KADIR HAS UNIVERSITY
SCHOOL OF GRADUATE STUDIES
DEPARTMENT OF SOCIAL SCIENCES AND HUMANITIES

THE EFFECTS OF SECOND LANGUAGE PROFICIENCY AND LANGUAGE DISTANCE ON YOUNG ADULTS' EXECUTIVE FUNCTIONING PERFORMANCE

BETÜL FİRDEVS ZENGİN
ASSIST. PROF. ASLI ERCİYES

MASTER OF ARTS THESIS
PSYCHOLOGICAL SCIENCES

ISTANBUL, JUNE, 2022

Betül Firdevs Zengin Master of Arts Thesis 2022

THE EFFECTS OF SECOND LANGUAGE PROFICIENCY AND LANGUAGE DISTANCE ON YOUNG ADULTS' EXECUTIVE FUNCTIONING PERFORMANCE

BETÜL FİRDEVS ZENGİN

A thesis submitted to
the School of Graduate Studies of Kadir Has University
in partial fulfillment of the requirements for the degree of
Master of Arts in
Psychological Sciences

Istanbul, June, 2022

APPROVAL

This thesis, titled THE EFFECTS OF SECOND LANGUAGE PROFICIENCY AND LANGUAGE DISTANCE ON YOUNG ADULTS' EXECUTIVE FUNCTIONING PERFORMANCE submitted by BETÜL FİRDEVS ZENGİN, in partial fulfillment of the requirements for the degree of Master of Arts (Psychological Sciences) is approved by

Dr. Öğretim Üyesi, Aslı Erciyes (Advisor) …………………..
(Kadir Has University)

Dr. Öğretim Üyesi, Ahu Gökçe …………………..
(Kadir Has University)

Öğretim Görevlisi, İlmiye Seçer …………………..
(Koç University)

I confirm that the signatures above belong to the aforementioned faculty members.

Prof. Dr. Mehmet Timur Aydemir
Director of the School of Graduate Studies
Date of Approval:

DECLARATION ON RESEARCH ETHICS AND PUBLISHING METHODS

I, BETÜL FİRDEVS ZENGİN; hereby declare

- that this Master of Arts Thesis that I have submitted is entirely own work and I have cited and referenced all material and results that are not my own in accordance with the rules;
- that this Master of Arts Thesis does not contain any material from any research submitted or accepted to obtain a degree or diploma at another educational institution;
- and that I commit and undertake to follow the "Kadir Has University Academic Codes of Conduct" prepared in accordance with the "Higher Education Council Codes of Conduct".

In addition, I acknowledge that any claim of irregularity that may arise in relation to this work will result in a disciplinary action in accordance with the university legislation.

Betül Firdevs Zengin

____

Date (9/06/2022)

To My Family...

ACKNOWLEDGEMENT

First and foremost, I would like to thank my thesis advisor Dr. Aslı Aktan-Erciyes whose guidance and knowledge steered me throughout my M.A. studies. I received invaluable feedback and support whenever I needed it and I feel extremely grateful to have come across a great advisor.

Thank you to Dr. Ahu Gökçe and Dr. İlmiye Seçer for being in my thesis committee and for their feedback and time.

I am thankful to my family for their emotional support at every step of the way. Special thanks to my M.A. classmates. I am so happy to have met all of them right before the pandemic. I am extremely grateful for my thesis study buddies Pınar Karataş and Elif Altın. If it weren't for the countless times of support and encouragement I received from them, the road would be much harder.

Thank you to everyone who participated in my study.

Lastly, I am thankful to myself for conducting a study on this topic, which to me is very precious as it has been my childhood dream to understand the cognitive effects of bilingualism.

THE EFFECTS OF SECOND LANGUAGE PROFICIENCY AND LANGUAGE DISTANCE ON YOUNG ADULTS' EXECUTIVE FUNCTIONING PERFORMANCE

ABSTRACT

The bilingual advantage hypothesis suggests that knowing and controlling more than one language enhances cognitive capacities. While there are studies that have shown a positive relationship between bilingualism and various cognitive factors there is also a growing literature finding no difference between monolinguals and bilinguals. Finding pure monolinguals has become almost impossible, especially in the young adult population. Hence, this study aims to investigate two bilingual groups that have different genetic language distances between their first language (L1) and second language (L2) (i.e., L1-Turkish-L2-English and L1-Turkish-L2-Arabic) and examine whether language proficiency plays a role in task performances of executive functioning (henceforth EF). The sample of the study consisted of 108 participants with Turkish as their first language, 55 of which had English as their second language (Female = 40, Male = 15, M_{age} = 22.96) and 53 with Arabic as their L2 (Female = 40, Male = 13, M_{age} = 22.05). We collected data in two sessions; the first session included computerized versions of the Stroop task as a measure of inhibition, Wisconsin Card Sorting Task for cognitive flexibility and 2-Back for verbal working memory and both the forward and backward Corsi Block tests for spatial working memory. The second session included the second language proficiency task PPVT-IV, Penn Matrix Analysis Test (PMAT24) as a measure of non-verbal reasoning, and the letter verbal fluency task to control for L1 fluency. The findings suggest that L2 proficiency was not a significant predictor of EF task performance in our sample. Additionally, the genetic language distance score in our study was based on how distant the languages originated from one another. However different aspects of language distance such as orthography and word borrowing can play a role in how language distance effects EF performance therefore, they can be considered for future studies.

Keywords: Bilingualism, L2 proficiency, Language distance, Executive functions

İKİNCİ DİL YETKİNLİĞİNİN VE DİLBİLİMSEL MESAFENİN GENÇ YETİŞKİNLERDE YÖNETİCİ İŞLEVLERE ETKİSİ

ÖZET

İki dillilik avantaj hipotezi birden fazla dil bilmenin ve kontrol etmenin bilişsel kapasiteyi artırdığını ileri sürmektedir. Çift dillilik ve çeşitli bilişsel süreçler arasında olumlu bir ilişki bulan çalışmaların yanında tek dilli bireyler ile çok dilli bireyler arasında fark bulamayan çalışmalarda da artış bulunmaktadır. Özellikle genç yetişkinlerde ikinci dile maruz kalmayan bireyler bulmak imkansıza yakın hale gelmiştir. Bu sebeple bu çalışmanın amacı birinci dil (D1) olan Türkçeye genetik dil mesafesi farklı olan 2 farklı ikinci dilin (D2) (D1 Türkçe- D2- İngilizce ve D1- Türkçe D2- Arapça) ikinci dil yetkinliğine bağlı olarak yönetici işlev çalışma performansına etkisini incelemektir.Bu çalışmanın örneklemi ana dili Türkçe olan ikinci dili İngilizce olan 55 (K = 40, E = 15, $Ort_{yaş}$ = 22.96) ve ikinci dili Arapça olan 53 (K = 40, E = 13, $Ort_{yaş}$ = 22.05), toplam 108 katılımcıdan oluşmaktadır. Veri toplama 2 oturumda gerçekleşmiştir. İlk oturumda bilgisayara uyarlanmış ketleme ölçümü için Stroop çalışması, bilişsel esneklik ölçmek için Wisconsin kart eşleme çalışması ve sözel çalışır bellek ölçmek için 2-geri çalışması ve mekansal çalışır bellek için ileri ve geri Corsi çalışması kullanılmıştır. İkinci oturumda ikinci dil yetkinliğini ölçmek için PPVT-IV, Penn Matriks analiz testi (PMAT-24) sözel olmayan nedenselleştirme ölçmek için ve birinci dildeki akıcılığı kontrol etmek için harf akıcılık testi verilmiştir. Bulgular örneklemimizde ikinci dil yetkinliğini yönetici işlev performansında anlamlı bir yordayıcı olarak göstermemiştir. Çalışmamızdaki genetik dil mesafesi dillerin kökeninin birbirine uzaklığını belirten bir ölçüdür. Türkçe-Arapça grubun mesafesi Türkçe-İngilizce mesafesinden daha fazladır. Bununla birlikte, alfabe farklılığı ve başka dilden kelime ödünç alma gibi dil mesafesi ölçümünün farklı yönleri, dil mesafesinin yönetici işlev performansını nasıl etkilediği konusunda rol oynayabilir, bu nedenle gelecekteki çalışmalar için dikkate alınması tavsiye edilir.

Anahtar Kelimeler: İki dillilik, İkinci dil yetkinliği, Dil mesafesi, Yönetici işlevler

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONMYMS AND ABBREVIATIONS

Age of Acquisition (AoA)

American Council of Teaching Foreign Languages (ACTFL)

Automated Similarity Judgment Program (ASJP)

Executive functions (EF)

First language (L1)

Language distance (LD)

Second language (L2)

Socioeconomic status (SES)

Web-based Computerized Neurocognitive Battery (WebCNP)

Wisconsin Card Sorting Task (WCST)

1. INTRODUCTION

All around the world knowing more than one language has become prevalent for the majority. For example, in Europe, 54 % reported their ability to converse in a second language (European Commission, 2012). While this rate shows differences across countries the rate can go up to nearly 80% in countries like Indonesia (Institute of Current World Affairs, 2022) and even higher for some European cities like Luxemburg (European Commission, 2012). As a result of this population growing whether second language (L2) learning can be associated with any changes in the mind by bringing cognitive advantages or disadvantages for the individual has been the interest of research. While there certain social, linguistic and even economic benefits suggested in the literature (Espinosa, 2015) other advantages due to the strong relationship between cognition and language are thought to appear. These cognitive advantages, which have been listed as conflict monitoring and conflict resolution (Hofweber et al., 2016, Costa et al., 2008), inhibition of irrelevant information (Soveri et al., 2011, Bialystok, et al., 2008), shifting (Prior & MacWhinney, 2010) and several other advantages that are related to executive function domains. These domains are commonly known as inhibition, working memory, and cognitive flexibility (Miyake et al.,, 2000). This advantage has been referred to as the bilingual advantage hypothesis and studies conducted with samples from infants to late adulthood have findings supporting this hypothesis (e.g., Abutalebi et al., 2012; Bialystok, 2017). However, with the increase in studies the compelling literature has also increased with many failures to replicate the previous studies findings (Paap & Greenberg, 2013; Paap et al., 2015; Woumans & Duyck, 2015). This led to the questioning of the bilingual advantage hypothesis. The increase of controversial findings in the literature has brought up the need for more research in understanding the relationship between bilingualism and executive functions with bigger samples, executive function domains measured with standardized tests and taking various factors of being a bilingual into consideration. Some of these factors can be listed as the age of second language acquisition, L2 proficiency, the measure of similarities between languages, in this case L1 and L2, defined as the language distance, and living in a L1 or L2 dominant context etc.

Although an exact number of second language (L2) users cannot be given for Turkey, like many countries in which English is not the first language (L1) the education system requires all children to take English classes starting from the 2nd grade (MEB, 2021). As a consequence of the 10 years of compulsory English education it is expected for all students to be at a certain level, nevertheless the variance in second language mastery is to a great extent. Despite this education some people can be equivalent to monolinguals, but due to their long-term exposure to English education it would not be possible to categorize them as monolingual. There are also many children who start learning Arabic from middle school, as their choice of school requires them to, or university students who learn Arabic as their main academic language. Similarly, to English education there is great variance in language abilities of these students. The present study asks two main questions: (1) How second language proficiency effects executive functioning task performance in different bilingual groups of young adults (L1-Turkish: L2-English vs. L1-Turkish L2-Arabic) and (2) How language distance (between L1 and L2) might be influential on both proficiency and relationship between proficiency and EF. Therefore, this study aims to investigate different bilingual groups which are Turkish-English and Turkish-Arabic.

Overall, since the population of interest is young adults and there are nearly no monolingual adults available in this age group comparing bilingual groups becomes necessary. Furthermore, limited and little empirical work has been done to compare discrepancies between different groups of bilinguals it is crucial to understand the effects L2 proficiency on the bilingual cognition. Although as a result of the formal education system many people start learning L2 at around the same age, in a matter of several years, the level of mastery for each person varies significantly. Thus, in this study my aim was to test the bilingual advantage hypothesis through second language proficiency and language distance of L1 and L2. Language proficiency can be understood as the functional ability of the language while language distance is a measure of differences amongst languages based on certain linguistic aspects such as orthographic, syntactic, phonologic etc. Before thoroughly explaining the research question the development and theoretical background of the bilingual literature will be explained followed by studies that focus on L2 proficiency and language distance.

1.1.Literature Review

1.1.1.Defining Bilingualism and Executive Functions

Simply defined bilingualism is “knowing” two languages (Valdez & Figueora, 1994). While previous definitions are clear cut recently the concept is seen and advised to be a continuum (Gottardo & Grant, 2008). Most often the proficiency for one language can be higher than the other or proficiency in one language can be limited with one domain such as writing skills so native-like proficiency in both languages, referred to as “true” bilingualism, is rare (Cutler et al.,1992; Grosjean, 1982). Other than acknowledging the importance of varying proficiency levels the age and time relation of the language acquisition makes a difference in defining bilingualism. Simultaneous bilingualism is considered to occur when two languages are acquired from birth or prior to one year of age (De Houwer, 2005). Sequential bilingualism is when one language is acquired following another and in this case the age of acquisition makes a difference (Bohn & Flege, 1992).

Executive functions can be defined as a group of mental processes that are used when attention is required or in other words when the situation is not possible to be conducted with automatic or instinctive act. Executive functions require attention and concentration thus making them an effortful process. There are three main executive functions described in the literature which are inhibitory control, working memory, and cognitive flexibility. Inhibitory control is known as the process of controlling attention more specifically this EF allows the person to react to a certain stimulus out of the many encountered simultaneously. Working memory makes it possible to hold information and depending on the information held it can be categorized as verbal or non-verbal working memory. Lastly there is cognitive flexibility or in other words shifting is the ability to shift or switch from one rule or task to another (Miyake & Friedman, 2012). This domain is explained to be based on the other two executive function domains and allows to have change in perception (Diamond, 2013).

1.1.2. Cognitive consequences of bilingualism

The idea of a second language bringing benefits comes from the assumption that two languages will train the mind and have a positive effect on various cognitive processes, even those that are not particularly related to language (Bialystok, 2017). For the bilingual, during the use of one language the other is controlled and monitored in order to use the specific language (Green, 1998; Green & Abutalebi, 2013). In previous studies it was shown that even when one language is in use, both languages are active in the process (Costa et al., 1999; Green, 1998; van Heuven, Schriefers, Dijkstra, & Hagoort, 2008). A consequence of this constant practice inhibiting one language to speak in the other, inhibition especially inhibitory control processes are thought to be enhanced and serve as the base mechanism for the bilingual advantage hypothesis (Green, 1998; Hilchey & Klein, 2011). To be more precise, while there are several explanatory hypotheses and models that the bilingual advantage hypothesis relies on some of the foremost are the inhibitory control model (Green, 1998), Bilingual Interaction Activation (BIA) and the BIA+ model (Dijkstra et al., 1998; Dijkstra & van Heuven, 2002), the Bilingual Inhibitory Control Advantage (BICA) and the Bilingual Executive Processing Advantage (BEPA) hypothesis (Hilchey & Klein, 2011). The Inhibitory Control Hypothesis (ICM; 1986, 1993, 1998) explains the process of language production through the activation and suppression of lexical nodes of the target and non-target language. More clearly Green suggests that the increase in the number of lexical nodes that are activated not only within the language but across languages increases the ability to suppress more as the activation and suppression is seen proportional leading to an overall stronger inhibition. The BIA model and the updated version BIA+ focuses on the visual word recognition across languages. Based on the model an important aspect of bilingual inhibition is based on the similarity of the words' visual representations, thus, orthographic differences are thought to be effective in the process (Dijkstra & van Heuven, 2002). So, sharing similar orthography will require more inhibition compared to different orthographies (Coderre & Heuven, 2014). Lastly while they are not seen as completely separate hypotheses (Coderre, 2012), the BICA states an advantage in situations of conflict and the BEPA states a global advantage throughout all processing.

Other domains that have found to also associate with this hypothesis is working memory (Grundy & Timmer, 2017) and cognitive flexibility (Prior and & Gollan, 2011; Ibrahim et al., 2013). Moreover, there are many studies that examine all these domains under the term executive function and have found an advantage in EF for bilinguals (Bialystok et al., 2009, Bialystok, 2012). Other than these, episodic memory recall (Schroeder & Marian, 2012; Ljungberg et al., 2013), alertness (Costa et al., 2008) and verbal fluency (Ljungberg et al., 2013) have been found to be a part of the advantage hypothesis. Overall, through many studies the advantages were found to be associated with several cognitive facets.

These advantages were not limited to a certain age, as there are multiple studies that have examined individuals from very early months and others from older ages. For example, Kovács and Mehler (2009) found that even as young as 7-month-olds who grew up in a bilingual environment showed better cognitive control. As preschool years or early childhood is known to be a crucial point in development and perhaps a peak for neurological plasticity there is a major literature focusing on this age group (e.g, Poulin-Dubois et al., 2011; Carlson & Meltzoff, 2008). The advantage for the elderly can be even more important as the findings indicate that it can delay decline of executive functions and dementia (Bialystok et al., 2007; Olsen et al., 2015). In sum, these studies have shown that there are lifespan advantages.

As the sample of the present study will be young adults, studies that focused on young adults will be explained in more detail. The cognitive development is matured and mostly stable in young adulthood compared to early years of life when development is fast and compared to older years when it starts to decline. It is also known that the twenties are the peak for cognitive efficiency (Bialystok et al., 2009). Thus, based on these it is expected that if there were to be a difference in cognitive processes at this age, when cognition is at best performance for all, this would indicate a strong support for the bilingual advantage (Xie, 2018). There are certain studies that find significant differences between monolinguals and bilinguals in various executive tasks (Bialystok et al., 2012; Bialystok, 2017). There are also studies that have found the effects of second language proficiency on different domains of cognitive control such as inhibition (Colzato et al., 2008), conflict monitoring (Xie, 2018) and selective attention (Mishra et al., 2012, Vega-Mendoza et al., 2015). Another study that used non-verbal measures to observe the effects of L2 proficiency is by Costa et al. (2008). Their findings supported the idea that non-verbal tasks were performed better by bilinguals than monolingual young adults. However, not all studies find an advantage for bilinguals and there are also studies that could not replicate previous findings of the advantage hypothesis. In fact, compared to other age groups the studies on young adults are found to be the most varying. The following section will expand on the studies with contrary or null findings on the bilingual advantage hypothesis.

1.1.3 Counter arguments to the bilingual advantage hypothesis

Despite the many studies that have found the bilingual advantage in various domains of cognitive ability the inconsistent findings of replication studies have also increased in the literature. One reason of the previous findings is said to be small sample sizes and studies that were conducted without considering statistical power (Paap et al., 2015). One of the first studies that opposed to the bilingual advantage was by Morton and Harper (2007). Following this, many studies carried out with different age groups such as children (Antón et al., 2014; Duñabeitia et al., 2014; Ladas et al.,2015), young adults (Paap & Greenberg, 2013; Vivas et al., 2017) and older adults (Antón, et al., 2016, Sörman et al., 2019) also found results that supported the view that there is not a general advantage of bilingualism. Even in a life-span study that aimed to look at the bilingual advantage they could not find results that showed any positive effects of bilingualism on EF (Gathercole et al., 2014). Similarly, Dick et al. (2019) conducted a study with 1740 children and did not find any differences between monolingual and bilingual children. All this controversy in the findings has led to the discussion that the measurements used to assess cognitive processes and the many variables that contribute to the differences amongst bilinguals are the reason for the noise in the findings. More specifically the methodology is lacking in terms of generalizability of the affects as most of the studies use a single task for assessment of EF (Paap & Greenberg, 2013). So, it was suggested that for future research the use of diverse standardized tests that have convergent validity is crucial as well as considering and controlling as many bilingual aspects as possible.

In the following sections, I will focus on two factors that might shed light on the controversial findings for cognitive consequences of bilingualism, namely: (1) L2 Proficiency and (2) Language distance between L1 and L2

1.1.4. L2 Proficiency, bilingualism and cognitive consequences

While there are various factors affecting the association between bilingualism and cognitive control, one of the core factors is thought to be second language proficiency. Proficiency is defined by the American Council of Teaching Foreign Languages (ACTFL) as functional language ability that is applicable in real life experiences. This L2 ability is seen as a continuum from highly articulate to no functional ability (ACTFL, 2012). The amount of language experience and benefit that is related to cognition is expected to be positively correlated. In different studies the positive relationship between performance on cognitive measures and the longer experiences in the language supported this view (Carlson & Meltzoff, 2008; Luk et al., 2011). In fact, it can be said that without a certain level of experience and proficiency in the second language the bilingual advantage will not appear. However, as language learning is generally a non-stop process the important question here is whether cognition is affected from this change/improvement in language.

In the literature many of the studies that focus on language expertise compare balanced and unbalanced bilinguals. The notion of being balanced and proficient should not be seen as equivalent terms however the term and studies are highly related with the current study, thus they are explained. While proficiency generally refers to the amount of knowledge in that language, being a balanced bilingual refers to being equally fluent in both languages (Vega & Fernandez, 2010) . Therefore, it is possible and common to be a proficient but an unbalanced bilingual. In different studies it was shown that there were differences in inhibition and increased performance on executive function tasks between balanced and unbalanced bilinguals (Carlson & Meltzoff, 2008; Costa & Santesteban, 2004; Rosselli et al., 2002)

In some studies, all the participants are chosen form unbalanced bilinguals and they are compared on their proficiency or with monolinguals. For instance, in Vega-Mendoza et al. (2015), the results showed that when young adults who were late unbalanced bilinguals are tested on different aspects of attention, the proficiency in L2 contributes to enhancing attention and overall cognitive control. In another study conducted by Xie, (2018) unbalanced Chinese-English bilingual young adults were grouped in to three according to their L2 (by self -rating and verbal fluency task). They were assessed with Flanker task and Wisconsin Card Sorting Task for conflict monitoring, inhibition and set shifting. A strong element of this study was that it also measured fluid intelligence (Ravens Advanced Progressive Matrices (Raven et al., 1977; Li, 1989) and controlled for Socioeconomic Status (SES). The results showed that while there was no significant difference in the WCST task (set shifting) or the performance in Flanker task for congruent and incongruent trials (assessing inhibition) proficient bilinguals were significantly faster in responding to the Flanker task trials indicating an advantage for conflict monitoring. Overall, these studies have considered a crucial factor of bilingualism, L2 proficiency, and have found positive associations with several cognitive tasks testing unbalanced bilinguals.

Khare et al. (2013) examined how L2 proficiency effected reactive inhibition measured by the attentional blink test. The sample consisted of Hindi-English young adult bilinguals (mean age = 18.5 years) and the results showed that the size of the attentional blink effect correlates with the degree of second language proficiency and not with the degree of intelligence. In another study that used target detection task to measure cognitive control, young adult bilinguals (ages between 19.5– 22.1 years) with different levels of L2 English proficiency was compared and those with higher proficiency were found to have smaller reaction times indicating better cognitive control (Mishra et al., 2012). Thus, these findings indicate that a cognitive advantage of higher second language proficiency can be observed through various tasks.

A study that examined the effects of aging on this relationship of L2 proficiency and executive functions used a sample aged 50 to 75 years. The participants were from two different bilingual groups: Swedish-Finnish and Swedish-English, and with this they aimed to look at whether language distance plays a role in this relationship (Sörman, Hansson & Ljungberg, 2019) which makes this study have common aspects with the aim of the current study (language distance will be further discussed). They used the Flanker, Stroop, and Simon task to assess inhibition and the Number-letter, Color-Shape, Local-global task to assess switching ability. An additional strength of this study is that they measured fluid intelligence (with The Raven Advanced Progressive Matrices Test (Arthur and Day, 1994)). Although the results could not find any effect of L2 proficiency on the performance of these tasks it is important to note that proficiency of Finnish and English were measured through self- reports only and not via objective language measures of vocabulary, fluency etc. In another study that was conducted with third and fourth grade balanced and less balanced Spanish-English bilingual children the WCST and Stroop task was used to assess EF (Vega-Fernandez, 2011). They measured language proficiency with a bilingual verbal ability task and categorized children's balance based on this. This study also measured intelligence. They used the Wechsler Abbreviated Scale of Intelligence to better understand whether proficiency or intelligence effects EF task performance. Overall, the results showed that children that were more proficient had less perseveration errors compared to less balanced/proficient children on the WCST. Therefore, recent literature shows that L2 proficiency is a critical element in the bilingual experience and has been found to be associated with the bilingual advantage.

While all the mentioned studies so far have found a difference amongst their comparisons whether it be proficiency or language balance, there are also studies that have found null effects of L2 proficiency on cognitive control such as Rosselli et al. (2016). Additionally, other studies (Verreyt et al., 2016) haves reported that variables such as language switching rather than proficiency to influence cognition. In a study conducted by Dong and Xie (2014), participants were categorized based on their L2 proficiency and language switching experience and cognitive control was measured through the Flanker task and the WCST. The results of this study indicated that while there were no significant differences in all the groups for Flanker task, those who had more switching experience were better at mental set shifting as measured with the WCST. However as mentioned in their discussion the proficiency levels between the two groups were relatively small. If there were to be greater variance the effects of proficiency on cognitive control may have appeared. One alternative way in assessing language proficiency as stated by Bialystok, Craik and Luk (2012) is to compare individuals who have high and low L2 proficiency rather than bilinguals and monolinguals. This is because finding pure monolinguals has become almost impossible especially in the young adult population. Thus, comparing bilinguals with monolinguals has become obsolete and observing the effects of L2 proficiency within bilingual groups would be more meaningful. The following section will discuss the role of language distance on cognitive consequences of bilingualism.

1.1.5. Language distance and effects on cognitive competence in bilinguals

Another factor that is important to consider in bilingual studies is the language or linguistic distance between L1 and L2 (Wichmann et al., 2010). Linguistic distance or relative language distance (RLD) refers to orthographic, phonologic and/or semantic difference that two languages have. While there are various measures that calculate this difference based on different criteria the online genetic distance calculator for languages uses a list of 18 common words (See Appendix B Table 1 and Table 2) to assess the similarities in the letter order and phoneme. This list has 14 words from the subset of the Swadesh list (Swadesh, 1950) known as Swadesh–Yakhontov list (Yakhontov,

1991) which is highly similar to the Automated Similarity Judgment Program (ASJP) list (for a visual representation of language distance graphic based on the ASJP scoring See Appendix C). The Swadesh list was created to be used in comparative language studies from words that existed in every language. Originally the list included 207 words which reduced to the 100 Swadesh list (Swadesh, 1971) and subsets of the list were made for more concise calculations of different aspects across languages. Out of the 18 words used in this study 14 of them were chosen from the Swadesh list. The calculation formula is also provided under the word lists. Based on this, the similarity between Turkish and English (92,2) and Turkish and Arabic (97,2) are both high meaning they are from very distinctive language groups (elinguistics.net). It is important to note that both the language groups consist of language pairs that have high language distance, however Arabic is much more distinct to Turkish which also has an orthographic difference. Thus, these differences make it worthy to understand how LD plays a role in the bilingual experience.

In various studies it was shown that learning two languages from the same language family and from different language families have different effects on cognitive control (Gollan et al., 2011). Although due to the inhibitory control hypothesis underlying the bilingual advantage the expectation would be that when two languages from the same language family are acquired the interference is more likely to occur consequently inhibiting is required more. However, there are very few studies on linguistic distance and an opposite effect has been observed when comparing English–Cantonese bilinguals with English–German or an English- French speaking group (Bialystok et al., 2005; Wierzbicki, 2014). Wierzbicki (2014) stated that there is limited evidence of any effects of linguistic distance on cognitive control, because the results of the study showed no difference amongst the three groups (monolinguals, English-German pair and English-Chinese pair), however the expectation was for the English-German pair to be better at conflict resolution but the English-Chinese pair exceeded. So, although the results are not conclusive, this may be an indication of high language distance being more advantageous. Furthermore, as stated in a study that investigated the effects of linguistic distance on episodic memory and verbal fluency (Ljunberg, Elbe & Sörman, 2019) linguistic distances are most important to take into account if the task is sufficiently difficult because bilingual linguistic distances only significantly impact tasks with high executive function demands. In sum, various findings showed the cognitive consequences of language distance between L1 and L2 in bilinguals therefore, LD is an important factor that should be controlled.

Aside from behavioral studies there are also neurological findings that show differences between bilinguals that have different L1 and L2 linguistic distance. In a recent study, Ramanujan (2019) compared three bilingual groups with different levels of relative language distance (RLD). The results showed that there are neurobiological differences when it comes to a bilingual's experience of using or repressing a language. The ACC (anterior cingulate cortex) is seen to show more activity in bilinguals with low RLD and as the language distances increases the activity is less.

Overall, as there is not much research on language distance and how it affects executive functions in the literature, this study aims to investigate how LD for different pairs of language (TR-ENG and TR-ARABIC) and L2 proficiency influences cognitive consequences of bilingualism. Turkish has many words adapted from Arabic but there is also a prominent orthographic difference between Arabic and Turkish. Additionally, as the Arabic knowing group also knows English the effects of knowing more than one language from a different language family can be observed.

1.2.Present Study

As previously mentioned, the present study asks two questions first how second language proficiency effects executive functioning performance in different bilingual groups of young adults (L1-Turkish: L2-English vs. L1-Turkish: L2-Arabic). Second how language distance might be influential on both proficiency and relationship between proficiency and EF. To investigate these research questions two different bilingual groups of young adults were recruited. The first group consisted of participants with Turkish as their L1 and English as their L2 who have full or partial English curriculum in their undergraduate studies (TR-ENG). The second group are students whom their L1 is Turkish and Arabic is their L2 follow a full or partial Arabic curriculum (TR-ARABIC). Thus, the entire sample consisted of sequential bilinguals as all our participants were raised with Turkish as their L1 and had a mean age of 9.4 (SD= 2.09) for their L2 age of acquisition (AoA).

The first of the two predictors in the present study is language proficiency which is operationally defined above as the functional language ability that is applicable in real life experiences, which can be graded on a continuum (ACTFL, 2012). While there are studies that use self-assessment scales only (e.g., Sörman et al., 2019) and some studies use a vocabulary assessment, there are also studies that measure proficiency by using both self-assessment scales and objective language measures (e.g., Xie, 2018). In this study participants will be assessed via the PPVT-IV form in English for the TR-ENG group and English and Arabic for the TR-ARABIC group. The reason for double PPVT-IV for the TR-ARABIC group is because although the second language for this sample is Arabic it is inevitable that they were exposed to English, thus it is important to control their English proficiency level as well.

The second predictor variable known as language distance (LD), is a measure of how similar or distant the L1 and L2 of a person who has acquired more than one language has amongst these languages. It is operationally defined as the orthographic, phonologic and/or semantic difference that two languages have (Ramanujan, 2019). In this study I will use the genetic proximity calculator for languages, which indicates that the genetic distance between Turkish and English is 92 and the genetic distance between Turkish and English is 97. This calculation is termed as the genetic distance as it aims to show the distance between the origins of the languages and at which point in time they appeared based on the phonological calculation (See Appendix B Table 1 and Table 2 for example)

To assess executive functioning performance four tasks were given. For inhibitory control Stroop task is used. To assess working memory forward and backward Corsi block-tapping task (CBTT) and 2-back task is used. Wisconsin Card Sorting Task (WCST) will be used for cognitive flexibility. All these tasks are computer based and was conducted and collected through the psytoolkit.com website (Stoet, 2010).

Overall, based on these it is hypothesized when controlled for age, gender, non-verbal reasoning and L1 verbal fluency. Those who have higher L2 proficiency measured by PPVT-IV and a smaller language distance score will have an advantage on

i. Inhibition as assessed by Stroop task by responding to congruent and incongruent trials in less varying reaction times.

ii. Working memory performance assessed with the 2-back task and Corsi lock tests

iii. Cognitive flexibility as measured by the WCST by making less perseveration errors as the rule for card sorting changes.

2. METHOD

One hundred and eight non-immigrant (M_{age} = 22.5 SD = 2.62) Turkish speaking adults participated. All participants were born in Turkey and raised with Turkish as their L1. The Turkish-English group consisted of 55 (F = 40, M = 15, M_{age} = 22.96) and the Turkish-Arabic group consisted of 53 (F = 40, M = 13, M_{age} = 22.05) participants. Fifty-four of the Turkish-English participants reported English as their second language (one person was raised with Turkish and Armenian as their first language). For the Turkish-Arabic group there were many who reported Arabic as their third or fourth language (N= 26) however their Arabic was their most academically excelled language after Turkish.

Due to the formal education system implementing English as second language starting from 4th grade and even earlier for some (2nd grade) none of the participants can be considered monolingual but are expected to have a huge variability in their second language proficiency. Similarly, those who have attended high schools or middle schools that require Arabic as third language has increased in recent years so the population that learned Arabic similar to English in a school environment has a huge variability in terms of their Arabic proficiency. As a result of the elementary education and high school education being very insufficient to label someone as bilingual and in order to control for the exposure of second language to some degree all the participants were required to be university attendees that come from majors with a partial curriculum of 30% in English or Arabic or a program that is completely in English or Arabic. Due to Arabic being the second most common second language in formal education in Turkey and considering the language distance between Turkish-English bilinguals which both use the Latin alphabet and have high transfer words from English and the difference of genetic language distance between Turkish and Arabic and the alphabetical differences as well as direction differences these two groups were compared to observe whether the morphological differences and language distances would have an effect on the basis of second language proficiency.

2.1. Measures and Instruments

Language proficiency

2.1.1.Peabody Picture Vocabulary Test- IV:

This is a standardized test of receptive vocabulary. It is utilized to evaluate English language competence and language learning for L2 speakers as well as to identify language deficits. It can be used from ages 2 years 6 months up to 90. The test consists of 228 pages, each containing four pictures. The items are separated into 19 sets of 12 items, each set there is an increment in difficulty. The test has two forms which are Form A and Form B that have a reliability coefficient between .87 and .93 making these two forms very reliable in terms of their similarity of content and design. In the original administration the test is done face to face with the instructor rotating the pages as the participant progresses. For this study a scanned version of the booklet was used, and the words were pre-recorded for each item. When the test was administered via zoom the experimenter only recorded the answer which was saying which picture illustrates that word by indicating the number of the picture on the page and clicked for the next item. Because all the participants were at university level or above, we started the initial set from set 4 and reverted to a previous set if there were 2 or more wrong answers. When the participant could not give the correct answer for 8 or more items in a set the test was ended. To assess English Proficiency form A was given to every participant. To assess

Arabic proficiency Form B was translated into Arabic and was voiced by a native Arabic speaker for online administration.

2.1.2. Verbal fluency task:

To assess first language fluency of the participants the category and phonetic verbal fluency test was given to participants. For this task participants are required to produce orally as many words as possible in Turkish within one minute according to the randomly chosen letter. In the literature various letters such as b, s, k, p, f, n, z, r, v, a, e, ü (Tunçer, 2011) for the Turkish version have been used to assess phonemic or letter fluency. However, the most standardized letters to be used were decided on as K, A and S (Şentürk, 2019) for Turkish. Most common categories asked for the category fluency task is animals, food and drinks, clothing items etc. (Şentürk, 2019). Thus, for this study the letter T was given for letter fluency as the letter frequency for T and S are very similar in Turkish 3,31 and 3,01 respectively (Serengil & Akın, 2015). For the category task instead of limiting it with category the task was made a little more complicated by also adding a letter limitation. So, the participants were required to list animals that start with the letter K. This way we were able to combine the most often category with one of the most common letters which would more likely indicate better fluency compared to an only categoric fluency task. The participants were told to exclude names of people or places and words with the same root such as slow and slowly as they would not count for their final score (Shao et al., 2014))

2.1.3. The Language Experience and Proficiency Questionnaire (LEAP-Q):

This questionnaire was originally developed by Marian, Blumenfeld, and Kaushanskaya (2007) to measure the strength of all the languages an individual knows by utilizing an 11-point Likert scale (0-10). The questions cover a wide spectrum of the individual's language exposure and preferences. It was translated into Turkish by Yüksel-Sökmen and Şerifoğlu (2016). This questionnaire is filled out by the participants to observe both the self-ratings of second and third languages as well as to see the samples AoA, context the language is used and many more variables. In one of the studies conducted to validate the LEAP-Q a strong relationship was shown between performance on objective language measures, one of them being PPVT-IV, and self-reports from LEAP-Q indicating internal validity and more specifically criterion-based validity. Strongest predictor of speech and language measures was found to be self-ratings of L2 speaking proficiency. Previous administrations have shown that it takes around 15 minutes for bilinguals and an additional 5 minutes for each extra language of the individual. Also, in some studies self-reports of 7 or up were used as a determining factor of high proficiency (Stocco & Prat, 2014) and in some cases low self-reports such as 3 or below were categorized as monolinguals (e.g., Pelham & Abrams, 2014)

Fluid Intelligence test

2.1.4. PMAT-24:

The Penn Matrix Analysis Test is a test of non-verbal reasoning administered through the University of Pennsylvania's Web-based Computerized Neurocognitive Battery (WebCNP) (webcnp.med.upenn.edu/) (Gur et al., 2012; Gur et al., 2010). The tests on WebCNP are not used for diagnostic purposes and they are governed by US federal laws and international agreements. To administer the PMAT an administrators account was provided by the university in response to our application. The PMAT is a measure of abstract reasoning and flexible thinking. Each question requires the participant to conceptualize the relations between images based on spatial, numerical or design cues and patterns. The task consists of multiple-choice questions that have 5 possible answers to choose from and the pattern of the questions can be in three different arrangements 2x2, 3x3 and 1x5. Similar to the Raven's Standard Progressive Matrice's (RSPM) test the PMAT has increasing difficulty as the test progresses and was designed to achieve many of the RSPM's psychometric properties with fewer questions, as the original RSPM has 60 items while the PMAT has 24 items with 3 extra items. With less items the goal was to decrease learning effects. Despite the PMAT having comparably less questions this does not mean every participant answers every question because the test is concluded when the participant reaches five incorrect responses allowing for even faster time for administration. Although no time limits were specified a study by Dubois et.al reported a mean of 10 minutes for administration, thus, to give a restriction on time participants were advised to allocate 1 minute per question.

Executive Function tasks

All the EF tasks were administered through psytoolkit.com. Psytoolkit is an open-source software that is designed to create and run online questionnaires, simple response time tasks and choice response tasks (Kim, et al., 2019)

The tasks can only be done on desktops and laptops. All the instructions and stimuli feedback was translated and given in Turkish. The participants who volunteered were sent a link. The link starts off with an informed consent form and a demographic form. This is followed by the LEAP Questionnaire questions. After these the Stroop, Wisconsin Card Sorting, N-back and Corsi backward and forward tasks are given respectively. These experiments and their codes are chosen from the experiment library provided by the Psytoolkit platform.

Inhibition measures

2.1.5. Stroop Task:

The Stroop task is one of the most commonly used measures of inhibition and was initially designed to show the difficulty of identifying mismatched stimuli (Stroop, 1935). When the written color name and the ink it is written is mismatched the Stroop effect occurs (e.g., GREEN). In the computer-based version there are trials that are congruent (GREEN) and incongruent (YELLOW) and each trial has 2000ms to respond followed by 500ms breaks. The response is given via the keyboard and the person is asked to respond based on the ink color. The keys are k, y, m and s for red (kırmızı), green (yeşil), blue (mavi) and yellow(sarı). The answers are recorded as (1: right, 2: too slow, 3: wrong) and the score is calculated based on the reaction time differences between congruent and incongruent trials. For further analysis reaction time differences between only correct trials of congruent and incongruent trials were calculated as well as the correct answer ratio of congruent and incongruent trials. Lastly the overall reaction time known as the global RT was also included in the analysis.

Working Memory measures

2.1.6. N-back (Kirchner, 1958):

Participants are presented a sequence of stimuli one-by-one. For each stimulus, they need to decide if the current stimulus is the same as the one presented *N* trials ago. For this study only 2-back was used, so the participants were required to press the determined key (m) whenever they saw the same letter that they saw two letters ago. The letters used were A, B, C, D, E, H, I, K, L, M, O, P, R, S, and T. In total there are three trials that have 25 blocks in each trial. Each stimulus is presented for 500 ms and a 2500 ms black screen in between, so the participant has 3 seconds to respond if the stimuli was the same as the one 2 trials ago. If not, they wait and do not press anything until the next stimuli appears. The score was calculated as the d prime score which is equal to z score of hit rate minus z score of false alarm rate. Hit rate refers to the ratio of true scores for the matched trials while false alarm refers to the true score for the unmatched trials (Haatveit et al., 2010)

2.1.7. Corsi Block Task

a) Corsi Block Task - Forwards

The Corsi Block-Tapping task (CBTT), (Corsi, 1972) aims to assess non-verbal working memory through repeating back the observed pattern. In the computer-based version of this task the trial begins with a blank screen and nine pink squares are shown in random positions on a black background. After 1000 ms the blocks start to highlight by turning yellow and back to pink. In each trial the number of highlighted blocks increases. For example, in the first trial one block is highlighted and then a "go" voice is heard, after clicking on the highlighted block two blocks are highlighted one by one and then the person is asked to click on the blocks in the correct order. This goes on until the person fails to replicate the pattern three times in a row. The final score is the number of the highlighted blocks in the last correct trial. In different computer-based versions trials can be separated with a crosshatch in the middle or a blank screen in this version sound was used to indicate the participant to start clicking on the blocks.

b) Corsi block Task - Backwards

In the backwards version the task is the same except for the answer is the pattern of the blocks is clicked from the last highlighted block to the first. If the person fails to repeat the pattern three consecutive trials the test is finished, and the score is given based on how many steps they can repeat backwards. Meaning that the score is calculated the same as the forward task.

Overall, from these two tasks two scores will be achieved, while the forward Corsi block is generally seen as a base score and control for working memory the backward score is more distinctive.

Cognitive Flexibility measures

2.1.8. Wisconsin Card Sorting Task

The aim of this task is to categorize cards according to changing criteria. Grant and Berg (1948) developed it to study cognitive reasoning. In the computerized version of this task the person views a total of five cards, 1 card to be sorted and 4 cards at the top. One of these four cards match the rule of the trial and this card is clicked on as the answer. The categorization can be based on the shape, color or number of objects on the cards.

For example, in the trial seen below (See Figure 1) if the classification rule is based on the shape the first card, if the rule is color the second card and if the number of objects is the rule the third box can be the correct answer. The only way to be sure of the rule, is to try either one of these cards. After finding the correct rule for several trials this rule continues until you receive “wrong” as feedback. This indicates that the rule has changed and the classification is based on something else.

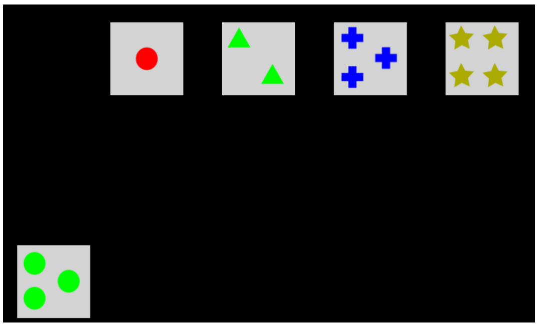


Figure 1. *WCST screen*

The rule changes every 10 cards. It is inevitable to make errors as the errors allow the participant to figure out the new rule of categorization. With this change in rules the task aims to measure how well the person is adapting to it.

As seen from the example figure all the cards are grey square shapes that have differing contents displayed on a black background. If the answer is correct a green box with “correct” written in it is shown as the feedback along a sound that indicates correct, if the answer is incorrect a white box with “wrong” written in it is given as feedback along with a sound that indicates the answer is wrong. The maximum reaction time is set as 10 seconds. If the answer is not provided within this time a yellow box with “too slow” written in it appears.

The incorrect responses are recorded in 3 different ways. The first is the total number of errors the second is the perseveration errors which occurs when the old rule is applied despite the rule change and the third rule is non-perseveration errors which are just errors that can occur from forgetting the rule or losing attention. When the 60* trials are over the number of errors and the percentage are recorded and a score is given to the participant according to these results.

2.2. Procedure

The study consisted of two sessions. The participants were sent a link for the initial session in which LEAP-Q and all the EF measures were administered. The link was created via Psytoolkit.com. After the demographic form questions of the LEAP-Q were given in sections which were mandatory to fill out. Later the Stroop, Wisconsin Card Sorting, N-back and Corsi forward and backward tasks were given in the written order. Both the LEAP-Q and the EF tasks around the same time to complete which was around 15 to 20 minutes so the first session was approximately 35 minutes. For the second session a zoom link was sent to the participant at the time determined by the participant. In the second session the first task was the English PPVT-IV administered by me with the scanned version of the PPVT-IV. For the Turkish-Arabic group the Arabic PPVT-IV was given first and the English PPVT-IV was given afterwards. The second task was the Penn-Matrix Analysis Test 24 which must be administered by someone with an WEBCNP account, so the PMAT-24 also had to be administered during the zoom session. Lastly the participants completed the verbal fluency task that was recorded. During the 2 minutes 1 minute was given for the phonemic task and 1 minute for the semantic part. Other than the voice record for the verbal fluency task the zoom session was not recorded, and the participants were clearly informed of nothing being recorded except for the 2 minutes of word listing.

3. RESULTS

3.1. Data preparation and Analysis Plan

Participants who completed the first part (N= 122) but did not attend the second part of the study were excluded. Additionally, reaction time was an important aspect of the Stroop task, and the tasks were used directly form Psytoolkit.com's library so the tasks had set time limits for each task. So, trials longer than 3000 ms were excluded prior to the analysis for the Stroop task as these were neither correct or wrong trials. Stroop score and Stroop global RT are different scores. While the Stroop score is the score calculated by subtracting Congruent RT from Incongruent RT (Incongruent RT - Congruent RT), the global RT is the mean RT for both congruent and incongruent trials. The score for the WCST is the percentile of correct trials. The score for the 2-back task is the d prime score, which is Z false alarm rate subtracted from Z-score hit rate, explained in detail in the methods. And lastly ,the Corsi Block Task scores are the maximum block they could remember before making two consecutive errors. The final sample includes 108 participants. The Turkish-English group has 55 participants (F = 40, M = 15, M_{age} = 22.96) and the Turkish-Arabic group has 53 (F = 40, M = 13, M_{age} = 22.05). All the descriptive data for the language tasks, non-verbal reasoning task, EF tasks scores and a mean score of their reading, comprehension, and speaking self-report score named as the L2 self-report variable can be found in Table 3.1. A detailed information of the participants self-report assessed by the LEAP-Q can be found in Table 3.2.

Table 3.1. *Descriptive Statistics for Demographic Information and EF Measures*

	Mean (SD)		
Group	**TR-ENG**	**TR-ARABIC**	
Age	23 (2.53)	22.1 (2.66)	
SES	2.76 (0.79)	2.75 (0.88)	
L2 Self-report	8.13 (1.34)	6.54 (2.46)	*
L2 AoA	8.85 (2.14)	13.8 (4.25)	*
PPVT-IV L2	118 (34.3)	78.7 (49.3)	*
PMAT-24	17.9 (4.51)	13.7 (4.53)	*
VFtotal	10.5 (3.71)	12.1 (3.04)	
Stroop score	80.9 (126)	102 (115)	*
Stroop global RT	1011 (154)	1161 (197)	*
WCST	86.9 (6.63)	83.2 (7.44)	*
2-back task	0.46 (1.10)	-0.48 (1.54)	*
Corsi F	5.27 (1.68)	4.78 (2.18)	
Corsi B	3.42 (2.77)	2.88 (2.70)	

*Shows significant differences amongst groups

Table 3.2. *Descriptive statistics for LEAP-Q*

Variable	English for TR-ENG	Arabic for TR-ARABIC	English for TR-ARABIC
	Mean	Mean	Mean
Self- evaluation			
Speaking	7.18	5.88	3.77
Comprehension	8.45	6.82	4.70
Reading	8.75	7.69	5.11
Exposure			
Interacting with friends	5.53	6.18	3.85
Interacting with family	2.02	2.94	1.98
Reading	8.65	8.45	5.49
Course/ Self-instruction	7.44	8.41	6.15
Watching	8.98	6.73	6.49
Listening to radio/music	9.00	8.08	6.55
Contribution to learning			
Interacting with friends	6.98	7.12	5.13
Interacting with family	3.78	3.65	3.19
Reading	8.91	8.37	6.09
Course/ Self-instruction	7.49	8.57	6.79
Watching TV	8.69	7.16	7.74
Listening to radio/music	9.02	8.18	7.40

To investigate the relationship between second language (L2) proficiency, language distance between first and second language (LD) and executive functioning performance, we tested 12 models in separate hierarchical regression analyses. Our outcome variables were performance scores on the Stroop task, WCST, 2-Back task, Corsi Forward and Corsi Backward task and global reaction time for the Stroop task. For the first seven regression analyses we used the following predictor variables: In the first step, we entered age as a predictor. The second step included the mean verbal fluency (VF) score of the two VF tasks (i.e. (1) phonemic and (2) categoric fluency), for first language (L1) and the PMAT-24 scores as control variables. For the third step we included L2 Proficiency scores and LD measure. For the rest of the seven regression analyses, we added an interaction in terms of L2 Proficiency x LD in the third step in addition to all other variables.

3.2. Correlation between Executive Function performance and L2 proficiency scores

The relationship between executive functions and L2 proficiency measured by PPVT-IV and LEAP-Q was investigated through a Pearson's correlation test. The PPVT-IV positively correlated with the self-reports of L2 (r= 0.688, p<.001) and PMAT-24 (r= -0.21, p=.029) and negatively correlated with L2 AoA (r= -0.582, p<.001) there was no significant relationship with EF task scores (Stroop, WCST, 2-back, Corsi forward and Corsi backward). L2 self-report of proficiency negatively correlated with verbal fluency in first language (r= -0.252, p=.008) but did not have a significant relationship with EF task performance (See Table 3.3).

Table 3.3. *Correlation Matrix for demographics and EF measures*

	1	2	3	4	5	6	7	8	9	10	11	12
1- Age	—											
2- L2 Proficiency	0.017	—										
3- PMAT-24	0.074	0.21*	—									
4 -L1 -VF	0.057	-0.171	-0.045	—								
5- Stroop score	-0.026	-0.002	0.072	0.074	—							
6- Stroop g rt	0.072	-0.119	-0.323***	-0.014	-0.012	—						
7- WCST	0.092	0.094	0.265**	-0.193*	-0.139	-0.108	—					
8- 2-back	0.091	0.193*	0.335***	0.054	0.002	-0.368***	0.284**	—				
9- Corsi F	0.097	0.088	0.128	-0.038	0.034	-0.153	0.245*	0.41**	—			
10- Corsi B	-0.147	0.08	-0.068	0.151	0.196*	0.104	0.042	0.102	0.065	—		
11- L2 self-report	0.022	0.688***	0.188	-0.252**	0.114	-0.175	0.13	0.06	0.084	-0.087	—	
12- L2 AoA	0.099	-0.582***	-0.26**	0.176	0.046	0.103	-0.177	-0.205*	0.01	-0.148	-0.488***	—

Note. * p < .05, ** p < .01, *** p < .001

3.3. Relations between Stroop task, LD and L2 Proficiency

The regression analysis for Stroop task performance showed that age at step one (R^2=0.00, F(1,102) = 0.02 , p = .792), adding verbal fluency score and PMAT-24 score on step two (R^2= 0.01 F(3,100) = 0.74, p = .74) and finally adding L2 proficiency and language distance variables at step three (R^2= 0.02, F(5,98)= 0.71 , p = .817) did not significantly predict the performance for this task. The interaction of L2 proficiency and LD was added in the third step for the second model (R^2= 0.06, F(6,97) = 0.713, p = .446) and similarly was not a significant predictor (See Table 3.4).

3.4. Relations between WCST, LD and L2 proficiency

For the Wisconsin Card Sorting Task both models were non-significant. Age at step one (R^2= 0.00, F(1, 106)= 0.9, p = .346) did not explain the model. Neither did adding verbal fluency measures and PMAT-24 scores at step two (R^2= 0.11, F(3, 104) = 4.3, p = 0.007) and adding L2 proficiency and language distance variables at step three (R^2= 0.12, F (5, 102)= 2.86, p =0.019) explain the model. Adding the interaction of L2 Proficiency x LD in the third step in the second model did not make it significant (R^2= 0.12, F(6, 101) = 2.36 , p =.035 (See Table 3.5).

3.5. Relations between 2-back, LD and L2 proficiency

For the 2-back task, step three revealed significance (R^2= 0.17, F (6, 100) = 3.57, p< .001. At the first step (R^2= 0.01, F(1,105)=0.89, p = 0.349) age was not a significant predictor, however at the second step (R^2=0.12, F(3,103)= 4.71, p = .004) the added PMAT-24 was related to 2-back performance (β= 0.28, p < .001). In the second model when the interaction of L2 proficiency and LD was added in the third step the model was insignificant (R^2= 0.02, F (6, 101) = 5.14, p = < .001) (Table 3.6).

Table 3.4. *Models Predicting Stroop Task*

Model 1					Model 2				
Predictors	*SE*(β)	β	*p*	R^2	Predictors	*SE*(β)	β	*p*	R^2
Step 1				0	Step 1				0
Age	4.65	-0.98	0.83		Age	4.68	0.72	0.878	
Step 2				0.01	Step 2				0.01
PMAT-24	2.65	28.26	0.29		PMAT-24	2.65	3.55	0.184	
L1-VF	3.62	20.33	0.576		L1-VF	3.58	2.21	0.539	
Step 3				0.02	Step 3				0.06
L2 Proficiency	0.29	0.09	0.765		L2 Proficiency	11.95	-22.52	0.063	
LD	5.85	57.73	0.326		LD	13.95	-18.24	0.194	
					L2 Proficiency* LD	0.13	0.24	0.062	

Table 3.5. *Models Predicting WCST Task*

Model 1					Model 2				
Predictors	*SE*(β)	β	*p*	R^2	Predictors	*SE*(β)	β	*p*	R^2
Step 1				0	Step 1				0
Age	0.26	0.18	0.506		Age	0.27	0.19	0.487	
Step 2				0.11	Step 2				0.11
PMAT-24	0.15	0.30	0.043		PMAT-24	0.15	0.31	0.043	
L1-VF	0.20	-0.34	0.098		L1-VF	0.2	-0.34	0.099	
Step 3				0.12	Step 3				0.12
L2 Proficiency	0.02	-0.01	0.745		L2 Proficiency	0.67	-0.16	0.813	
LD	0.33	-0.39	0.237		LD	0.78	-0.55	0.484	
					L2 Proficiency* LD	< .01	< .01	0.819	

3.6. Relations between Corsi tasks, LD, and L2 proficiency

The forward Corsi analysis was non-significant at all steps. Age at step one (R^2= 0.01, F(1,104)= 0.98, p = .324) verbal fluency measures and PMAT-24 added at the second step (R^2=0.03, F(3, 102)= 0.88, p = .455) and L2 proficiency and language distance added at the third step (R^2= 0.03, F(5, 100)= 0.617 , p = .687). The interaction of L2 proficiency and LD was added in the third step for the second model and this variable could not explain the model (R^2= 0.03, F(6,99) = 0.57, p = .75). (See Table 3.7)

Lastly for the Backward Corsi task none of the predictors were significantly related. Age at step one (R^2= 0.02, F (1,104) = 2.31, p = .132) the added verbal fluency measures and PMAT at the second step (R^2= 0.05, F (3,102) =1.76, p = .159) and the added L2 proficiency and language distance at the third step (R^2= 0.09, F (5,100) = 1.91, p = .099). When the interaction of L2 proficiency and LD was included in the third step of the second model did not make the model significant (R^2= 0.1, F (6,99) = 1.67, p = .136) (See Table 3.8)

The Stroop global RT analysis was significant at the third step (R^2= 0.22, F(5, 98)= 5.46 , p <.001). Age at step one was not a significant predictor (R^2= 0.01, F(1,102)= 0.53, p = .465) however, the added verbal fluency measures and PMAT-24 at the second step (R^2=0.11, F(3, 100)= 4.31, p = .007) and L2 proficiency and language distance at the third step were significant. The interaction of L2 proficiency and LD was added in the third step for the second model and this variable could explain the model (R^2= 0.25, F(6,97) = 5.41, p = .<001). (See Table 3.9)

Table 3.6. *Models Predicting 2-back Task*

Model 1					Model 2				
Predictors	*SE*(β)	β	*p*	R^2	Predictors	*SE*(β)	β	*p*	R^2
Step 1				< .01	Step 1				< .01
Age	0.05	0.01	0.785		Age	0.05	0.01	0.774	
Step 2				0.12	Step 2				0.12
PMAT-24	0.03	0.07	0.018		PMAT-24	0.03	0.06	< .01	
L1-VF	0.04	0.05	0.177		L1-VF	0.04	0.05	0.179	
Step 3				0.18	Step 3				0.17
L2 Proficiency	< .01	< .01	0.441		L2 Proficiency	0.12	-0.01	0.927	
LD	0.06	-0.13	0.041		LD	0.14	-0.14	0.339	
					L2 Proficiency* LD	< .01	< .01	0.912	

Table 3.7. *Models Predicting Forward Corsi Task*

Model 1					Model 2				
Predictors	*SE*(β)	β	*p*	R^2	Predictors	*SE*(β)	β	*p*	R^2
Step 1				0	Step 1				0.01
Age	0.07	0.06	0.413		Age	0.076	0.07	0.356	
Step 2				0.03	Step 2				0.03
PMAT-24	0.04	0.037	0.387		PMAT-24	0.043	0.04	0.349	
L1-VF	0.057	-0.01	0.843		L1-VF	0.06	-0.01	0.838	
Step 3				0.03	Step 3				0.03
L2 Proficiency	0	0	0.652		L2 Proficiency	0.19	-0.11	0.547	
LD	0.09	-0.032	0.725		LD	0.22	-0.16	0.482	
					L2 Proficiency* LD	< .01	< .01	0.54	

Table 3.8. *Models Predicting Backward Corsi Task*

Model 1					Model 2				
Predictors	*SE*(β)	β	*p*	R^2	Predictors	*SE*(β)	β	*p*	R^2
Step 1				0.02	Step 1				0.02
Age	0.1	-0.18	0.073		Age	0.1	-0.2	0.058	
Step 2				0.05	Step 2				0.05
PMAT-24	0.06	-0.07	0.209		PMAT-24	0.06	-0.08	0.181	
L1-VF	0.078	0.17	0.035		L1-VF	0.08	0.17	0.035	
Step 3				0.09	Step 3				0.09
L2 Proficiency	0.01	0	0.497		L2 Proficiency	0.26	0.19	0.46	
LD	0.13	-0.2	0.116		LD	0.3	0	0.999	
					L2 Proficiency* LD	< .01	< .01	0.47	

Table 3.9. *Models Predicting Stroop Task RT*

Model 1					Model 2				
Predictors	*SE*(β)	β	*p*	R^2	Predictors	*SE*(β)	β	*p*	R^2
Step 1				0	Step 1				0.01
Age	6.62	11.2	0.094		Age	6.64	13.83	0.04	
Step 2				0.11	Step 2				0.12
PMAT-24	3.78	-7.32	0.056		PMAT-24	3.76	-6.2	0.102	
L1-VF	5.16	-6.06	0.243		L1-VF	5.08	-5.8	0.256	
Step 3				0.21	Step 3				0.25
L2 Proficiency	0.41	0.28	0.501		L2 Proficiency	16.95	-34.55	0.044	
LD	8.32	29.6	< .001		LD	19.78	-7.4	0.709	
					L2 Proficiency* LD	0.18	0.36	0.043	

*Note*** p<.001*

3.7. Supplementary Analysis

Due to the hierarchical regression analysis being insignificant an additional analysis was conducted to determine whether there were any differences between Turkish English group and Turkish-Arabic group in the domains of executive functioning, that is, inhibition, working memory, and cognitive flexibility. A 2 x 3 (groups x domains) repeated-measures ANOVA was performed. To compare the variance the z-scores of Stroop task, WCST and 2-back tasks were used for inhibition, working memory, and cognitive flexibility domains respectively. The analysis revealed that there was no main effect of the EF domain on EF performance ($F(2,100) = 0.09$, $p=.914$, $\eta^2 = 0.001$) but a main effect of group on EF performance ($F(1,100) = 11.1$, $p = .002$, $\eta^2 = 0.035$). There was also an interaction effect of EF domain and group ($F(2,100) = 5.56$, $p < .05$, $\eta^2 = 0.032$). Post hoc comparisons of EF and group interaction using the Tukey's HSD test indicated that there are no differences between TR-ENG and TR-ARABIC in inhibition (mean difference between groups: -0.02, $SE = 0.2$, $p = .950$) and cognitive flexibility (mean difference between groups: 0.5, $SE = 0.18$, $p = .011$). There was however a significant difference in working memory (mean difference between groups: 0.6, SE = 019, $p = .008$). Post hoc test for group comparison using the Tukey's HSD test showed that the mean difference between group 1 and 2 was 0.4 ($SE = 0.11$) and significant $p < .001$.

4. DISCUSSION

This study aimed to investigate two bilingual groups that had a common L1 but different L2 to investigate whether language distance and L2 proficiency played a role in young adults' executive functioning task performance. We asked (1) how second language proficiency affects executive functioning task performance in different bilingual groups (L1-Turkish: L2-English vs. L1-Turkish: L2-Arabic) and (2) how language distance might be influential on EF as well as on the relationship between L2 proficiency and EF. For this purpose, we recruited young adults from bilingual groups: Turkish- English and Turkish – Arabic bilinguals.

All participants were either university students or graduates with Turkish as their first language. We used Stroop, WCST, 2-back and Corsi block tasks to measure EF performance across different domains. We also assessed participants' non-verbal reasoning (i.e., fluid intelligence) as a control of general intelligence and verbal fluency as a control for L1 productivity. L2 proficiency was measured through PPVT-IV as a measure of receptive vocabulary and self-ratings and previous language experience was collected with the LEAP questionnaire. Lastly, the language distance score was calculated based on the distance of origin of languages via the genetic proximity calculator for languages.

Overall, this sample showed that second language proficiency and language distance was not a predictor of any of the executive function domains. The hypothesis for each of the domains are discussed below.

4.1. Inhibition

It was hypothesized that inhibition, measured by Stroop task, would have a positive relationship with L2 proficiency and lower language distance. This means that as the proficiency level increases the Stroop Effect score, which is Incongruent trials RT – congruent trails RT, is expected to decrease. The reason for this hypothesis relies on the inhibitory control hypothesis. According to Green (1998), when the lexico-semantic system has competition not only within the language but across languages, in the case of the speaker with two or more languages, the Inhibition Control model provides an explanation for the output of speech based on the aim of the speaker. More specifically it is suggested that there is a continuous suppressing of the non-target language and frequent top-down inhibition. Similar to this hypothesis the Bilingual Interaction Activation (BIA) and the updated BIA+ model suggest similar effects of inhibition on the bilingual mind while explaining it through bottom-up processes. According to the model orthographic similarity plays a role in how much cross-linguistic inhibition is required and the model would predict same script languages to have a higher bilingual advantage compared to different script bilinguals. Thus, due to higher similarities across-languages requiring frequent suppression they are expected to have less interference effects (Dijkstra & van Heuven, 2002). These hypotheses support the idea that less difference will result with more inhibition thus leading to better trained cognitive control. Studies finding a relationship between L2 proficiency and inhibition led to the hypothesis that the difference between congruent and incongruent trials would decrease resulting with a lower score on the Stroop (e.g., Colzato et al., 2008; Xie, 2018).

The Stroop Effect as previously explained is the reaction time difference between congruent and incongruent trials. More specifically incongruent trials are expected to have higher reaction times while congruent trials are expected to be answered faster thus the score will be incongruent RT- congruent RT. However, the score is affected by several variables of the task and based on the changes of these variables the effect is not always this simple to find. One of the main factors the effect is based on is the proportion of congruent and incongruent trials. When congruent trials make up for majority of the task the Stroop effect is found to be larger compared to incongruent trials having higher proportions. For the present study the Stroop task had 40 trials in total with high proportion incongruent (M= 9.83) the lowest trail count being 4 and the highest being 14. As a result of this there were many participants with low scores and even those with negative scores indicating faster reaction times for incongruent trials. The main reason for this result may be that due to the majority of the trials being incongruent the participants overall become more trained to ignore the writing and only focus on the color which results in the incongruent trials to not interfere and decrease of facilitation of congruent trials leading to a smaller effect (Lindsay & Jacoby, 1994). Overall, it can be suggested that proportions of the trials are a possible explanation for insignificant results for the Stroop task.

4.2. Working Memory

Working memory was measured with two different tasks. The 2-back was used to measure verbal working memory while the Corsi Block tests were given as a measure of spatial working memory. For the 2-back task it was hypothesized that as proficiency and verbal working memory will have a positive relationship. Consequently, as L2 proficiency increases the number of correct trials for 2-back was also expected increase.

Studies that investigated the effects of L1, L2, L3 proficiency and various working memory tasks (e.g., digit span task, letter-number ordering) were the base of this hypothesis such as Noort et al. (2006) which focused on how complex working memory tasks (e.g., reading span task) affected L2 proficiency and Zavaleta and Nicol (2018) focused on the effects of L2 proficiency by using word learning in L3 as a measure of working memory. Similarly, for both the forward and backward Corsi Block test it was hypothesized that the number of blocks remembered will increase with proficiency. In our study we did find a significant model for the 2-back task however, the Backward Corsi Block Task which is used more often than the Forward Corsi Block Task as a measure of working memory showed floor effects. Floor effects are described as the effect when 15% or more of the participants score at the lowest range of a certain task (Lim, et al., 2015). There were more than 40 participants that were eliminated in the first step of the Backward Corsi Block Task, causing a floor effect for this task. Other working memory measures such as a combination of a Symmetry and Reading span may be better suited to test whether language group influences task performance. Moreover, the groups differed significantly in their working memory performance, shown under supplementary analysis, TR-ARABIC group had a lower score compared to TR-ENG group in 2-back performance, this may have led to the insignificant findings as the groups differed from the start and the effects of LD and L2 proficiency may have been overrode by this initial difference.

4.3. Cognitive Flexibility

Cognitive flexibility was measured via WCST, and it was hypothesized that as proficiency increases the number of correct responses would increase, so the outcome variable is the percentage of correct trials. The score for the WCST is based on number of errors but the important aspect is if this error is a perseverance error because it is inevitable to not make a non-perseveration error as the rule changes every ten trials and you must make a mistake to find the new rule. So aside from the base error rate (the percent of non-perseveration errors) which is around 6 trials or 8% of the task how many errors you make is the score. A reason of our insignificant findings could be due to the ineffectiveness of the WCST detecting within group variances for neurodevelopmentally typical participants despite being a validated cognitive flexibility measure. In recent studies it is primarily used to assess patient's level of brain damage to the prefrontal cortex (Nyhus & Barceló, 2009). So, this can be an explanation for the high correct rate for both groups and thus have led to the insignificant findings.

Language distance affecting cognitive mechanisms goes both ways in the literature. As previously discussed, the one end is that closer languages will enhance executive functioning more because the more similar, they are the more inhibition that is required. The other end is that if the two languages of the bilingual is very far apart and have different orthographies this difference will aid in lexical selection and overall selective processes (Guo et al., 2005) however this is seen as a scant argument (Coderre & Heuven, 2014). For this study, we expected a difference between the two bilingual groups but due to both languages being highly distant to L1 Turkish it was hypothesized that a lower distance score would result with higher EF levels based on the inhibitory control hypothesis (Green, 1998). A reason why we could not find any EF differences amongst the two groups can be due to the TR-ENG group having higher proficiency levels compared to the TR-ARABIC group but the TR-ARABIC group had some exposure to at least three languages. In fact, as mentioned under the participants section more than half of the participants were exposed to a third language prior to their exposure to Arabic making Arabic their fourth language despite it being their most relevant academic L2. Meaning that, although Arabic learners were not as proficient enough their exposure to other languages and training in a second alphabet could have allowed for the same level of training in the mind. In other words, exposure to three or more languages may have compensated for their lack of proficiency.

Global reaction times are suggested as a more common advantage than bilingual interference advantage when comparing monolinguals and bilinguals (Hilchey & Klein, 2011). This refers to the overall reaction time of both congruent and incongruent trials. Similar to the explanation of inhibitory control hypothesis global reaction time advantage suggests faster responses for tasks that require conflict resolution. In the study conducted by Coderre and Heuven (2014) when they compared monolinguals with two bilingual groups, they were expecting to find a bilingual advantage however the different script bilinguals which were English-Arabic had the highest RT's for both Stroop and the Simon task. In the present study the Turkish-Arabic group had significantly higher reaction times for the Stroop task and a higher mean for the WCST global RT.

5. CONCLUSION

5.1. Limitations and future direction

While most of the literature is based on a sample from an English-speaking country in which mother tongue changes in the home environment this study aimed to look at how educational L2 effects EF performance. This is an important issue to address as almost every country in the world implements L2 from a very early age in their education system. However, at which level of proficiency does the language have an effect and to what extent are these effects seen is still an on-going research question. With this study we aimed to look at two different education languages most common in Turkey. While English was an inevitable L2 for all participants our Arabic L2 sample was chosen from those who had an Arabic curriculum during their undergrad studies making Arabic their most prominent L2 in the educational setting. Additionally, it is important to state that while the starting point of this research was to examine the bilingual advantage hypothesis, our study did not include a monolingual sample that could be used in the comparison due to every young adult who is attending a university being exposed a L2 through formal education. Overall, this study was unique in addressing how to languages of the education system with different language distances to L1 Turkish affected EF task performance in relation to L2 proficiency.

One limitation to our study was that our groups differed in the L2 proficiency. Thus, this difference from the start may have caused insignificant findings. Additionally, both English and Arabic have a high score in language distance and this difference was shown to be significantly different, however with Arabic having a higher score and being different orthographically it was thought that this would also affect EF performance similar to studies that investigated a close and distant language pair.

However, Turkic languages are the only languages that have a small LD score, and they are neither an educational L2 nor common in Turkey. Additionally, both of our groups were low in L2 proficiency from the start especially the TR-ARABIC group. Despite their university education being in L2. Based on the threshold hypothesis (Cumming, 2001) unless the second language is at a certain proficiency level it will not benefit as a medium of instruction. Despite the current study finding null results for L2 proficiency, this study was also aimed to increase awareness of the importance of L2 proficiency in the school setting as the education system.

This study was conducted with young adults, and it is stated that the twenties are the peak of cognitive performance thus if we were to find a difference when cognitive performance is at its peak it would have been a strong indicator of proficiency affecting EF. As the current study exclusively focused on a young adult population, we may not generalize our findings beyond this group, yet these results are consistent with a growing body of literature that has failed to demonstrate that a bilingual advantage truly exists (Paap & Greenberg, 2013; Gathercole et al., 2014; Dick et al., 2018). For future studies this can be done with older adults and perhaps focus on how different orthographies and LD’s play a role in cognitive abilities. Additionally, the language distance score used in the current study was calculated based on phonological differences and while there are many studies that look into the similarities of L1 and L2 visually, such as orthographic overlap, phonological similarity is mostly unexplored (Frances et al., 2021) and can be looked into for future studies.

This study was also important in addressing the shortcoming mentioned in the literature in terms of convergent validity and using few numbers of tasks when measuring executive functioning. Many of the previous studies focus on a single domain and we aimed to cover different aspects of EF with different EF tasks. However, there are still limitations to the tasks that we used as previously mentioned. Thus, it is important to use tasks that are designed to measure a more domain general executive functions. -

It is important to note that null results are often set aside with the understanding that they are much harder to publish (Paap et al., 2015). De Bruin, Treccani, & Della Sala (2015) conducted a study showing the bias in the presentations and publications in favor of the bilingual advantage.

In conclusion, future research should continue investigations, with assessment tools that tap onto multiple aspects of EF as well as focus on how different measures of language distance plays a role on both L1 and L2 proficiency. Despite not finding an effect of L2 proficiency in our study L2 proficiency was shown to be an effective aspect on the bilingual advantage, thus, to ascertain whether there are cognitive differences among individuals who speak multiple languages future research is needed.

REFERENCES

Abutalebi, J., Della Rosa, P. A., Green, D. W., Hernandez, M., Scifo, P., Keim, R., Cappa, S. F., & Costa, A. (2012). Bilingualism tunes the anterior cingulate cortex for conflict monitoring. *Cerebral cortex*, *22*(9), 2076–2086. https://doi.org/10.1093/cercor/bhr287

Abutalebi, J., & Green, D. (2007). Bilingual language production: The neurocognition of language representation and control. *Journal of Neurolinguistics*, *20*(3), 242-275.

American Council on the Teaching of Foreign Languages (2012). ACTFL proficiency guidelines for speaking. American Council on the Teaching of Foreign Language

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.

Antón, E., Duñabeitia, J. A., Estévez, A., Hernández, J. A., Castillo, A., Fuentes, L. J., Davidson, D.J., & Carreiras, M. (2014). *Is there a bilingual advantage in the ANT task? Evidence from children. Frontiers in Psychology, 5.* doi:10.3389/fpsyg.2014.00398

Bialystok, E. (2017). The bilingual adaptation: How minds accommodate experience. *Psychological Bulletin*, *143*(3), 233–262. https://doi.org/10.1037/bul0000099

Bialystok, E., Craik, F. I., & Freedman, M. (2007). Bilingualism as a protection against the onset of symptoms of dementia. *Neuropsychologia*, *45*(2), 459–464. https://doi.org/10.1016/j.neuropsychologia.2006.10.009

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., Luk, G., Peets, K. F., & Yang, S. (2010). Receptive vocabulary differences in monolingual and bilingual children. *Bilingualism*, *13*(4), 525–531. https://doi.org/10.1017/S1366728909990423

Bialystok, E., Craik, F. I. M., Green, D. W., & Gollan, T. H. (2009). Bilingual Minds. *Psychological Science in the Public Interest*, *10*(3), 89–129. https://doi.org/10.1177/1529100610387084

Bialystok, E., Craik, F. I., & 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

Bohn, O.S. & Flege, J. E. (1992). The production of new and similar vowels by adult German learners of English. *Studies in Second Language Acquisition*, *14*(2), 131–158.

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.

Colzato, L. S., Bajo, M. T., van den Wildenberg, W., Paolieri, D., Nieuwenhuis, S., La Heij, W., & Hommel, B. (2008). How does bilingualism improve executive control? A comparison of active and reactive inhibition mechanisms. *Journal of experimental psychology. Learning, memory, and cognition*, *34*(2), 302–312. https://doi.org/10.1037/0278-7393.34.2.302

"Compare Languages: Genetic Proximity Calculator." *e Comparative Linguistics*, www.elinguistics.net/Compare_Languages.aspx.

Costa, A., Hernández, M., & Sebastián-Gallés, N. (2008). Bilingualism aids conflict resolution: Evidence from the ANT task. *Cognition*, *106*(1), 59–86.

Costa, A., Miozzo, M., & Caramazza, A. (1999). Lexical selection in bilinguals: Do words in the bilingual's two lexicons compete for selection? *Journal of Memory and Language*, *41*(3), 365–397. https://doi.org/10.1006/jmla.1999.2651

Costa, A., & Santesteban, M. (2004). Lexical access in bilingual speech production: Evidence from language switching in highly proficient bilinguals and L2 learners. *Journal of Memory and Language*, *50*(4), 491–511. https://doi.org/10.1016/j.jml.2004.02.002

Cutler, A., Mehler, J., Norris, D., & Segui, J. (1992). The monolingual nature of speech segmentation by bilinguals. *Cognitive Psychology, 24*(3), 381–410. https://doi.org/10.1016/0010-0285(92)90012-Q

De Houwer, A. (2005). Early bilingual acquisition. Handbook of bilingualism: Psycholinguistic approaches, 30-48.

Dick, A. S., Garcia, N. L., Pruden, S. M., Thompson, W. K., Hawes, S. W., Sutherland, M. T., et al. (2019). No evidence for a bilingual executive function advantage in the ABCD study. *Nature Human Behaviour*, *3*(7), 692–701.

Dunn, L.M., & Dunn, D.M. (2007). The Peabody Picture Vocabulary Test, Fourth Edition. Bloomington, MN: NCS Pearson, Inc. Community-University Partnership for the Study of Children, Youth, and Families (2011). Review of the Peabody Picture Vocabulary Test, Fourth Edition (PPVT-4).

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.

Espinosa, Linda M. (2015). Challenges and benefits of early bilingualism in the Unites States' context. *Global Education Review, 2*(1), 14-31.

European Commission (2012). Directorate-General for Education and Culture, Directorate-General for Translation and Directorate-General for Interpretation, co-ordinated by Directorate-General for Communication (2012 - a survey conducted by TNS

Opinion & Social at the request of the E.C.). Europeans and their languages - Special Eurobarometer 386. Retrieved from: http://ec.europa.eu/commfrontoffice/publicopinion/archives/ebs/ebs_386_en.pdf.

Frances, C., Navarra-Barindelli, E. & Martin, C.D. (2021). Inhibitory and facilitatory effects of phonological and orthographic similarity on L2 word recognition across modalities in bilinguals. *Scientific Report*, *11*, 12812. https://doi.org/10.1038/s41598-021-92259-z

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*, 11.

Gottardo, A., & Grant, A. (2008). Defining bilingualism. *Encyclopedia of Language and Literacy Development* (pp. 1-7).

Green, D. W. (1998). Mental control of the bilingual lexico-semantic system. *Bilingualism 1*, 67–81. doi: 10.1017/S1366728998000133

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

Grosjean, F. (1982). Life with two languages. *Cambridge: Harvard University Press*. AILA Review *22*(1). 36–51.

Grundy, J. G., & Timmer, K. (2017). Bilingualism and working memory capacity: A comprehensive meta-analysis. *Second Language Research*, *33*(3), 325-340.

Guo, T., Peng, D., & Liu, Y. (2005). The role of phonological activation in the visual semantic retrieval of Chinese characters. *Cognition*, *98*, 21–34. doi: 10.1016/j.cognition.2005.02.004

Gur, R. C., Richard, J., Calkins, M. E., Chiavacci, R., Hansen, J. A., Bilker, W. B., Loughead, J., Connolly, J. J., Qiu, H., Mentch, F. D., Abou-Sleiman, P. M., Hakonarson, H., & Gur, R. E. (2012). Age group and sex differences in performance on a computerized neurocognitive battery in children age 8-21. *Neuropsychology*, *26*(2), 251–265. https://doi.org/10.1037/a0026712

Gur, R. C., Richard, J., Hughett, P., Calkins, M. E., Macy, L., Bilker, W. B., Brensinger, C., & Gur, R. E. (2010). A cognitive neuroscience-based computerized battery for efficient measurement of individual differences: standardization and initial construct validation. *Journal of neuroscience methods*, *187*(2), 254–262. https://doi.org/10.1016/j.jneumeth.2009.11.017

Haatveit, B. C., Sundet, K., Hugdahl, K., Ueland, T., Melle, I., & Andreassen, O. A. (2010). The validity of d prime as a working memory index: results from the "Bergen n-back task". *Journal of clinical and experimental neuropsychology*, *32*(8), 871–880.

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.

Ibrahim, R., Shoshani, R., Prior, A., & Share, D. (2013). Bilingualism and measures of spontaneous and reactive cognitive flexibility. *Psychology*, *4*(07), 1.

Iluz-Cohen, P., & Armon-Lotem, S. (2013). Language proficiency and executive control in bilingual children. *Bilingualism*, *16*, 884–899. doi: 10.1017/ S1366728912000788

Institute of Current World Affairs (2022). *ICWA. org*

Khare, V., Verma, A., Kar, B., Srinivasan, N., & Brysbaert, M. (2013). Bilingualism and the increased attentional blink effect: Evidence that the difference between bilinguals and monolinguals generalizes to different levels of second language proficiency. *Psychological Research*, *77*(6), 728-737.

Kim, J., Gabriel, U., & Gygax, P. (2019). Testing the effectiveness of the Internet-based instrument PsyToolkit: A comparison between web-based (PsyToolkit) and lab-based (E-Prime 3.0) measurements of response choice and response time in a complex psycholinguistic task. *PloS one*, *14*(9), e0221802. https://doi.org/10.1371/journal.pone.0221802

Kovacs, A. M., & Mehler, J. (2009). Cognitive gains in 7-month-old bilingual infants. *Proceedings of the National Academy of Sciences*, *106*(16), 6556–6560

Lim, C. R., Harris, K., Dawson, J., Beard, D. J., Fitzpatrick, R., and Price, A. J. (2015). Floor and ceiling effects in the OHS: an analysis of the NHS PROMs data set. *BMJ Open* 5. doi: 10.1136/bmjopen-2015-007765

Ljungberg, J. K., Hansson, P., Andrés, P., Josefsson, M., & Nilsson, L. G. (2013). A longitudinal study of memory advantages in bilinguals. *PloS one*, *8*(9), e73029.

Luk, G., Bialystok, E., Craik, F. I., & Grady, C. L. (2011). Lifelong bilingualism maintains white matter integrity in older adults. *Journal of Neuroscience*, *31*(46), 16808–16813.

Marian, V., Blumenfeld, H. K., & Kaushanskaya, M. (2007). The Language Experience and Proficiency Questionnaire (LEAP-Q): Assessing language profiles in bilinguals and multilinguals.

Martin, C. D., Dering, B., Thomas, E. M., & Thierry, G. (2009). Brain potentials reveal semantic priming in both the 'active' and the 'non-attended' language of early bilinguals. *NeuroImage*, *47*(1), 326–333. https://doi.org/10.1016/j.neuroimage.2009.04.025

Meule, A. (2017). Reporting and interpreting task performance in go/no-go affective shifting tasks. *Frontiers in Psychology, 8*, Article 701. https://doi.org/10.3389/fpsyg.2017.00701

Milli Eğitim Bakanlığı, (2021) İlkokul ve Ortaokul öğrencilerinin İngilizce Öğrenme Süreçlerine Renkli Etkinliklerle Destek. Retrieved from: https://www.meb.gov.tr/ilkokul-ve-ortaokul-ogrencilerinin-ingilizce-ogrenme-sureclerine-renkli-etkinliklerle-destek/haber/22319/tr

Mishra, R. K., Hilchey, M. D., Singh, N., & Klein, R. M. (2012). On the time course of exogenous cueing effects in bilinguals: higher proficiency in a second language is associated with more rapid endogenous disengagement. *Quarterly Journal of Experimental Psychology*, *65*(8), 1502-1510.

Miyake, A., & Friedman, N. P. (2012). The Nature and Organization of Individual Differences in Executive Functions: Four General Conclusions. *Current directions in psychological science*, *21*(1), 8–14. https://doi.org/10.1177/0963721411429458

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.

Morton, J. B., & Harper, S. N. (2007). What did Simon say? Revisiting the bilingual advantage. *Developmental Science*, *10*(6), 719–726.

Olsen, R. K., Pangelinan, M. M., Bogulski, C., Chakravarty, M. M., Luk, G., Grady, C. L., & Bialystok, E. (2015). The effect of lifelong bilingualism on regional grey and white matter volume. *Brain research*, *1612*, 128-139.

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.

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. doi: 10.1016/j.cortex.2015. 04.014

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., & Gollan, T. H. (2011). Good language-switchers are good task-switchers: Evidence from Spanish–English and Mandarin–English bilinguals. *Journal of the International Neuropsychological Society*, *17*(4), 682-691.

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

Ramanujan, K. (2019). The impact of Relative Language Distance on Bilingual Language Control–a functional imaging study. *BioRxiv*, 771212.

Raven, J. C., Court, J. H., & Raven, J. (1977). Manual for Raven's Advanced Progressive Matrices: Sets I and II. London: H. K. Lewis & Co., Ltd.

Rosselli, M., Ardila, A., Lalwani, L. N., & Velez-Uribe, I. (2016). The effect of language proficiency on executive functions in balanced and unbalanced Spanish–English bilinguals. *Bilingualism 19*, 489–503. doi: 10.1017/ S1366728915000309

Schroeder, S. R., & Marian, V. (2012). A bilingual advantage for episodic memory in older adults. *Journal of Cognitive Psychology*, *24*(5), 591-601.

Shao, Z., Janse, E., Visser, K., & Meyer, A. S. (2014). What do verbal fluency tasks measure? Predictors of verbal fluency performance in older adults. *Frontiers in psychology*, *5*, 772. https://doi.org/10.3389/fpsyg.2014.00772

Soveri, A., Rodriguez-Fornells, A., & Laine, M. (2011). Is There a Relationship between Language Switching and Executive Functions in Bilingualism? Introducing a within group Analysis Approach. *Frontiers in psychology*, *2*, 183. https://doi.org/10.3389/fpsyg.2011.00183

Stoet, G. (2010). PsyToolkit - A software package for programming psychological experiments using Linux. *Behavior Research Methods, 42(4)*, 1096-1104.

Stoet, G. (2017). PsyToolkit: A novel web-based method for running online questionnaires and reaction-time experiments. *Teaching of Psychology*, *44*(1), 24-31.

U. S. Census Bureau (2010) The 2011 Statistical Abstract. Language Spoken at Home – Cities With 100,000 Persons or More: 2008, Table 55. Retrieved August 4, 2011 from http://www.census.gov/compendia/statab/cats/population/ancestry_language_spoken_at_home.html

Valdés, G., & Figueroa, R. A. (1994). Bilingualism and testing: A special case of bias. *Ablex Publishing.*

van den Noort, M. W. M. L., Bosch, P., & Hugdahl, K. (2006). Foreign language proficiency and working memory capacity. *European Psychologist*, *11*(4), 289–296. https://doi.org/10.1027/1016-9040.11.4.289

van Heuven, W. J., Schriefers, H., Dijkstra, T., & Hagoort, P. (2008). Language conflict in the bilingual brain. *Cerebral cortex*, *18*(11), 2706–2716. https://doi.org/10.1093/cercor/bhn030

Vega-Mendoza, M., West, H., Sorace, A., and Bak, T. H. (2015). The impact of late, non-balanced bilingualism on cognitive performance. *Cognition*, *137*, 40–46. doi: 10.1016/j.cognition.2014.12.008

Vivas, A. B., Ladas, A. I., Salvari, V., & Chrysochoou, E. (2017). Revisiting the bilingual advantage in attention in low SES Greek-Albanians: does the level of bilingual experience matter? *Language, Cognition and Neuroscience*, *32*(6), 743–756.

Xie, Z., and Dong, Y. (2017). Contributions of bilingualism and public speaking training to cognitive control differences among young adults. *Bilingualism*, *20*, 55–68. doi: 10.1017/S1366728915000474

Zavaleta, K. L., & Nicol, J. L. (2018). Effects of second language proficiency and working memory span on novel language learning. *Journal of Second Language Studies*, *1*(1), 79-105. https://doi.org/10.1075/jsls.17025.zav

APPENDIX A

Language Experience and Proficiency Questionnaire (LEAP-Q)

Last Name		First Name		Today's Date	
Age		Date of Birth		Male ☐	Female ☐

(1) Please list all the languages you know **in order of dominance**:

1	2	3	4	5

(2) Please list all the languages you know **in order of acquisition** (your native language first):

1	2	3	4	5

(3) Please list what percentage of the time you are *currently* and *on average* exposed to each language.
(*Your percentages should add up to 100%*):

List language here:					
List percentage here:					

(4) When choosing to read a text available in all your languages, in what percentage of cases would you choose to read it in each of your languages? Assume that the original was written in another language, which is unknown to you.
(*Your percentages should add up to 100%*):

List language here					
List percentage here:					

(5) When choosing a language to speak with a person who is equally fluent in all your languages, what percentage of time would you choose to speak each language? Please report percent of total time.
(*Your percentages should add up to 100%*):

List language here					
List percentage here:					

(6) Please name the cultures with which you identify. On a scale from zero to ten, please rate the extent to which you identify with each culture. (Examples of possible cultures include US-American, Chinese, Jewish-Orthodox, etc):

List cultures here					
	(click here for scale)	(click here for scale)	(click here for scale)	(click here for scale)	(click here for scale)

(7) How many years of formal education do you have? ______________________________
Please check your highest education level (or the approximate US equivalent to a degree obtained in another country):

☐ Less than High School	☐ Some College	☐ Masters
☐ High School	☐ College	☐ Ph.D./M.D./J.D.
☐ Professional Training	☐ Some Graduate School	☐ Other:

(8) Date of immigration to the USA, if applicable ______________________________
If you have ever immigrated to another country, please provide name of country and date of immigration here. ______________________________

(9) Have you ever had a vision problem ☐, hearing impairment ☐, language disability ☐, or learning disability ☐ ? (Check all applicable). If yes, please explain (including any corrections):
____

Language:

This is my (please select from pull-down menu) language.

All questions below refer to your knowledge of .

(1) Age when you…:

began acquiring :	*became fluent* in :	*began reading* in :	*became fluent reading* in :

(2) Please list the number of years and months you spent in each language environment:

	Years	Months
A country where is spoken		
A family where is spoken		
A school and/or working environment where is spoken		

(3) On a scale from zero to ten, please select your *level of* ***proficiency*** in speaking, understanding, and reading from the scroll-down menus:

Speaking	(click here for scale)	Understanding spoken language	(click here for scale)	Reading	(click here for scale)

(4) On a scale from zero to ten, please select how much the following factors contributed to you learning :

Interacting with friends	(click here for pull-down scale)	Language tapes/self instruction	(click here for pull-down scale)
Interacting with family	(click here for pull-down scale)	Watching TV	(click here for pull-down scale)
Reading	(click here for pull-down scale)	Listening to the radio	(click here for pull-down scale)

(5) Please rate to what extent you are currently exposed to in the following contexts:

Interacting with friends	(click here for pull-down scale)	Listening to radio/music	(click here for pull-down scale)
Interacting with family	(click here for pull-down scale)	Reading	(click here for pull-down scale)
Watching TV	(click here for pull-down scale)	Language-lab/self-instruction	(click here for pull-down scale)

(6) In your perception, how much of a foreign accent do you have in ?

(click here for pull-down scale)

(7) Please rate how frequently others identify you as a non-native speaker based on your accent in :

APPENDIX B

Table 1. Genetic language distance calculator word list

word	Comments
Eye	Stable word, with little exposure to semantic shift.
Ear	Pretty stable, semantically and also against erosion. Little probability to get borrowed from another language!
Nose	Very stable word, with little exposure to semantic shift. One of the best suited word for comparative linguistics!
Hand	As many other parts of the body, little exposure to borrowing and good semantic stability. However, in many languages, the meaning shifts from "hand" to "arm" or the other way round.
Tongue	Very stable - similar to nose, although it is also being used for "language" in many languages and gives it an exposure to semantic shift or at least to confusion.
Tooth	Very stable - similar conditions as "nose". However, this word has been subject to semantic shift in parts of the Indo-European family - with a mix "Tooth"/"Tongue" ("-Z-B-" in Slavic/Indo-Iranan languages).
Death	As an abstract concept, the use of this word for comparing remote languages is somewhat hazardous. However, if this is not due to chance interference, it is the one best linking the Indo-European and Semitic language families (Arabic الموت (mut)/ Hebrew מוות (mavet) -> French "Mort" / Slavic "Mertv"... In some languages, the root of the verb "to die" has been taken instead of the substantive "death" when it was not available ("to die" is an element of the Swadesh list "death" is not)
Water	Very interesting word, although it is in intensive use and as such subject to more erosion. Moreover, semantic shift exposure is higher than for body parts. Water is the word best linking the Indo-European and Finno-Ugric language families (Finnish "Vesi" / Hungarian "Vez" -> German "Wasser" / Slavic "Voda") - provided this resemblance is not due to chance.
Sun	This word has a big exposure to semantic shift but delivers good results in comparative linguistics. Probably less suited for remote language relationships
Wind	As all nature related words, should have existed in early languages.
Night	Very classical example in Indo-European studies...
Two	Little exposure to semantic shift but intensive use in daily life ("erosion")
Three	Little exposure to semantic shift but intensive use in daily life ("erosion"). Sometimes exposure to borrowing like in Kabylian (see Kabylian to Arabic comparison)
Four	Little exposure to semantic shift but intensive use in daily life ("erosion"). Exposure to borrowing similar to "three".

I	Very high exposure to erosion (intensive use in daily life) but little chance of semantic shift. Another problem with "I" is that it is monosyllabic in many languages - and monosyllabic resemblances between two languages are statistically more exposed to chance resemblance.
You	Very high exposure to erosion (intensive use in daily life) but little chance of semantic shift
Who	May be the least suited word in the study (erosion, semantic shift)
Name	This word links many languages to each other - although it should be used with caution as it is not sure it is common to proto-languages older than several thousands of years. Moreover, it may have been subject to borrowing in very remote times so that, after erosion, this borrowing isn't recognizable. Semantic shift between "name", "surname", "nickname"...

Table 2. Turkish-English Comparison

English	Turkish	English	Comments	Points
Death	**-L-M-** Ölüm	**-D-TH-** Death		0,00
Ear	**-K-L-K-** Kulak	**-R-** Ear		0,00
Eye	**-G-Z-** Göz	**-J-** Eye		0,00
Four	**-D-R-T-** Dört	**-F-R-** Four	Exact consonant match -R-/-R- Too weak signals! -> no point	0,00
Hand	**-L-** El	**-H-N-D-** Hand		0,00
I	**-B-N-** Ben	**-J-** I		0,00
Name	**-D-** Ad	**-N-M-** Name		0,00
Night	**-G-ZH-** Gece	**-N-T-** Night		0,00
Nose	**-B-R-N-** Burun	**-N-S-** Nose		0,00
Sun	**-G-N-SH-** Güneş	**-S-N-** Sun	Exact consonant match -N-/-N- Wrong order! (switched matches -> no point)	0,00

Three	**-CH-** Üç	**-TH-R-** Three	Related consonant match -CH-/-TH-	31,22
Tongue	**-D-L-** Dil	**-T-N-G-** Tongue	Related consonant match -D-/-T- Too weak signals! -> no point-D---T-	0,00
Tooth	**-D-SH-** Diş	**-T-TH-** Tooth	Related consonant match -D-/-T- Related consonant match -SH-/-TH-	75,78
Two	**-K-** Iki	**-T-** Two		0,00
Water	**-S-** Su	**-W-T-R-** Water	Related consonant match -S-/-T- Too weak signals! -> no point	0,00
Who	**-K-M-** Kim	**-W-** Who		0,00
Wind	**-J-L-** Yel	**-W-N-D-** Wind		0,00
You (thou)	**-S-N-** Sen	**-TH-** Thou [1]	Related consonant match -S-/-TH-	36,89

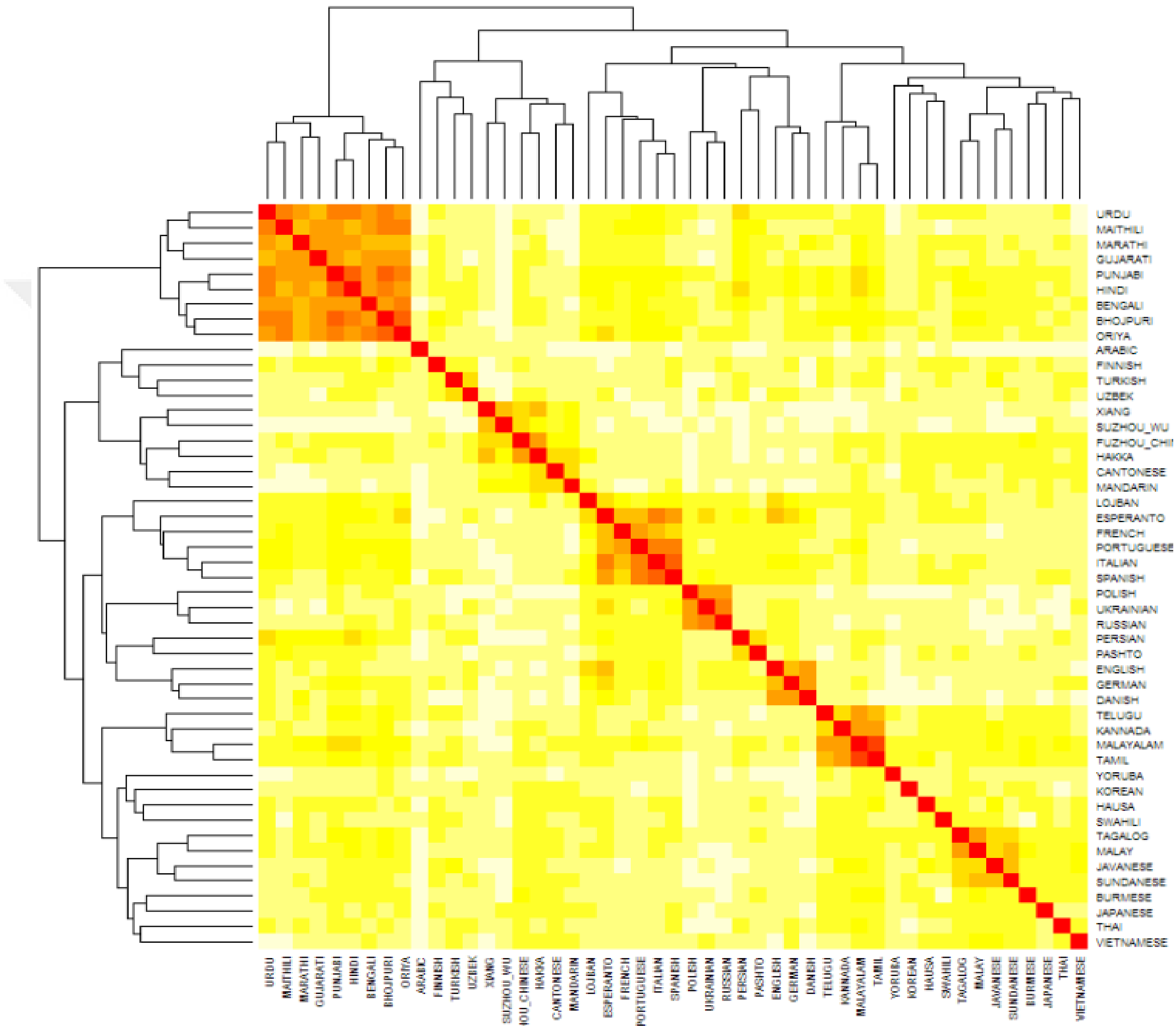
Table 2.Turkish-Arabic Comparison

English	Turkish	Arabic	Comments	Points
Death	**-L-M-** Ölüm	**-M-T-** Mawt (موت)		0,00
Ear	**-K-L-K-** Kulak	**-Z-N-** Izn (إذن)		0,00
Eye	**-G-Z-** Göz	**-7-N-** ayn (عين)		0,00
Four	**-D-R-T-** Dört	**-R-B-** Arba'a (أربعة)	Exact consonant match -R-/-R- Too weak signals! -> no point	0,00
Hand	**-L-** El	**-J-D-** Yad (يد)		0,00
I	**-B-N-** Ben	**-N-** Ana (أنا)	Exact consonant match -N-/-N-	50,00
Name	**-D-** Ad	**-S-M-** Ism (اسم)		0,00
Night	**-G-ZH-** Gece	**-L-L-** Laila (ليل)		0,00
Nose	**-B-R-N-** Burun	**-N-F-** Anf (أنف)		0,00
Sun	**-G-N-SH-** Güneş	**-SH-M-S-** Shams (شمس)	Related consonant match -SH-/-S- Too weak signals! -> no point	0,00
Three	**-CH-** Üç	**-TH-L-TH-** Thalatha (ثلاثة)	Related consonant match -CH-/-TH- Too weak signals! -> no point-CH---TH-	0,00
Tongue	**-D-L-** Dil	**-L-S-N-** Lisan (لسان)		0,00
Tooth	**-D-SH-** Diş	**-S-N-** Sinn (سن)		0,00
Two	**-K-** Iki	**-TH-N-N-** Ithnan (اثنان)		0,00
Water	**-S-** Su	**-M-** Ma'a (ماء)		0,00

Who	**-K-M-** Kim	**-M-N-** Man (من)		0,00
Wind	**-J-L-** Yel	**-R-H-** Rih (ريح)		0,00
You (thou)	**-S-N-** Sen	**-N-T-** Anta (أنت)	Wrong order! (switched matches -> no point)	0,00

APPENDIX C

Distance Matrix



The scale goes from red for identical langauges over yellow to white for very dissimiliar languages.

CURRICULUM VITAE

Betül Firdevs Zengin

EDUCATION

2019-2022 M.A. Psychological Science (GPA: 3.69)
Kadir Has University, Istanbul, Turkey
(Thesis title: The effects of second language proficiency and language distance on young adults executive functioning performance.)

2015 – 2019 B.Sc. Psychology (GPA: 3.64),
Biology Minor (GPA: 3.00)
Middle East Technical University, Ankara, Turkey

HONORS and AWARDS

TÜBİTAK- BİDEB scholar 2020- present
Kadir Has University Scholarship 2019-present
High Honor's in B.Sc. in Psychology, METU

WORK EXPERIENCE

Sep 2020 – present Teaching asistant, Kadir Has University
PSYC201- Research Methods
PSYC112- Developmental Psychology
PSYC202- Research Methods II

- Teaching in labs, grading assignments, mentoring groups of students in their research projects.

Aug 2020 – Feb 2021 Graduate researcher, Kadir Has University
TÜBİTAK 3501 project

- Translation of materials and eye-tracking data collection

Sep 2019- present Research assistant & Lab manager
SILAB, Kadir Has University
Studies on Language and Bilingualism

- Organization of previous research and data analysis

Aug – Sep 2018 Intern
Lider Rehabilitation Center, Gaziantep, Turkey

- worked with teachers specialized in autism and learning disabilities during classes.

- conducted sessions for immigrant children with the organizations’ psychologist.
- worked with schizophrenic students.

Jun 2017- Jun 2019	Intern Child and Adolescent Development Lab METU, Ankara, Turkey - collected data through interviews, transcribed data
Sept 2015 – Feb 2016	Private Tutor Turkish-American Association Ankara,Turkey - gave speaking classes, developed creative teaching skills

PUBLICATIONS and PRESENTATIONS

Aktan-Erciyes, A., Ünlütabak, B. & **Zengin, B.F.** (2021) Effects of second language acquisition on character introductions in 5- and 7-year-old bilingual and monolingual children’s frog story narratives, *First Language.*

Aktan-Erciyes, A., Örengül, A.Ş., Sayım, B., **Zengin, B.F.,** Atalay, E. (2019, January) *Effects of second language acquisition on character referencing in elicited narratives.* Poster session presented at 2019 Budapest CEU Conference on Cognitive Development, Budapest.