measuring inhibition. However, with the limited amount of studies in diglossia it is difficult to confirm this argument and it remains to be tested.

5.2. The importance of investigating the effects of diglossia/bidialectalism on cognition

Studying the implications of bidialectalism/diglossia for EFs can have great implications beyond the theoretical interest. Education is one of the most important fields that can be improved through studying these cognitive implications. Educators, teachers and parents around the world have been concerned about the cognitive implications of learning and using two varieties of one language. Many studies discussed these cognitive implications, for example, in African American varieties (Padilla, Fairchild, & Valadez, 1990; Rickford, 1997), Australian–Aboriginal English (Malcolm et al., 1999), and Caribbean Creole (Edwards, 1976). The general idea is that forcing children to use the H (Standard) and suppress the L (local/non-Standard) leads to educational underachievement (Yiakoumetti, 2007). As Edwards (1983) highlighted, children who use both the H and the L face major confusions in which variety should be used, and therefore they are presented with more opportunities for errors (Yiakoumetti, 2007).

Specifically, the implications of Arabic diglossia on cognition have been an interest for many linguists and scholars (Maamouri, 1998). According to Maamouri (1998), there is a general awareness that many educational problems such as high illiteracy, school underachievement, and reading difficulties are linked to Arabic diglossia. Generally, children in the Arab world are only exposed to the H when they enter school, at approximately seven years old. They are then expected to learn the complex grammatical system and to read and learn various forms of science through it. Maamouri (1998) hypothesised that learning the H is of great difficulty because it is no one's native language. Maamouri (1998) also argued that code-switching between the L and the H in schools can lead to serious pedagogical problems, such as inadequate language competence, low linguistic self-confidence, and consequent social problems. It was found that EFs play a role in children's ability to establish social connections, illustrated in increased cognitive flexibility, impulsive response inhibition, and self-regulation (Linsey & Colwell, 2003; Peterson & Flanders, 2005). Further, a substantial amount of studies explored the negative implications of diglossia on Arabic diglossic children (see Albirini, 2016). Moreover, these social and pedagogical difficulties were suggested to persist into adulthood (Eviatar & Ibrahim, 2014). The situation can be even more complex when Arab immigrants move from one Arab country to another, where they will be faced with two varieties, one of their country and the other of the country they moved to, in addition to the Standard Arabic.

Despite tremendous efforts in exploring ways to improve teaching, and avoid any pedagogical difficulties in these communities, children speaking two varieties of the same language still underachieve (Yiakoumetti, 2007). There has also been a lot of debate regarding which language variety should be used as a medium of education, as using a unified variety could reduce negative implications (see Edwards, 1976; Yiakoumetti, 2007). Yet, diglossia still exists in many countries, including in the Arab world. A consistent observation in the two empirical studies of this thesis was the longer RTs by diglossics compared to the other groups. While many studies raised concerns about the implications of diglossia (Yiakoumetti, 2007), one point to be considered for future studies is the role of diglossia in slowing the overall RTs.

Generally, we found that some effects of diglossia and bidialectalism can be explained by the ACH. A potential factor guiding the predictions of the ACH for the SLC is the clear separation of each variety in different contexts in bidialectalism and diglossia (Kirk et al., 2014; Rowe & Grohmann, 2013). This makes it easier to identify the appropriate conversational context (SLC). On the other hand, while studies often regard bilingualism as a DLC, including our study, it appears that the situation in bilingualism may be more complex. Specifically, in bilingualism more factors could interfere, such as the amount of switching, making it more difficult to identify the appropriate conversational context for the bilingual group. While this thesis does not report a bilingual advantage, it cannot be argued that the bilingual advantage does not exist. Instead, future studies should aim to explore new factors that could contribute to the inconsistencies along with context. For instance, Zhou and Krott (2016) called for unifying the methodologies used to investigate the bilingual advantage across all studies, including data trimming procedures and the maximum time allowed for responses. This could explain the inconsistencies found, especially in conflict tasks, as it was reported that the bilingual advantage is most likely to be found in studies that did not trim slow responses (Zhou & Krott, 2016). Further, considering that many studies reported results supporting the predictions of the ACH for the DLC (see Hartanto & Yang, 2016; Henrard & van Daele, 2017; Struys et al., 2019), we attribute our lack of advantages to other factors that we did not control for. We also argue that more attention should be taken when determining which bilinguals belong to which conversational context. Successful findings of the predictions of the ACH for the DLC were observed in a study that used the profession to determine the conversational context (see Henrard & van Daele, 2017), where bilingual interpreters and translators showed enhanced EFs, as predicted by the

DLC. A similar method could be useful when categorising bilinguals as dual language speakers, single language speakers, or dense code-switchers.

This thesis supports recent studies highlighting the role of different factors/variables in modulating EFs. According to Surrain and Luk (2019), social characteristics of each community, language usage, language history and school language should be reported in studies investigating the bilingual advantage in EFs, as these patterns could lead to different effects on EFs. This supports our conclusion that not all bilinguals should be labeled as DLC speakers, similarly, not all diglossics should be labelled as SLC speakers. Rather, each language environment should be investigated on its own, and the language experience of individuals within this environment should be carefully measured. Moreover, it has been recently suggested that there are individual differences between participants that could have an effect on EFs. For instance, it has been found that individuals who exercise, play music or video games show more EF advantages (Valian, 2015). Accordingly, such life experiences require more attention which results in more EF advantages. This thesis supports the previously discussed studies by showing that the relationship between bilingualism/diglossia and EFs is a complex one which involves different variables that need to be controlled.

5.3. Conclusion

To conclude, this thesis has shown some enhancements related to the SLC in diglossia. The ACH predicted that speakers in the SLC will show enhanced performances in tasks measuring goal maintenance. Specifically, we found a diglossic advantage amongst older adults, in Stroop task, when compared to monolinguals. However, the ACH also predicted that speakers in the DLC will perform similarly, or better than speakers in SLC in tasks that tap into goal maintenance. This was not achieved in this thesis where bilingual older adults exhibited a larger Flanker effect compared to diglossics. The ACH also fails to explain the larger Flanker effect by diglossic young adults compared to monolinguals. Further, this thesis highlights the importance of taking into account some factors that could explain performances on EF tasks. For instance, the lack of advantage in any task by diglossic young adults could be explained by the age group, which rarely shows advantages (Berkes et al., 2021). The lack of a bilingual advantage amongst older adults in this study could be related to the young age of the tested bilinguals compared to other studies, which reported a bilingual advantage in older adults. Therefore, this thesis highlights the importance of investigating the bilingual advantage in EFs amongst the appropriate age range. It is also important to highlight that simply speaking two languages, or two varieties, does not guarantee enhanced EFs. Instead, enhanced EF abilities are related to the opportunities for, and amount of, switching. This means that not all bilingual situations should be labelled as DLCs. Similarly, not all diglossic or bidialectal situations should be labelled as SLCs.

REFERENCES

Abutalebi, J., Canini, M., Della Rosa, P. A., Green, D. W., & Weekes, B. S. (2015). The neuroprotective effects of bilingualism upon the inferior parietal lobule: A Structural Neuroimaging Study in Aging Chinese Bilinguals. *Journal of Neurolinguistics*, *33*, 3–13. https://doi.org/10.1016/j.jneuroling.2014.09.008

Albirini, A. (2016). *Modern Arabic sociolinguistics: Diglossia, variation, codeswitching, attitudes and identity*. London; New York: Routledge, Taylor & Francis Group.

Alloway, T. P. (2015). *AWMA-2-NL: Alloway Working Memory Assessment* (2nd ed.). London: Pearson.

Alrwaita, N., Houston-Price, C., & Pliatsikas, C. (2020). *The effects of using two variants of one language on cognition: Evidence from bidialectalism and diglossia.* https://doi.org/10.31234/osf.io/9c7df

Alrwaita, N., Meteyard, L., Houston-Price, C., & Pliatsikas, C. (2021). *Is there an effect of diglossia on cognition? An investigation of the relationship between diglossia and Executive Functions in young adults.* https://doi.org/10.31234/osf.io/rv3n5

Amara, M. H., & Mar'I, A. A.-R. (Eds.). (2002). Policy and Teaching Arabic as a Mother Tongue. In *Language Education Policy: The Arab Minority in Israel* (pp. 61–86). Dordrecht: Springer Netherlands. https://doi.org/10.1007/0-306-47588-X_4

Amer, T., Kalender, B., Hasher, L., Trehub, S. E., & Wong, Y. (2013). Do Older Professional Musicians Have Cognitive Advantages? *PLoS ONE*, *8*(8), e71630. https://doi.org/10.1371/journal.pone.0071630

Anderson, J. A. E., Mak, L., Keyvani Chahi, A., & Bialystok, E. (2018). The language and social background questionnaire: Assessing degree of bilingualism in a diverse population. *Behavior Research Methods*, *50*(1), 250–263. https://doi.org/10.3758/s13428-017-0867-9

Ansaldo, A. I., Marcotte, K., Scherer, L., & Raboyeau, G. (2008). Language therapy and bilingual aphasia: Clinical implications of psycholinguistic and neuroimaging research. *Journal of Neurolinguistics*, *21*(6), 539–557. https://doi.org/10.1016/j.jneuroling.2008.02.001

Antón, E., Carreiras, M., & Duñabeitia, J. A. (2019). The impact of bilingualism on executive functions and working memory in young adults. *PLOS ONE*, *14*(2), e0206770. https://doi.org/10.1371/journal.pone.0206770

Antón, E., Fernández García, Y., Carreiras, M., & Duñabeitia, J. A. (2016). Does bilingualism shape inhibitory control in the elderly? *Journal of Memory and Language*, *90*, 147–160. https://doi.org/10.1016/j.jml.2016.04.007

Antoniou, K., Kambanaros, M., Grohmann, K. K., & Katsos, N. (2016). *Is Bilectalism Similar to Bilingualism? An Investigation into Children's Vocabulary and Executive Control Skills*. BUCLD 38: Proceedings of the 38th Annual Boston University Conference on Language Development, *1*, 12–24.

Antoniou, K., & Spanoudis, G. (2020). *An Investigation of the Multilingual and Bi-dialectal Advantage in Executive Control*. 8.

Ardila, A. (2008). On the evolutionary origins of executive functions. *Brain and Cognition*, *68*(1), 92–99. https://doi.org/10.1016/j.bandc.2008.03.003

Auer, P. (2005). Europe's sociolinguistic unity, or: A typology of European dialect/standard constellations. In N. Delbecque, J. van der Auwera & D. Geeraerts (Eds.), *Perspectives on Variation*. Berlin, New York, NY: De Gruyter Mouton. https://doi.org/10.1515/9783110909579.7

Barac, R., & Bialystok, E. (2012). Bilingual Effects on Cognitive and Linguistic Development: Role of Language, Cultural Background, and Education. *Child Development*, *83*(2), 413–422. https://doi.org/10.1111/j.1467-8624.2011.01707.x

Basak, C., Boot, W. R., Voss, M. W., & Kramer, A. F. (2008). Can training in a real-time strategy video game attenuate cognitive decline in older adults? *Psychology and Aging*, *23*(4), 765–777. https://doi.org/10.1037/a0013494

Bates, D., Kliegl, R., Vasishth, S., & Baayen, H. (2018). Parsimonious Mixed Models. *ArXiv:1506.04967*. Retrieved from http://arxiv.org/abs/1506.04967

Beauvillain, C., & Grainger, J. (1987). Accessing interlexical homographs: Some limitations of a language-selective access. *Journal of Memory and Language*, *26*(6), 658–672. https://doi.org/10.1016/0749-596X(87)90108-2

Berkes, M., Calvo, N., Anderson, J. A. E., & Bialystok, E. (2021). Poorer clinical outcomes for older adult monolinguals when matched to bilinguals on brain health. *Brain Structure and Function*, *226*(2), 415–424. https://doi.org/10.1007/s00429-020-02185-5

Bialystok, E. (2011). Reshaping the mind: The benefits of bilingualism. *Canadian Journal of Experimental Psychology/Revue Canadienne de Psychologie Expérimentale*, *65*(4), 229–235. https://doi.org/10.1037/a0025406

Bialystok, E. (2021). Bilingualism: Pathway to Cognitive Reserve. *Trends in Cognitive Sciences*, *25*(5), 355–364. https://doi.org/10.1016/j.tics.2021.02.003

Bialystok, E., Craik, F. I. M., Klein, R., & Viswanathan, M. (2004). Bilingualism, Aging, and Cognitive Control: Evidence From the Simon Task. *Psychology and Aging*, *19*(2), 290–303. https://doi.org/10.1037/0882-7974.19.2.290

Bialystok, E., Craik, F. I. M., & Luk, G. (2012). Bilingualism: Consequences for mind and brain. *Trends in Cognitive Sciences*, *16*(4), 240–250. https://doi.org/10.1016/j.tics.2012.03.001

Bialystok, E., Craik, F. I. M., & Ryan, J. (2006). Executive control in a modified antisaccade task: Effects of aging and bilingualism. *Journal of Experimental*

Psychology: Learning, Memory, and Cognition, *32*(6), 1341–1354. https://doi.org/10.1037/0278-7393.32.6.1341

Bialystok, E., Craik, F., & Luk, G. (2008). Cognitive control and lexical access in younger and older bilinguals. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *34*(4), 859–873. https://doi.org/10.1037/0278-7393.34.4.859

Bialystok, E., Martin, M. M., & Viswanathan, M. (2005). Bilingualism across the lifespan: The rise and fall of inhibitory control. *International Journal of Bilingualism*, *9*(1), 103–119. https://doi.org/10.1177/13670069050090010701

Birsong, D., Gertken, L., & Amengual, M. (2012). Bilingual Language Profile | An Easy-to-Use Instrument to Assess Bilingualism. Retrieved from https://sites.la.utexas.edu/bilingual/

Blom, E., Boerma, T., Bosma, E., Cornips, L., & Everaert, E. (2017). Cognitive Advantages of Bilingual Children in Different Sociolinguistic Contexts. *Frontiers in Psychology*, *8*, 552. https://doi.org/10.3389/fpsyg.2017.00552

Blumenfeld, H. K., & Marian, V. (2013). Parallel language activation and cognitive control during spoken word recognition in bilinguals. *Journal of Cognitive Psychology, 25*(5). https://doi.org/10.1080/20445911.2013.812093

Bosma, E., Blom, E., & Versloot, A. (2017a). Language balance and cognitive advantages in Frisian-Dutch bilingual children. In F. Lauchlan & M. del C. P. Couto (Eds.), *Bilingualism and Minority Languages in Europe: Current Trends and Developments*. Cambridge Scholars Publishing.

Bosma, E., Hoekstra, E., Versloot, A., & Blom, E. (2017b). The Minimal and Short-Lived Effects of Minority Language Exposure on the Executive Functions of Frisian-Dutch Bilingual Children. *Frontiers in Psychology*, *8*, 1453. https://doi.org/10.3389/fpsyg.2017.01453

Callahan, R. M., & Gándara, P. C. (2014). *The Bilingual Advantage: Language, Literacy and the US Labor Market*. Multilingual Matters.

Calvo, A., & Bialystok, E. (2014). Independent effects of bilingualism and socioeconomic status on language ability and executive functioning. *Cognition*, *130*(3), 278–288. https://doi.org/10.1016/j.cognition.2013.11.015

Carlson, S. M., & Meltzoff, A. N. (2008). Bilingual experience and executive functioning in young children. *Developmental Science*, *11*(2), 282–298. https://doi.org/10.1111/j.1467-7687.2008.00675.x

Chen, Z. (2003). Attentional focus, processing load, and Stroop interference. *Perception & Psychophysics*, *65*(6), 888–900. https://doi.org/10.3758/BF03194822

Chevalier, N., Sheffield, T. D., Nelson, J. M., Clark, C. A. C., Wiebe, S. A., & Espy, K. A. (2012). Underpinnings of the Costs of Flexibility in Preschool Children: The Roles of Inhibition and Working Memory. *Developmental Neuropsychology*, *37*(2), 99–118. https://doi.org/10.1080/87565641.2011.632458

Costa, A., Hernández, M., Costa-Faidella, J., & Sebastián-Gallés, N. (2009). On the bilingual advantage in conflict processing: Now you see it, now you don’t. *Cognition*, *113*(2), 135–149. https://doi.org/10.1016/j.cognition.2009.08.001

Costa, A., Hernández, M., & Sebastián-Gallés, N. (2008). Bilingualism aids conflict resolution: Evidence from the ANT task. *Cognition*, *106*(1), 59–86. https://doi.org/10.1016/j.cognition.2006.12.013

Craik, F. I. M., Bialystok, E., & Freedman, M. (2010). Delaying the onset of Alzheimer disease: Bilingualism as a form of cognitive reserve. *Neurology*, *75*(19), 1726–1729. https://doi.org/10.1212/WNL.0b013e3181fc2a1c

Darcy, N. T. (2012). A Review of the Literature on the Effects of Bilingualism upon the Measurement of Intelligence. *The Pedagogical Seminary and Journal of Genetic*

Psychology, *82*(1), 21–57. Retrieved from https://www.tandfonline.com/doi/abs/10.1080/08856559.1953.10533654

de Bruin, A., & Della Sala, S. (2015). The decline effect: How initially strong results tend to decrease over time. *Cortex*, *73*, 375–377. https://doi.org/10.1016/j.cortex.2015.05.025

de Groot, A. M. B. (2012). Bilingualism and Cognition. In C. A. Chapelle (Ed.), *The Encyclopedia of Applied Linguistics* (p. wbeal0099). Oxford: Blackwell Publishing Ltd. https://doi.org/10.1002/9781405198431.wbeal0099

de Groot, A. M. B., & Kroll, J. F. (2014). *Tutorials in Bilingualism: Psycholinguistic Perspectives*. Psychology Press.

DeLuca, V., Rothman, J., Bialystok, E., & Pliatsikas, C. (2019). Redefining bilingualism as a spectrum of experiences that differentially affects brain structure and function. *Proceedings of the National Academy of Sciences*, *116*(15), 7565–7574. https://doi.org/10.1073/pnas.1811513116

Diamond, A. (2013). Executive Functions. *Annual Review of Psychology*, *64*(1), 135–168. https://doi.org/10.1146/annurev-psych-113011-143750

Dijkstra, J. (2013). *Growing up with Frisian and Dutch: The role of language input in the early development of Frisian and Dutch among preschool children in Friesland* (Unpublished doctoral dissertation). University of Groningen.

Donnelly, S., Brooks, P. J., & Homer, B. D. (2019). Is there a bilingual advantage on interference-control tasks? A multiverse meta-analysis of global reaction time and interference cost. *Psychonomic Bulletin & Review*, *26*(4), 1122–1147. https://doi.org/10.3758/s13423-019-01567-z

Duñabeitia, J. A., Hernández, J. A., Antón, E., Macizo, P., Estévez, A., Fuentes, L. J., & Carreiras, M. (2014). The Inhibitory Advantage in Bilingual Children Revisited:

Myth or Reality? *Experimental Psychology*, *61*(3), 234–251. https://doi.org/10.1027/1618-3169/a000243

Dunn, L. M., & Dunn, L. M. (1997). *PPVT-III: Peabody picture vocabulary test*. Circle Pines, MN: American Guidance Service.

Dux, P. E., Tombu, M. N., Harrison, S., Rogers, B. P., Tong, F., & Marois, R. (2009). Training Improves Multitasking Performance by Increasing the Speed of Information Processing in Human Prefrontal Cortex. *Neuron*, *63*(1), 127–138. https://doi.org/10.1016/j.neuron.2009.06.005

Edwards, V. K. (1976). Effects of dialect on the comprehension of West Indian children. *Educational Research*, *18*(2), 83–95. https://doi.org/10.1080/0013188760180201

Edwards, V. (1983). *Language in multicultural classrooms*. London: Batsford Academic and Educational.

Emmorey, K., Luk, G., Pyers, J. E., & Bialystok, E. (2008). The Source of Enhanced Cognitive Control in Bilinguals: Evidence From Bimodal Bilinguals. *Psychological Science*, *19*(12), 1201–1206. https://doi.org/10.1111/j.1467-9280.2008.02224.x

Engel de Abreu, P. M. J., Cruz-Santos, A., Tourinho, C. J., Martin, R., & Bialystok, E. (2012). Bilingualism Enriches the Poor: Enhanced Cognitive Control in Low-Income Minority Children. *Psychological Science*, *23*(11), 1364–1371. https://doi.org/10.1177/0956797612443836

Eriksen, B. A., & Eriksen, C. W. (1974). Effects of noise letters upon the identification of a target letter in a nonsearch task. *Perception & Psychophysics*, *16*(1), 143–149. https://doi.org/10.3758/BF03203267

Eviatar, Z., & Ibrahim, R. (2014). Why is it Hard to Read Arabic? In E. Saiegh-Haddad & R. M. Joshi (Eds.), *Handbook of Arabic Literacy: Insights and Perspectives* (pp. 77–96). Dordrecht: Springer Netherlands. https://doi.org/10.1007/978-94-017-8545-7_4

Ferguson, C. A. (1959). Diglossia. *WORD*, *15*(2), 325–340. https://doi.org/10.1080/00437956.1959.11659702

Ferreira, D., Correia, R., & Nieto, A. (2015). Cognitive decline before the age of 50 can be detected with sensitive cognitive measures. *Psicothema*, *27*(3), 216–222. https://doi.org/10.7334/psicothema2014.192

Fishman, J. (1972). Domains and the relationship between micro- and macrosociolinguistics. In D. Hymes & J. Gumperz (Eds.), *Directions in Sociolinguistics: The Ethnography of Communication*. Retrieved from https://www.wiley.com/en-sa/Directions+in+Sociolinguistics%3A+The+Ethnography+of+Communication-p-9780631149873

Frangoudaki, A. (1992). Diglossia and the present language situation in Greece: A sociological approach to the interpretation of diglossia and some hypotheses on today's linguistic reality. *Language in Society*, *21*(3), 365–381. https://doi.org/10.1017/S0047404500015487

Garraffa, M., Beveridge, M., & Sorace, A. (2015). Linguistic and Cognitive Skills in Sardinian–Italian Bilingual Children. *Frontiers in Psychology*, *6*. https://doi.org/10.3389/fpsyg.2015.01898

Gathercole, V. C. M., Thomas, E. M., Kennedy, I., Prys, C., Young, N., Viñas Guasch, N., … Jones, L. (2014). Does language dominance affect cognitive performance in bilinguals? Lifespan evidence from preschoolers through older adults on card sorting, Simon, and metalinguistic tasks. *Frontiers in Psychology*, *5*. https://doi.org/10.3389/fpsyg.2014.00011

Gold, B. T., Kim, C., Johnson, N. F., Kryscio, R. J., & Smith, C. D. (2013). Lifelong Bilingualism Maintains Neural Efficiency for Cognitive Control in Aging. *Journal of Neuroscience*, *33*(2), 387–396. https://doi.org/10.1523/JNEUROSCI.3837-12.2013

Green, C. S., Li, R., & Bavelier, D. (2010). Perceptual Learning During Action Video Game Playing. *Topics in Cognitive Science*, *2*(2), 202–216. https://doi.org/10.1111/j.1756-8765.2009.01054.x

Green, D. W., & Abutalebi, J. (2013). Language control in bilinguals: The adaptive control hypothesis. *Journal of Cognitive Psychology*, *25*(5), 515–530. https://doi.org/10.1080/20445911.2013.796377

Green, D. W., & Wei, L. (2014). A control process model of code-switching. *Language, Cognition and Neuroscience*, *29*(4), 499–511. https://doi.org/10.1080/23273798.2014.882515

Grosjean, F. (1982). *Life with Two Languages: An Introduction to Bilingualism*. Harvard University Press.

Grundy, J. G. (2020). The effects of bilingualism on executive functions: An updated quantitative analysis. *Journal of Cultural Cognitive Science*, *4*(2), 177–199. https://doi.org/10.1007/s41809-020-00062-5

Guerrero, S. L., Mesite, L., Surrain, S., and Luk, G. (2015). Mixed language use and cognitive flexibility in young bilinguals. Retrieved from https://bef2015.commons.gc.cuny.edu/2015/04/30/mixed-language-use-and-cognitive-flexibility-in-young-bilinguals/

Gunnerud, H. L., ten Braak, D., Reikerås, E. K. L., Donolato, E., & Melby-Lervåg, M. (2020). Is bilingualism related to a cognitive advantage in children? A systematic review and meta-analysis. *Psychological Bulletin*, *146*(12), 1059. https://doi.org/10.1037/bul0000301

Hartanto, A., & Yang, H. (2016). Disparate bilingual experiences modulate task-switching advantages: A diffusion-model analysis of the effects of interactional context on switch costs. *Cognition*, *150*, 10–19. https://doi.org/10.1016/j.cognition.2016.01.016

Henrard, S., & van Daele, A. (2017). Different Bilingual Experiences Might Modulate Executive Tasks Advantages: Comparative Analysis between Monolinguals, Translators, and Interpreters. *Frontiers in Psychology*, *8*, 1870. https://doi.org/10.3389/fpsyg.2017.01870

Hernández, M., Martin, C. D., Barceló, F., & Costa, A. (2013). Where is the bilingual advantage in task-switching? *Journal of Memory and Language*, *69*(3), 257–276. https://doi.org/10.1016/j.jml.2013.06.004

Hilchey, M. D., & Klein, R. M. (2011). Are there bilingual advantages on nonlinguistic interference tasks? Implications for the plasticity of executive control processes. *Psychonomic Bulletin & Review*, *18*(4), 625–658. https://doi.org/10.3758/s13423-011-0116-7

Hoshino, N., & Thierry, G. (2011). Language selection in bilingual word production: Electrophysiological evidence for cross-language competition. *Brain Research*, *1371*, 100–109. https://doi.org/10.1016/j.brainres.2010.11.053

Houtzager, N., Lowie, W., Sprenger, S., & de Bot, K. (2017). A bilingual advantage in task switching? Age-related differences between German monolinguals and Dutch-Frisian bilinguals. *Bilingualism: Language and Cognition*, *20*(1), 69–79. https://doi.org/10.1017/S1366728915000498

Hsu, H.-L. (2021). Cognitive control in older Minnan-Mandarin and Hakka-Mandarin bidialectal adults: Advantages in Stroop-type tasks. *Lingua*, 103041. https://doi.org/10.1016/j.lingua.2021.103041

Hsu, H.-L. (2017). An Interaction Between the Effects of Bilingualism and Cross-linguistic Similarity in Balanced and Unbalanced Bilingual Adults' L2 Mandarin Word-Reading Production. *Journal of Psycholinguistic Research*, *46*(4), 935–962. https://doi.org/10.1007/s10936-016-9472-9

Hudson, A. (2002). Outline of a theory of diglossia. *International Journal of the Sociology of Language*, *2002*(157), 1–48. https://doi.org/10.1515/ijsl.2002.039

Hughes, C., Ensor, R., Wilson, A., & Graham, A. (2009). Tracking Executive Function Across the Transition to School: A Latent Variable Approach. *Developmental Neuropsychology*, *35*(1), 20–36. https://doi.org/10.1080/87565640903325691

Kapa, L. L., & Colombo, J. (2013). Attentional control in early and later bilingual children. *Cognitive Development*, *28*(3), 233–246. https://doi.org/10.1016/j.cogdev.2013.01.011

Karyolemou, M. (2006). Reproduction and innovation of communicative patterns in a former-'diglossic' community. In *Reproduction and innovation in language and communication in different language cultures* (pp. 39–56). Wien: Peter Lang Verlag.

Kaye, A. S. (2001). Diglossia: The state of the art. *International Journal of the Sociology of Language*, *2001*(152), 117–129. https://doi.org/10.1515/ijsl.2001.051

Keller, R. (1982). Diglossia in German-speaking Switzerland. In *Standard Languages: Spoken and Written*. Manchester University Press.

Kendrick, L. T., Robson, H., & Meteyard, L. (2019). Executive control in frontal lesion aphasia: Does verbal load matter? *Neuropsychologia*, *133*, 107178. https://doi.org/10.1016/j.neuropsychologia.2019.107178

Kirk, N. W., Fiala, L., Scott-Brown, K. C., & Kempe, V. (2014). No evidence for reduced Simon cost in elderly bilinguals and bidialectals. *Journal of Cognitive Psychology*, *26*(6), 640–648. https://doi.org/10.1080/20445911.2014.929580

Kousaie, S., & Phillips, N. A. (2012). Ageing and bilingualism: Absence of a "bilingual advantage" in Stroop interference in a nonimmigrant sample. *Quarterly Journal of Experimental Psychology*, *65*(2), 356–369. https://doi.org/10.1080/17470218.2011.604788

Kroll, J. F., & Bialystok, E. (2013). Understanding the consequences of bilingualism for language processing and cognition. *Journal of Cognitive Psychology*, *25*(5), 497–514. https://doi.org/10.1080/20445911.2013.799170

Kroll, J. F., Bobb, S. C., & Hoshino, N. (2014). Two Languages in Mind: Bilingualism as a Tool to Investigate Language, Cognition, and the Brain. *Current Directions in Psychological Science*, *23*(3), 159–163. https://doi.org/10.1177/0963721414528511

Kroll, J. F., Bobb, S. C., Misra, M., & Guo, T. (2008). Language selection in bilingual speech: Evidence for inhibitory processes. *Acta Psychologica*, *128*(3), 416–430. https://doi.org/10.1016/j.actpsy.2008.02.001

Kroll, J. F., Dussias, P. E., Bogulski, C. A., & Kroff, J. R. V. (2012). Juggling Two Languages in One Mind. In *Psychology of Learning and Motivation* (Vol. 56, pp. 229–262). Elsevier. https://doi.org/10.1016/B978-0-12-394393-4.00007-8

Lamb, W. (2008). Scottish Gaelic Speech and Writing: Register Variation in an Endangered Language. In J. M. Kirk & P. Donall (Eds.), *Belfast Studies in Language, Culture and Politics*. Queen's University Belfast.

Lauchlan, F., Parisi, M., & Fadda, R. (2013). Bilingualism in Sardinia and Scotland: Exploring the cognitive benefits of speaking a 'minority' language. *International Journal of Bilingualism*, *17*(1), 43–56. https://doi.org/10.1177/1367006911429622

Lee Salvatierra, J., & Rosselli, M. (2011). The effect of bilingualism and age on inhibitory control. *International Journal of Bilingualism*, *15*(1), 26–37. https://doi.org/10.1177/1367006910371021

Lehtonen, M., Soveri, A., Laine, A., Järvenpää, J., de Bruin, A., & Antfolk, J. (2018). Is bilingualism associated with enhanced executive functioning in adults? A meta-analytic review. *Psychological Bulletin*, *144*(4), 394–425. https://doi.org/10.1037/bul0000142

Limberger, B. K., & Buchweitz, A. (2014). Os efeitos do bilinguismo e do multilinguismo nas funções executivas. *Fórum Linguístico*, *11*(3), 261. https://doi.org/10.5007/1984-8412.2014v11n3p261

Linck, J., Hoshino, N., & Kroll, J. (2008). Cross-language lexical processes and inhibitory control. *The Mental Lexicon*, *3*(3), 349–374. https://doi.org/10.1075/ml.3.3.06lin

Linsey, E. W., & Colwell, M. J. (2003). Preschoolers' emotional competence: Links to pretend and physical play. *Child Study Journal*, *33*(1), 39–52.

Luo, L., Craik, F. I. M., Moreno, S., & Bialystok, E. (2013). Bilingualism interacts with domain in a working memory task: Evidence from aging. *Psychology and Aging*, *28*(1), 28–34. https://doi.org/10.1037/a0030875

Lustig, C., Shah, P., Seidler, R., & Reuter-Lorenz, P. A. (2009). Aging, Training, and the Brain: A Review and Future Directions. *Neuropsychology Review*, *19*(4), 504–522. https://doi.org/10.1007/s11065-009-9119-9

Maamouri, M. (1998). Arabic diglossia and its impact on the quality of education in the Arab region. *The Mediterranean Development Forum*. Washington, DC: The World Bank.

MacAulay, D. (1982). Register range and choice in Scottish Gaelic. *International Journal of the Sociology of Language*, *35*, 25–48. https://doi.org/10.1515/ijsl.1982.35.25

MacAulay, D. (Ed.). (1993). The Scottish Gaelic Language. In D. MacAulay, *The Celtic Languages*. Cambridge; New York, NY: Cambridge University Press.

Macnamara, J., & Kushnir, S. L. (1971). Linguistic independence of bilinguals: The input switch. *Journal of Verbal Learning and Verbal Behavior*, *10*(5), 480–487. https://doi.org/10.1016/S0022-5371(71)80018-X

Madau, P., Ferguson, H. C., Dickinson, M. E., Giavalisco, M., Steidel, C. C., & Fruchter, A. (1996). High-redshift galaxies in the Hubble Deep Field: Colour selection and star formation history to z ∼ 4. *Monthly Notices of the Royal Astronomical Society*, *283*(4), 1388–1404. https://doi.org/10.1093/mnras/283.4.1388

Malcolm, I. G., Haig, Y., Konsignberg, P., Rochecouste, J., Collard, G., Hill, A., & Cahill, R. (1999). *Towards more user-friendly education for speakers of Aboriginal English*. Perth, Australia: Edith Cowan University.

Marian, V., Blumenfeld, H. K., & Kaushanskaya, M. (2007). The Language Experience and Proficiency Questionnaire (LEAP-Q): Assessing Language Profiles in Bilinguals and Multilinguals. *Journal of Speech, Language, and Hearing Research*, *50*(4), 940–967. https://doi.org/10.1044/1092-4388(2007/067)

Marian, V., Spivey, M., & Hirsch, J. (2003). Shared and separate systems in bilingual language processing: Converging evidence from eyetracking and brain imaging. *Brain and Language*, *86*(1), 70–82. https://doi.org/10.1016/S0093-934X(02)00535-7

Martin-Rhee, M. M., & Bialystok, E. (2008). The development of two types of inhibitory control in monolingual and bilingual children. *Bilingualism: Language and Cognition*, *11*(1), 81–93. https://doi.org/10.1017/S1366728907003227

Masica, C. P., & Sinha, A. K. (1986). *South Asian Languages: Structure, Convergence and Diglossia: 2nd International Conference on South Asian Languages and Linguistics: Selected Papers*. Motilal Banarsidass.

Masrai, A., & Milton, J. (2019). How many words do you need to speak Arabic? An Arabic vocabulary size test. *The Language Learning Journal*, *47*(5), 519–536. https://doi.org/10.1080/09571736.2016.1258720

McLaughlin, B. (1978). *Second-language acquisition in childhood*. Hillsdale, NJ: Erlbaum.

Mejía, A.-M. D. (2002). *Power, Prestige, and Bilingualism: International Perspectives on Elite Bilingual Education*. Multilingual Matters.

Miller, N., & Kroll, J. (2002). *Stroop effects in bilingual translation*. Retrieved from https://link.springer.com/article/10.3758/BF03194963

Miyake, A., Emerson, M. J., Padilla, F., & Ahn, J. (2004). Inner speech as a retrieval aid for task goals: The effects of cue type and articulatory suppression in the random task cuing paradigm. *Acta Psychologica*, *115*(2–3), 123–142. https://doi.org/10.1016/j.actpsy.2003.12.004

Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., Howerter, A., & Wager, T. D. (2000). The Unity and Diversity of Executive Functions and Their

Contributions to Complex "Frontal Lobe" Tasks: A Latent Variable Analysis. *Cognitive Psychology*, *41*(1), 49–100. https://doi.org/10.1006/cogp.1999.0734

Morales, J., Calvo, A., & Bialystok, E. (2013). Working memory development in monolingual and bilingual children. *Journal of Experimental Child Psychology*, *114*(2), 187–202. https://doi.org/10.1016/j.jecp.2012.09.002

Morton, J. B., & Harper, S. N. (2007). What did Simon say? Revisiting the bilingual advantage. *Developmental Science*, *10*(6), 719–726. https://doi.org/10.1111/j.1467-7687.2007.00623.x

Muysken, P. (2000). *Bilingual speech: A typology of code-mixing*. Cambridge; New York, NY: Cambridge University Press.

Nyberg, L., Lövdén, M., Riklund, K., Lindenberger, U., & Bäckman, L. (2012). Memory aging and brain maintenance. *Trends in Cognitive Sciences*, *16*(5), 292–305. https://doi.org/10.1016/j.tics.2012.04.005

Oh, S., & Lewis, C. (2008). Korean Preschoolers' Advanced Inhibitory Control and Its Relation to Other Executive Skills and Mental State Understanding. *Child Development*, *79*(1), 80–99. https://doi.org/10.1111/j.1467-8624.2007.01112.x

Ooi, S. H., Goh, W. D., Sorace, A., & Bak, T. H. (2018). From Bilingualism to Bilingualisms: Bilingual experience in Edinburgh and Singapore affects attentional control differently. *Bilingualism: Language and Cognition*, *21*(4), 867–879. https://doi.org/10.1017/S1366728918000020

Oschwald, J., Schättin, A., von Bastian, C. C., & Souza, A. S. (2018). Bidialectalism and Bilingualism: Exploring the Role of Language Similarity as a Link Between Linguistic Ability and Executive Control. *Frontiers in Psychology*, *9*, 1997. https://doi.org/10.3389/fpsyg.2018.01997

Owen, A. M., Hampshire, A., Grahn, J. A., Stenton, R., Dajani, S., Burns, A. S., … Ballard, C. G. (2010). Putting brain training to the test. *Nature*, *465*(7299), 775–778. https://doi.org/10.1038/nature09042

Paap, K. (2019). The Bilingual Advantage Debate: Quantity and Quality of the Evidence. In J. W. Schwieter & M. Paradis (Eds.), *The Handbook of the Neuroscience of Multilingualism* (pp. 701–735). Chichester: John Wiley & Sons, Ltd. https://doi.org/10.1002/9781119387725.ch34

Paap, K. R., Anders-Jefferson, R., Zimiga, B., Mason, L., & Mikulinsky, R. (2020). Interference scores have inadequate concurrent and convergent validity: Should we stop using the flanker, Simon, and spatial Stroop tasks? *Cognitive Research: Principles and Implications*, *5*(1), 7. https://doi.org/10.1186/s41235-020-0207-y

Paap, K. R., & Greenberg, Z. I. (2013). There is no coherent evidence for a bilingual advantage in executive processing. *Cognitive Psychology*, *66*(2), 232–258. https://doi.org/10.1016/j.cogpsych.2012.12.002

Paap, K. R., Johnson, H. A., & Sawi, O. (2015). Bilingual advantages in executive functioning either do not exist or are restricted to very specific and undetermined circumstances. *Cortex, 69*, 265–278. https://doi.org/10.1016/j.cortex.2015.04.014

Padilla, A. M., Fairchild, H. H., & Valadez, C. M. (Eds.). (1990). *Bilingual education: Issues and strategies*. Newbury Park, CA: Sage Publications.

Palmer, J. (2008). Arabic diglossia: Student perceptions of spoken Arabic after living in the Arabic-speaking world. *Arizona Working Papers in SLA & Teaching*, *15*, 81–95. Retrieved from: https://journals.uair.arizona.edu/index.php/AZSLAT/article/view/21255/20835

Papapavlou, A. N., & Pavlou, P. (1998). A Review of the Sociolinguistic Aspects of the Greek Cypriot Dialect. *Journal of Multilingual and Multicultural Development*, *19*(3), 212–220. https://doi.org/10.1080/01434639808666353

Pavlou, P. (2004). Greek dialect use in the mass media in Cyprus. *International Journal of the Sociology of Language*, *2004*(168). https://doi.org/10.1515/ijsl.2004.026

Peal, E., & Lambert, W. E. (1962). The relation of bilingualism to intelligence. *Psychological Monographs: General and Applied*, *76*(27), 1–23. https://doi.org/10.1037/h0093840

Pelham, S. D., & Abrams, L. (2014). Cognitive advantages and disadvantages in early and late bilinguals. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *40*(2), 313–325. https://doi.org/10.1037/a0035224

Peterson, J. B., & Flanders, J. L. (2005). Play and the Regulation of Aggression. In R. E. Tremblay, W. W. Hartup & J. Archer (Eds.), *Developmental origins of aggression* (pp. 133–157). New York, NY: The Guilford Press.

Piper, B. J., Li, V., Eiwaz, M. A., Kobel, Y. V., Benice, T. S., Chu, A. M., … Mueller, S. T. (2012). Executive function on the Psychology Experiment Building Language tests. *Behavior Research Methods*, *44*(1), 110–123. https://doi.org/10.3758/s13428-011-0096-6

Pliatsikas, C. (2019). Multilingualism and Brain Plasticity. In J. W. Schwieter & M. Paradis (Eds.), *The Handbook of the Neuroscience of Multilingualism* (pp. 230–251). Chichester: John Wiley & Sons, Ltd. https://doi.org/10.1002/9781119387725.ch11

Pliatsikas, C., DeLuca, V., & Voits, T. (2020). The Many Shades of Bilingualism: Language Experiences Modulate Adaptations in Brain Structure. *Language Learning*, *70*(S2), 133–149. https://doi.org/10.1111/lang.12386

Poarch, G. J., & Krott, A. (2019). A Bilingual Advantage? An Appeal for a Change in Perspective and Recommendations for Future Research. *Behavioral Sciences*, *9*(9), 95. https://doi.org/10.3390/bs9090095

Poarch, G. J., & van Hell, J. G. (2012). Executive functions and inhibitory control in multilingual children: Evidence from second-language learners, bilinguals, and trilinguals. *Journal of Experimental Child Psychology*, *113*(4), 535–551. https://doi.org/10.1016/j.jecp.2012.06.013

Poarch, G. J., & van Hell, J. G. (2019). Does performance on executive function tasks correlate? In I. A. Sekerina, L. Spradlin & V. Valian (Eds.), *Bilingualism, Executive Function, and Beyond: Questions and insights* (pp. 223–236). John Benjamins Publishing Company. Retrieved from https://benjamins.com/catalog/sibil.57.14poa

Poarch, G. J., Vanhove, J., & Berthele, R. (2019). The effect of bidialectalism on executive function. *International Journal of Bilingualism*, *23*(2), 612–628. https://doi.org/10.1177/1367006918763132

Portes, A., & Schauffler, R. (1994). Language and the Second Generation: Bilingualism Yesterday and Today. *The International Migration Review*, 28(4), 640–661. https://doi.org/10.2307/2547152

Pot, A., Keijzer, M., & de Bot, K. (2018). Intensity of Multilingual Language Use Predicts Cognitive Performance in Some Multilingual Older Adults. *Brain Sciences*, *8*(5), 92. https://doi.org/10.3390/brainsci8050092

Potter, L. M., & Grealy, M. A. (2008). Aging and Inhibition of a Prepotent Motor Response during an Ongoing Action. *Aging, Neuropsychology, and Cognition*, *15*(2), 232–255. https://doi.org/10.1080/13825580701336882

Poulin-Dubois, D., Blaye, A., Coutya, J., & Bialystok, E. (2011). The effects of bilingualism on toddlers' executive functioning. *Journal of Experimental Child Psychology*, *108*(3), 567–579. https://doi.org/10.1016/j.jecp.2010.10.009

Prior, A., & MacWhinney, B. (2010). A bilingual advantage in task switching. *Bilingualism: Language and Cognition*, *13*(2), 253–262. https://doi.org/10.1017/S1366728909990526

Raven, J. C., Court, J. H., & Raven, J. E. (1956). *Raven's progressive matrices and vocabulary scales*. San Antonio, TX: Harcourt Assessment.

Reijnders, J., van Heugten, C., & van Boxtel, M. (2013). Cognitive interventions in healthy older adults and people with mild cognitive impairment: A systematic review. *Ageing Research Reviews*, *12*(1), 263–275. https://doi.org/10.1016/j.arr.2012.07.003

Rickford, J. R. (1997). Unequal partnership: Sociolinguistics and the African American speech community. *Language in Society*, *26*(2), 161–197. https://doi.org/10.1017/S0047404500020893

Ross, J., & Melinger, A. (2017). Bilingual advantage, bidialectal advantage or neither? Comparing performance across three tests of executive function in middle childhood. *Developmental Science*, *20*(4), e12405. https://doi.org/10.1111/desc.12405

Rowe, C., & Grohmann, K. K. (2013). Discrete bilectalism: Towards co-overt prestige and diglossic shift in Cyprus. *International Journal of the Sociology of Language*, *2013*(224). https://doi.org/10.1515/ijsl-2013-0058

Saiegh-Haddad, E., & Joshi, R. M. (2014). *Handbook of Arabic Literacy: Insights and Perspectives*. Springer Science & Business Media.

Salminen, T., Strobach, T., & Schubert, T. (2012). On the impacts of working memory training on executive functioning. *Frontiers in Human Neuroscience*, *6*. https://doi.org/10.3389/fnhum.2012.00166

Salthouse, T. A. (2000). Aging and measures of processing speed. *Biological Psychology*, *54*(1–3), 35–54. https://doi.org/10.1016/S0301-0511(00)00052-1

Samuel, S., Roehr-Brackin, K., Pak, H., & Kim, H. (2018). Cultural Effects Rather Than a Bilingual Advantage in Cognition: A Review and an Empirical Study. *Cognitive Science*, *42*(7), 2313–2341. https://doi.org/10.1111/cogs.12672

Scaltritti, M., Peressotti, F., & Miozzo, M. (2017). Bilingual advantage and language switch: What's the linkage? *Bilingualism: Language and Cognition*, *20*(1), 80–97. https://doi.org/10.1017/S1366728915000565

Schroeder, S. R., & Marian, V. (2017). Cognitive consequences of trilingualism. *International Journal of Bilingualism*, *21*(6), 754–773. https://doi.org/10.1177/1367006916637288

Schweizer, T. A., Ware, J., Fischer, C. E., Craik, F. I. M., & Bialystok, E. (2012). Bilingualism as a contributor to cognitive reserve: Evidence from brain atrophy in Alzheimer's disease. *Cortex*, *48*(8), 991–996. https://doi.org/10.1016/j.cortex.2011.04.009

Sharoff, S., Umanskaya, E., & Wilson, J. (2013). *A Frequency Dictionary of Contemporary Russian: Core Vocabulary for Learners*. Routledge.

Simpson, T., Camfield, D., Pipingas, A., Macpherson, H., & Stough, C. (2012). Improved Processing Speed: Online Computer-based Cognitive Training in Older Adults. *Educational Gerontology*, *38*(7), 445–458. https://doi.org/10.1080/03601277.2011.559858

Stern, Y. (2012). Cognitive reserve in ageing and Alzheimer's disease. *The Lancet Neurology*, *11*(11), 1006–1012. https://doi.org/10.1016/S1474-4422(12)70191-6

Stroop, J. R. (1935). Studies of Interference in Serial Verbal Reactions. *Journal of Experimental Psychology*, *18*, 643–662.

Struys, E., Woumans, E., Nour, S., Kepinska, O., & Van Den Noort, M. (2019). A domain-general monitoring account of language switching in recognition tasks: Evidence for adaptive control. *Bilingualism: Language and Cognition*, *22*(3), 606–623. https://doi.org/10.1017/S1366728918000342

Surrain, S., & Luk, G. (2019). Describing bilinguals: A systematic review of labels and descriptions used in the literature between 2005–2015. *Bilingualism: Language and Cognition*, *22*(2), 401–415. https://doi.org/10.1017/S1366728917000682

Tsiplakou, S. (2020). Diglossia. In *The International Encyclopedia of Linguistic Anthropology* (pp. 1–6). American Cancer Society. https://doi.org/10.1002/9781118786093.iela0101

Tuller, L. (2015). 11. Clinical Use of Parental Questionnaires in Multilingual Contexts. In *Assessing Multilingual Children* (pp. 301–330). Multilingual Matters. https://doi.org/10.21832/9781783093137-013

Valenzuela, M. J., & Sachdev, P. (2006). Brain reserve and dementia: A systematic review. *Psychological Medicine*, *36*(4), 441–454. https://doi.org/10.1017/S0033291705006264

Valian, V. (2015). Bilingualism and cognition. *Bilingualism: Language and Cognition*, *18*(1), 3–24. https://doi.org/10.1017/S1366728914000522

Vance, D., Dawson, J., Wadley, V., Edwards, J., Roenker, D., Rizzo, M., & Ball, K. (2007). The accelerate study: The longitudinal effect of speed of processing training on cognitive performance of older adults. *Rehabilitation Psychology*, *52*(1), 89–96. https://doi.org/10.1037/0090-5550.52.1.89

Verhagen, J., Mulder, H., & Leseman, P. P. M. (2017). Effects of home language environment on inhibitory control in bilingual three-year-old children. *Bilingualism: Language and Cognition*, *20*(1), 114–127.

Verhoeven, L., & Vermeer, A. (2002). *Verantwoording Taaltoets Alle Kinderen (TAK)*. Arnhem: Cito.

Wechsler, D., & Psychological Corporation. (1949). *Wechsler intelligence scale for children: Manual*. New York, NY: Psychological Corp.

Wu, Y. J., & Thierry, G. (2013). Fast Modulation of Executive Function by Language Context in Bilinguals. *Journal of Neuroscience*, *33*(33), 13533–13537. https://doi.org/10.1523/JNEUROSCI.4760-12.2013

Yang, H., Hartanto, A., & Yang, S. (2016). The Complex Nature of Bilinguals' Language Usage Modulates Task-Switching Outcomes. *Frontiers in Psychology*, *7*. https://doi.org/10.3389/fpsyg.2016.00560

Yiakoumetti, A. (2007). Choice of classroom language in bidialectal communities: To include or to exclude the dialect? *Cambridge Journal of Education*, *37*(1), 51–66. https://doi.org/10.1080/03057640601179046

Zhou, B., & Krott, A. (2016). Data trimming procedure can eliminate bilingual cognitive advantage. *Psychonomic Bulletin & Review*, *23*(4), 1221–1230. https://doi.org/10.3758/s13423-015-0981-6

APPENDICES

APPENDIX A: LANGUAGE AND SOCIAL BACKGROUND QUESTIONNAIRE (ARABIC VERSION)

استبيان عن الخلفية اللغوية والاجتماعية

تاريخ اليوم ____________

- الجنس: ذكر انثى
- الوظيفة / الحالة الدراسية (مثال: منظم / غير منتظم/ المرحلة الدراسية) ____________
- تستخدم اليد اليمنى اليسرى
- تاريخ الميلاد ____________
- هل تمارس العاب الفيديو الاكشن والتي تتضمن العاب الطلق

الالكترونية من منظور الشخص الاول؟ نعم لا

اذا كان الجواب نعم، فكم ساعة في الأسبوع تمارس فيها هذه النوعية من العاب الفيديو؟ ________

- هل تعاني من أي مشاكل سمعية؟ نعم لا
- اذا كان الجواب نعم، فهل تستخدم أي سماعات خاصة؟ نعم لا
- هل تعاني من أي مشاكل في النظر؟ نعم لا
- اذا كان الجواب نعم، هل تستخدم نظرات طبية او عدسات؟ نعم لا
- هل تم تصحيح نظرك الى الحد الطبيعي بالنظارات او العدسات؟ نعم لا
- هل لديك عمى الوان؟ نعم لا
- اذا كان الجواب نعم، فأي نوع؟ ____________
- هل تعرضت الى إصابة في الرأس؟ نعم لا
- اذا كان الجواب نعم، هل من الممكن ان تشرح لنا ____________
- هل تعاني من أي مشاكل عصبية ؟(مثال, الصرع) نعم لا
- اذا كان الجواب نعم، الرجاء تسميتها ____________
- هل تتعاطى حاليا أي علاجات نفسية؟ نعم لا
- اذا كان الجواب نعم، الرجاء تسمية الادوية____________

الرجاء تحديد أعلى مرحلة دراسية ووظيفية لكل من الاب والام:

الأب:	**الأم:**
بدون شهادة ثانوية _____	بدون شهادة ثانوية _____
شهادة ثانوية_____	شهادة ثانوية_____
شهادة ما بعد المرحلة الثانوية_____	شهادة ما بعد المرحلة الثانوية_____
دبلوم _____	دبلوم _____
شهادة دراسات عليا _____	شهادة دراسات عليا _____
الوظيفة:__________	الوظيفة:__________
اللغة الاولى:__________	اللغة الاولى:__________
اللغة الثانية:__________	اللغة الثانية:__________
لغات أخرى:__________	لغات أخرى:__________

- هل ولدت في السعودية؟ نعم لا
- اذا كان الجواب لا، اين ولدت؟ ______________
- متى قدمت للسعودية؟ ______________

- هل عشت مسبقا في أي دولة لا تستخدم اللغة العربية كلغة سائدة؟ نعم لا

اذا كان الجواب نعم، اين و وكم كانت المدة؟	١/____________	من:	الى:
	٢/____________	من:	الى:
	٣/____________	من:	الى:

الخلفية اللغوية

- الرجاء ذكر جميع اللغات واللهجات التي تتحدثها وتفهمها مع ترتيبها حسب اتقانك لها، مع ذكر اللغة العربية.

اللغة:	أين تعلمتها:	العمر عند التعلم (ضع ٠ اذا كنت تعلمتها منذ الولادة)	هل توقفت عن استخدام هذه اللغة في أي مرحله؟ الرجاء ذكر المدة.
١/___________	المنزل المدرسة المجتمع مكان اخر:______		
٢/___________	المنزل المدرسة المجتمع مكان اخر:______		
٣/___________	المنزل المدرسة المجتمع مكان اخر:______		
٤/___________	المنزل المدرسة المجتمع مكان اخر:______		

الرجاء تقييم درجة مهاراتك اللغوية من ٠ الى ١٠ في اللغة العربية واللغات الأخرى التي تتقنها.

- العربية الفصحى:

٠ غير متقن ٥ ١٠ متقن

التحدث

الفهم

القراءة

الكتابة

- عند قيامك بالنشاطات التالية، كم من الوقت تستخدم فيه اللغة العربية الفصحى:

	اطلاقا	قليلا	بعض الوقت	غالبا	جميع الوقت
التحدث	☐	☐	☐	☐	☐
الاستماع	☐	☐	☐	☐	☐
الكتابة	☐	☐	☐	☐	☐
القراءة	☐	☐	☐	☐	☐

- اللهجة العربية العامية:

٠ غير متقن ٥ ١٠ متقن

التحدث

الفهم

القراءة

الكتابة

- عند قيامك بالنشاطات التالية، كم من الوقت تستخدم فيه اللهجة العامية:

	اطلاقا	قليلا	بعض الوقت	غالبا	جميع الوقت
التحدث	☐	☐	☐	☐	☐
الاستماع	☐	☐	☐	☐	☐
الكتابة	☐	☐	☐	☐	☐
القراءة	☐	☐	☐	☐	☐

- اللغة الانجليزية:

٠ غير متقن ٥ ١٠ متقن

التحدث

الفهم

القراءة

الكتابة

- عند قيامك بالنشاطات التالية، كم من الوقت تستخدم فيه اللغة الانجليزية:

	اطلاقا	قليلا	بعض الوقت	غالبا	جميع الوقت
التحدث	☐	☐	☐	☐	☐
الاستماع	☐	☐	☐	☐	☐
الكتابة	☐	☐	☐	☐	☐
القراءة	☐	☐	☐	☐	☐

اللغة المستخدمة في المجتمع

الرجاء تحديد أي لغة كنت تسمعها او تستخدمها بشكل متكرر داخل او خارج المنزل في المراحل العمرية الاتية:

	جميعها عربي	معظمها عربي	نصفها عربي ونصفها لغة اخرى	معظمها لغة اخرى	اللغة الأخرى فقط
رضيع					
الروضة					
المرحلة الابتدائية					
المرحلة الثانوية					

الرجاء تحديد اللغة المستخدمة بشكل عام عند التحدث مع الأشخاص التاليين:

	جميعها اللغة العربية العامة	جميعها لغة عربية فصحى	نصفها عامي ونصفها لغة اخرى	نصفها فصحى ونصفها لغة اخرى	معظمها لغة اخرى	اللغة الأخرى فقط
الابوين						
الأخوة						
الاجداد						

الأقارب الاخرون						
الزوج/الزوجة						
الزملاء						
الجيران						
الاصدقاء						

الرجاء تحديد أي اللغات تستخدم بشكل عام في الاوضاع التالية:

	جميعها اللغة العربية العامة	جميعها لغة عربية فصحى	نصفها عامي ونصفها لغة اخرى	نصفها فصحى ونصفها لغة اخرى	معظمها لغة اخرى	اللغة الأخرى فقط
المنزل						
المدرسة						
العمل						
النشاطات الاجتماعية (الخروج مع الأصدقاء مثلا)						
النشاطات الدينية						
النشاطات الغير روتينية (الرياضة ، الهوايات، الألعاب)						
التسوق، المطاعم						
الرافق الصحية، المرافق الحكومية، المكاتب، البنوك.						

الرجاء تحديد أي اللغات تستخدم بشكل عام في النشاطات التالية:

	جميعها اللغة العربية العامة	جميعها لغة عربية فصحى	نصفها عامي ونصفها لغة اخرى	نصفها فصحى ونصفها لغة اخرى	معظمها لغة اخرى	اللغة الأخرى فقط
القراءة						
البريد الالكتروني						
الرسائل النصية						
التواصل الاجتماعي(فيس بوك، تويتر،..)						
كتابة لائحة المشتريات، اخذ ملاحظات						
مشاهدة الأفلام						
تصفح الانترنت						
الصلاة						

في بعض من الاوقات نقوم بالتحويل من لغة/ لهجة الى أخرى، مثلا نتحدث اللغة العربية العامية ثم نحول الكلام الى اللغة العربية الفصحى، تعرف هذه الظاهرة بـ "التحويل اللغوي".
الرجاء تحديد مقدار تحويلك بين اللغات في الحالات التالية:

التحويل بين اللغة العربية الفصحى والعربية العامية:

	ابدا	قليلا	احيانا	غالبا	دائما
مع الابوين والعائلة					
مع الاصدقاء					
في مواقع التواصل الاجتماعي(فيس وك، تويتر...)					

التحويل بين اللغة العربية والإنجليزية:

	ابدا	قليلا	احيانا	غالبا	دائما
مع الابوين والعائلة					
مع الاصدقاء					
في مواقع التواصل الاجتماعي(فيس وك، تويتر...)					