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The Complexity of the Bilingual Experience: Linguistic Variables Predict Cognition in Older Adults

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The Complexity of the Bilingual Experience: Linguistic Variables Predict Cognition in Older Adults

by

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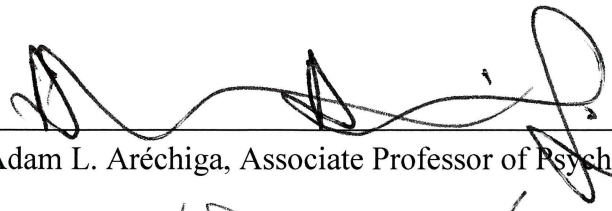
Each person whose signature appears below certifies that this dissertation in his/her opinion is adequate, in scope and quality, as a dissertation for the degree Doctor of Philosophy.



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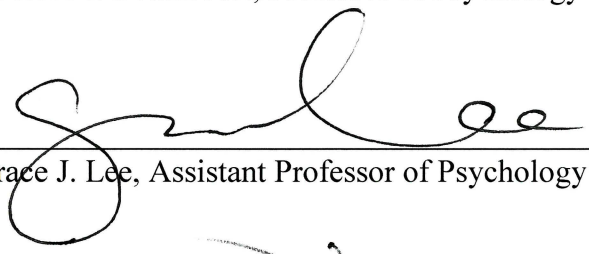

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ABBREVIATIONS

AOA	Age of Acquisition
EF	Executive Functioning
LP	Linguistic Processing
$L1^-$	First Language
L2	Second Language
SES	Socioeconomic Status
WAHA	Walnuts and Health Aging Study
LEAP-Q	Language Experience and Proficiency Questionnaire
COWAT	Controlled Oral Word Association
ANIM	Animals COWAT Subtest
BNT	Boston Naming Task
TMT-B	Trails Making Test Part B
MLR	Multiple Linear Regression
SPSS	Statistical Package for Social Sciences

ABSTRACT OF THE DISSERTATION

The Complexity of the Bilingual Experience: Linguistic Variables Predict Cognition in Older Adults

by

K'dee D. Elsen

Doctor of Philosophy, Graduate Program in Clinical Psychology
Loma Linda University, September 2019
Dr. Adam Aréchiga, Chairperson

Background: It has been estimated that more than half of the world's population is bilingual. With the rates of bilingualism exponentially growing, researchers have been increasingly interested in the effects of bilingualism on the brain. Although the literature continues to expand, it remains limited in its understanding of how the complex bilingual experience impacts cognition. **Objective:** The current study, therefore, will focus on investigating how the bilingual experience affects cognition, specifically the cognitive domains of executive functioning and linguistic processing within an older adult population. **Methods:** Participants were 144 healthy older adults (67% female) between the ages of 63 and 78. A series of hierarchical multiple linear regression analyses were conducted, including controlling for various demographic factors. **Results:** The bilingual experience significantly predicted linguistic processing, including the bilingual factors of proficiency, age of acquisition, and their interaction as significant predictors. Executive functioning was not significantly predicted by the bilingual experience. **Discussion:** Implications of the findings are discussed, as well as promising follow-up research that can be done to address the limitations and further explain the findings of the current study.

CHAPTER ONE

INTRODUCTION

The prevalence of bilingualism and multilingualism in the world is continuously and rapidly increasing. It has been estimated that more than half of the world's population is bilingual or multilingual (Grosjean, 2012). In the United States alone, a nationwide survey (American Community Survey 2007) revealed that more than 51 million Americans (~20% of the population) reported speaking at least two languages at home; indicating a rapid and dramatic 140% increase since 1980 (Shin & Kominski, 2010). Furthermore, these rates are projected to increase due to two-thirds of all American children being currently raised in bilingual homes (Bialystok, Craik, Green & Gollan, 2009). It appears as if bilingualism is no longer the exception but the norm, especially in the modern age of globalization.

The exponential growth of bilingualism is best explained by the progression of globalization. A continual interconnection of individuals, cultures, and languages has been established through technological advancements, travel, migration, and cyberspace/media for political, business, social, and/or any other reasons (Maguire et al., 2000; Bialystok, Craik, Green & Gollan, 2009; Abutalebi & Weekes, 2014). For example, the invention and expansion of social media enables an individual in the United States to communicate with someone across the globe in Japan, which previously would have been impossible or quite arduous. This interconnection has drastically impacted the linguistic world. As Blommaert (2010) commented in her book on the sociolinguistics of globalization, "…the mobility of people also involved the mobility of linguistic and sociolinguistic resources…" (p. 4). With globalization and its simultaneous growth of

bilingualism, researchers have not only recognized the consequences of bilingualism, but have been increasingly interested in its study; with a special interest of its effect on the brain.

The research of bilingualism and the brain has been expansive and evolving over many years. From simple questions of whether its effects on cognition were beneficial or negative to more detailed questions of how specific linguistic factors (e.g., age of acquisition, AoA) affect the brain. Although the literature continues to grow and expand, it remains limited in its understanding of how a more holistic bilingual experience—including it being complex and multifaceted—impacts cognition. The current study, therefore, will focus on investigating how multiple key linguistic factors that make up a more holistic bilingual experience affect cognition, specifically looking at the domains of executive functioning (EF) and linguistic processing (LP), which have been emphasized by the literature. Furthermore, with the high concern for the growing older adult population and the aging brain and the growing literature supporting a possible neuroprotective effect of bilingualism (Wilson et al., 2002; Daffner, 2010; Gold, Kim, Johnson, Kryscio & Smith, 2013), we will be studying the bilingual experience in an older adult population.

CHAPTER TWO

BACKGROUND

As previously stated, the research on the effect of bilingualism on the brain has been growing and rapidly developing. Throughout the numerous years of study, much debate, confusion, and controversy has risen. Although the field has generally reached a consensus, questions remain. The developmental history of the research, therefore, will be first discussed, followed by the current stance of the literature and the remaining unaddressed questions.

History of Bilingualism Research

In the developmental history of bilingualism research, whether or not language had an effect on the brain was never the question at hand; rather, the debatable question was whether bilingualism had a positive or negative impact on the brain. The answer to this question, however, was not always clear; with it being often manipulated by the zeitgeist or the ethnic diversity climate of its time (Fitzgerald, 1993). For instance, a general societal consensus in the U.S. was established on a positive acceptance of bilingualism whereas, a notable shift began to take place from the 1880's to 1920's.

Detrimental Effects

Following the societal view of the 1920's, many key research studies concluded that the consequences of bilingualism were not only negative, but also detrimental to cognition (Smith, 1923; Saer, 1923; Yoshioka, 1929). The literature demonstrated a consistent trend of monolinguals (interchangeable for monoglot or unilingual) outperforming bilinguals (polyglot) on standard intelligence tests. However, it is

important to note that this conclusion of inferior intelligence was established on the basis of two main studies (Saer 1923; Smith 1923).

The first study, conducted by Saer (1923) at a university in Wales, investigated the differences between 1,400 monoglots and bilinguists on Stanford-Binet intelligence tests. After testing the students, Saer concluded that monoglots performed significantly superior in comparison to their bilingual counterparts. Although apparently conclusive, it is vital to highlight that these significant differences were only found when comparing the language groups who lived in rural settings (no significance was found when comparing those in urban settings), as well as only applicable to specific academic areas (e.g., dextrality, rhythm, vocabulary, etc.).

The second historical study that concluded that the effects of bilingualism were disadvantageous on cognition was Smith's (1923) study. Similar to Saer (1923), Smith compared monolinguals with bilinguals in Wales with the difference of studying its effects over the span of 2 years in school-aged children (8 to 11). The results concluded that over the 2-year span the monoglot children made better progress, specifically in expression, vocabulary, and thought accuracy. As a result of these studies and others, the zeitgeist of the early 1900's began to shift and bilingualism was established as having a detrimental impact on intellectual functioning; with some researchers even suggesting possible mental retardation and referring to it as the "handicap of bilingualism" (Darcy, 1963).

Several studies were subsequently published, and although ensuing with mixed or non-significant results, they were interpreted with this negative prevailing view of bilingualism. For example, Pintner's (1932) study found that when comparing

monolinguals and bilinguals on two tests in three schools that monolinguals were superior on one test in two schools, inferior on the second test in those same two schools, and performed no differently on either test in the third school. Although both contradicting and non-significant findings, Pintner concludes that these findings support the view of the bilingualism handicap. Various studies followed and were added in support of the rally against bilingualism.

The Decisive Shift Towards Advantageous Effects

It was not until the 1960's where a notable shift began to take place in support of bilingualism. Of the most noteworthy articles was Peal and Lambert's (1963) review on "The Relation of Bilingualism to Intelligence." In this article, the preceding literature (including the studies aforementioned) was critically analyzed and revealed significant methodological limitations that questioned the validity of their conclusions. The soundness of the argument of the disadvantageous bilingualism was first evaluated, and it was found that bilingualism and intelligence were not accurately operationalized. For example, in reviewing Pintner's study (1932), a major limitation was uncovered in its operationalization of bilingualism. Bilingualism was erroneously defined by merely looking at the child's name.

Continuing the analysis of the literature, Peal and Lambert (1963) also discovered that most (if not all) of the studies failed to control for critical variables that have been found to confound with language, such as immigration, age, and non-verbal versus verbal intelligence tests (Guzmán-Vélez & Tranel, 2014). The authors, therefore, conducted their own study to address both the methodological concerns for operationalization and

confound variables. The results indicated that instead of monolinguals outperforming bilinguals, bilinguals demonstrated superior performance on both the verbal and non-verbal intelligence tests. Publication of these findings, as well as the critique and limitations of the previous studies, began to not only change the zeitgeist, but also direct future researchers on the method of accurately investigating the effects of language on the brain.

Following Peal and Lambert's study (1963), a growing number of studies were conducted and found to also support the new advantageous position; and with no other possible limitations to address, the debate appeared to have been resolved. Researchers, therefore, instead of focusing on whether or not bilingualism was detrimental, shifted their focus of study to answer the question of "how" it was beneficial. While on this new research path of discovering the specific beneficial effects, however, selected studies discovered a contradictory bilingual disadvantage (Paap & Greenberg, 2013; Paap & Liu, 2014; Ansaldo, Ghazi-Saidi & Adrover-Roig, 2015).

Researchers who still supported a bilingual disadvantage argued that the drastic shift in support of bilingualism resulted in a publication bias and file-drawer problem; implying that only the studies that supported bilingualism were being published and those against bilingualism were not being published (Bruin, Treccani & Salar, 2015). Other researchers, in comprehensively analyzing the literature, came to the conclusion that both arguments were correct—that bilingualism had both a negative and positive impact on the brain. They posited that the bilingual experience is complex; and therefore, its effect must depend on numerous varied factors (e.g., cognitive domain, linguistic factors, demographic factors, etc.).

Bilingualism and Cognitive Domains

Most of the discrepancies and seeming contradictions in the literature were first and best explained by how the impact of bilingualism on the brain depended on which cognitive domain was being studied. More specifically, researchers began to recognize two major trends of bilingualism—that the two major findings, positive or negative effects, were based on the two major cognitive domains of linguistic processing and executive functioning (Bilaystok, Criak & Luk, 2012).

Linguistic Processing

The first major trend in the literature is a bilingualism disadvantage for the domain of linguistic processing ("LP", also known as verbal processing; Mindt et al., 2008). The results have indicated various decrements for bilinguals on a wide variety of linguistic abilities. For example, bilinguals often exhibit limited vocabularies (Perani et al., 2003; Portocarrero, Burright and Donovick, 2007) that result in further deficits of enhanced difficulty in word comprehension and production (as evidenced by more tip-of-the-tongue experiences; Gollan & Silverberg, 2001), fluency tasks (letter and category; Gollan, Montoya, & Werner, 2002; Rosselli et al., 2000), picture-naming (both in delayed and erroneous responses; Gollan, Montoya, Fennema-Notestine, & Morris, 2005; Roberts, Garcia, Desrochers, & Hernandez, 2002), and numerous others. To ensure actual LP deficits in bilinguals, Bialystok and her colleagues (2009) conducted a study that eliminated any potential confounds of the language of the test. For example, the bilingual participants were tested in their native and dominant languages, allowed to respond in either of their preferred languages, and were even given phonemic and semantic cues to

trigger responses. The results showed that the bilingualism disadvantage persisted even with these accommodating testing conditions (Bialystok, Craik, Green, & Gollan, 2009). Additionally, when testing linguistic processes in older adults, the data showed that the decrements persisted with aging (Gollan, Fennema-Notestine, Montoya and Jernigan, 2007).

Although a continuous trend in the literature, researchers are uncertain as to why bilinguals exhibit such deficits in verbal fluency. Some researchers posit the "weaker-links hypothesis," which suggests that the deficits are due to the low utility of each language that in turn results in weaker links and connections within the language network (Gollan et al., 2008). Other researchers hypothesize a theory based on high utility, but more specifically, suggest a competition between the utilization of both languages (Mindt et al., 2008). Instead of one language being activated during a conversation (monolinguals), bilinguals have both languages simultaneously activated. Therefore, in a context that requires the use of only one language, bilinguals must inhibit the nontarget language in order to successfully engage in their target language (Kroll, Bobb, Misra, & Guo, 2008; Bialystok, Craik, & Luk, 2012). Although this process may result in a difficulty of lexical access, it can also result in enhanced inhibitory control, which explains the second major trend of the literature: the positive effects of bilingualism on executive functioning.

Executive Functioning

Executive functions refer to a broad range of higher-level cognitive processes involved in planning, organizing, decision-making, strategizing, inhibiting, and

controlling, and are carried out by the frontal lobe and prefrontal cortex (Lezak, 1995; Alvarez and Emory, 2006; Daffner, 2010; Drag and Bieliauskas, 2010). As previously mentioned, the bilingual brain requires executive control functions to inhibit the nontarget language and attend to the target language in a monolingual context (Kroll, Bobb, Misra, & Guo, 2008; Bialystok, Craik, & Luk, 2012). In a bilingual context, executive controls are also utilized, including monitoring and task switching, which allows the speaker to switch from one language to another. Due to this continual utilization of executive functions, regardless of the context, a consistent and reliable advantage has been found for bilinguals (Kirk et al., 2014; Ansaldo, Ghazi-Saidi & Adrover-Roig, 2015). Furthermore, it is of value to note, that although executive functions (unlike linguistic processes) decline during the aging process, the research shows a steady bilingual advantage for executive functions in later adulthood (Bialystok, Craik, Klein and Viswanathan, 2004).

The Bilingual Experience and Cognition

Another key factor to consider when understanding and explaining the apparent contradictions of the bilingualism research is the complex bilingual experience, starting with its operationalization. As Peal and Lambert (1963) highlighted in their research, many studies poorly, if at all, define bilingualism. This variation is due to the real-world complexity of the bilingual experience and the availability of specific study samples. For example, some studies have defined bilingualism as an equal daily engagement of both languages (i.e., balanced bilingualism) due to being in a region where both languages are in constant usage (e.g., Spaniards equally utilizing both Spanish and Catalan); whereas

others have defined it as simply knowing two languages (e.g., imbalanced) due to being more in an acculturated region due to high rates of immigration (i.e., Americans utilizing English, and at times Spanish; Bialystok, Klein, Craik & Viswanathan, 2004; Bilaystok, Martin & Viswanathan, 2005; Kavé, Eyal, Shorek & Cohen-Mansfield, 2008). Consequently, although both groups are defined as "bilingual," there are significant differences that may result in different cognitive outcomes.

Various recent studies have recognized these methodological differences and have begun to investigate how bilinguals and their outcomes differ based on these linguistic variables. For example, a common question that has been posed by researchers in the recent literature is: Do bilinguals differ if raised bilingual (often referred to as early bilinguals or early onset) when compared to those acquiring a second language (L2) later on in their lives (i.e., late bilinguals or late onset; Luk, De Sa & Bialystok, 2011; Pelham & Abrams, 2014)? Other common questions in the research have focused on proficiency, utilization of a language, and others that will be further discussed below. These questions, although beneficial in further teasing apart the effects of bilingualism on cognition, continue to solely focus on select linguistic factors while ignoring others.

If the experience of bilingualism is multifaceted and complex, as previously touched upon, these factors should be studied collectively as a holistic experience. In a 2017 review on the impact of the bilingual experience on the brain, Bialystok discusses the power of enriching and stimulating experiences on both the brain and cognition. She supports this idea by referencing the impact of impoverished environments (e.g., low SES) on brain volume, structure, and cognitive processes (Noble, Houston, Kan, & Sowell, 2012); and even the impact of environments like musical and juggling training

(Lappe, Trainor, Herholz, & Pantev, 2011; Peretz & Zatorre, 2005; Draganski et al., 2004). Bialystok (2017) argues that not only were these general environments influential on the brain, but that the bilingual experience "is the most intense, sustained, and integrative experience in which humans engage;" and therefore, impacts the brain and cognition in a most powerful and unique way (p. 233). Although other studies have hinted at the importance of the whole experience by testing different linguistic factors like AoA, proficiency, and others, few studies have examined the actual impact of the experience. Although we will be utilizing these studies that have looked at these key individual factors, the current study will be examining the real-world complexity of the bilingual experience and how it affects cognition.

Age of Acquisition

One of the most commonly studied linguistic factors of the bilingual experience and its effects on the brain is age of acquisition (AoA); the age that one begins to acquire a language (most studies coining AoA as "early" vs. "late;" Hernandez & Li, 2007). In delineating a specific age or a "critical period" at which effects on the brain take place, the research studies have been inconclusive (Lenneberg, 1967; Mayberry, 1993). Some researchers generally defining the critical period anytime "after puberty" (Kim, Relkin, Lee, & Hirsch, 1997) while others defining it more specifically (e.g., any time after 7 years old, Flege, Yeni-Komshian, & Liu, 1999; or defining "early" as before age 4 and "late" after age 10, Perani et al., 1998). Although the trend of the literature at first appears to suggest that early acquisition results in enhanced cognition (Luk, De Sa & Bialystok, 2011; Pelham & Abrams, 2014), some studies have demonstrated mixed results. In a

study investigating the effects of bilingualism on cognitive aging, Bak and colleagues 2014 found a positive effect, including cognitive advantages for those who acquired L2 in late-adulthood (i.e., slowed cognitive decline in the "late" bilinguals). Regardless of these discrepancies, the research supports AoA as playing a role in the bilingual experience and in affecting cognition.

Similar to the effect of bilingualism on the brain, outcomes depend on the cognitive domain of study. Perani and colleagues (1998) studied the effect of AoA on LP and found mixed results. When comparing early and late bilinguals, a L2 deficiency, in both phonology and morphology, was found for late bilinguals; however, there were no differences in regards to lexicon, which was found to remain intact for both early and late bilinguals. Brown and Watson (1987) found differences in the effects of AoA on word naming, with early bilinguals producing enhanced performances. Carroll and White (1973) and Ellis and Morrison (1998) also found differences of AoA on object naming, especially in speed, with early bilinguals naming objects more quickly. These studies, and their various outcomes, emphasize the importance of not only defining which cognitive domain is being assessed, but also what function of that domain is being studied, especially when studying LP.

Similar to the LP findings initially appearing to be inconclusive due to dependency on the function(s) at study, the outcomes of EF also rely on various factors. In studying cortical representations of native and second languages in early and late bilinguals, Kim and colleagues (1997) discovered that both languages (L1 and L2) activated the frontal cortical areas in early bilinguals, while the two languages were spatially separated in late bilinguals; however, there were no AoA-related differences in

activation of the Wernicke's area. These findings suggest enhanced EF in the activated frontal regions for early bilinguals compared to late bilinguals, as well as no difference between groups in LP. This finding of enhanced EF is often explained by stating that early bilinguals have to constantly monitor and shift between their two languages for a longer span of time compared to late bilinguals. However, some researchers have found enhanced executive functions among late bilinguals and they argue that late bilinguals have enhanced EF due to increased use of inhibiting interference from L1. Both of these seemingly contradictory findings were confirmed by Tao and colleagues (2011), which indicated that both early and late bilinguals were found to both have enhanced executive functions. Early bilinguals were found to have a stronger executive function of monitoring, while late bilinguals were found to have an advantage in conflict resolution. These outcomes of the impact of AoA were also found to be dependent on linguistic factors, such as proficiency and usage (Zevin & Seidenberg, 2002).

Proficiency

Proficiency, the degree of competence in or mastery of a language, has been strongly linked to cognition, with a general trend of higher proficiency resulting in enhanced cognition (Perani et al., 1998). Before discussing the evidence for and against these findings, it is first important to discuss the relationship previously mentioned between proficiency and AoA. Various studies have established a negative correlation between AoA and proficiency; the older an individual is when acquiring a second language, the lower his or her proficiency level (Johnson and Newport, 1989; Flege et al., 1995; Weber-Fox and Neville, 1996). As previously mentioned, Perani and colleagues

(1998) found no effect of AoA on brain representations when controlling for proficiency, and that attained proficiency was a stronger predictor than AoA. However, most studies solely focus on the effects of one without controlling or accounting for the other. It is imperative for studies to measure both and incorporate both in the analysis of the effect of bilingualism on cognition.

In analyzing the individual effect of proficiency on cognition, researchers have found a positive relationship. More specifically, a positive correlation has been established between L2 proficiency and various executive functions (e.g., inhibitory control; Iluz-Cohen and Armon-Lotem, 2013). In utilizing the Stroop task, a widely used measurement of EF, multiple studies found that bilinguals with higher levels of proficiency performed better than those with lower levels of proficiency (Zied et al., 2004; Singh & Mishra, 2012; Tse & Altarriba, 2012). In addition to overall better Stroop performance in these studies, high-proficient bilinguals demonstrated faster and more accurate reaction times and better control of the Stroop interference. Although many studies have been conducted on the relationship between proficiency and EF, no studies have yet to investigate the specific effect of proficiency on the domain of LP. Additionally, limited studies that highlight the various components of proficiency—including, but not limited to speaking, reading, listening, and writing—have investigated the specific effects of these subcomponents on cognition (Hernandez & Li, 2007).

Exposure/Usage

Along with the importance of distinguishing between the effects of AoA and proficiency on cognition, Dong & Li (2015) also emphasized how future studies should

investigate the effects of the amount of exposure/usage of a language. Before discussing the literature on these variables, it is important to note that they are independently often poorly defined and collectively used interchangeably. Some researchers define exposure as the length of time that the individual has been exposed to L2 (e.g., in a school, work, or other environments), and usage as the frequency of use; although again, at times they are used loosely and interchangeably (Bialystok & Barac, 2012: Luk, de Sa & Bialystok, 2011). On a study investigating the impact of both age and exposure on the Stroop task, Zied and colleagues (2004) discovered that bilinguals who were more frequently exposed to and utilized both of their languages had faster reaction times in comparison to lower-exposure and usage bilinguals, regardless of age.

In comparison to the other bilingual factors, exposure/usage has been considered one of the best predictors. When comparing AoA with usage on EF, Salvatierra and Rosselli (2010) demonstrated the larger impact of utilization on inhibitory control by showing an advantage in EF even in late bilinguals when engaging in both of their languages frequently. Carlson and Meltzoff (2008) found a similar result of enhanced EF (increased conflict resolution) in bilingual children who acquired both languages from birth and used/exposed to both languages more when compared to children who acquired L2 in kindergarten and utilized/exposed to both languages less. Researchers explain that if both languages are utilized and activated more, then a bilingual's need to inhibit a non-target language is also required, resulting in enhanced inhibition.

Depending on the categorization of usage/exposure, however, studies can result in mixed or non-significant findings. For example, Bak and colleagues (2014), in comparing low vs. high utilizers (categorized as "passive" versus "active" bilinguals), discovered

little to no difference in cognition. The researchers attributed this non-significant finding to the low frequency of L2 usage for the active bilinguals. Although minimal studies investigate the effect of usage/exposure on LP, an early study conducted by Fishman and Cooper (1969) demonstrated that proficiency and usage were the best predictors for linguistic ratings in a Puerto Rican sample, including the interaction of the two variables.

The Current Study

Population of Study

We have discussed the importance of considering the effect of bilingualism on cognitive domains, as well as the importance of studying the bilingual experience as a whole. Another key factor to keep in mind is age, and the current population of study: older adults. Although the current study does not investigate age as a variable, it does have an effect on the brain; and therefore, it is important to keep in mind as we investigate how the bilingual experience impacts both EF and LP.

An Older Adult Population

Older adults are both the fastest growing and most vulnerable segment of our population with approximately 841 million worldwide (United Nations 2013 Report). Not only is this rapid growth concerning, but of particular concern is the associated consequences of aging, including both normal deleterious aging of the brain (e.g., cognitive decline) and pathological aging (e.g., Alzheimer's disease and other dementias; National Institute on Aging, 2007; Fabiani, 2012). Due to the threat aging poses on the brain and overall quality of life researchers have continuously investigated what factors can either avert or reduce its harmful effects; including bilingualism and its possible

neuroprotective effect (Wilson et al., 2002; Bialystok, Craik, Green & Gollan, 2009; Daffner, 2010; Gold, Kim, Johnson, Kryscio & Smith, 2013).

Bilingualism and the Aging Brain

Due to the initial concern of the detrimental effects of bilingualism on intelligence (previously discussed), the vast majority of studies on bilingualism have been conducted on school-aged children or university students (Smith, 1923; Saer, 1923; Yoshioka, 1929). As the field progressed, especially in light of possible neuroprotective effects, researchers began studying other populations. Of special importance were populations with the most vulnerable and sensitive brains: infants and older adults (Kovács & Mehler, 2009; Bialystok, Martin, & Viswanathan, 2005). These studies on the various populations indicated similar "it depends" results, but instead of dependence on cognitive domain or specific language factors, the effects (positive, negative, or non-significant) varied based on the age. A summary of the results on the relationship between age and bilingualism demonstrates a bilingualism advantage found in childhood, silenced in adulthood, and most prominent for older adults (Bialystok, Klein, Craik, & Viswanathan, 2004; Bialystok, Craik, & Ryan, 2006; Bialystok, Luk, & Craik, 2012; Bialystok, Poarch, Luo, & Craik, 2014). Furthermore, these studies demonstrated that the bilingual advantage of enhanced EF appears earlier on in childhood years, is reserved more proficiently in adulthood years, and declines less in the older adult years; which attests to bilingualism being an experience that extends throughout the lifespan and suggests possible contribution to cognitive reserve.

Numerous studies have also solely investigated the effects of bilingualism on the brains of older adults. For instance, studies on the structure of the brain have found

several advantages including: counteracted age-associated neural efficiency declines (Gold, Kim, Johnson, Kryscio, Smith, 2013) and reduced age-associated white matter integrity loss in the corpus callosum (Luk, Bialystok, Craik & Grady, 2011). Researchers also discovered functional advantages due to bilingualism. For example, findings showed enhanced anterior-posterior functional connectivity (suggesting more brain reserve) in bilingual older adults compared to monolinguals (Bialystok, Craik & Luk, 2012).

Researchers have also discovered a bilingualism advantage in the context of pathological aging. Several studies have validated the finding that symptoms of mild cognitive impairment (MCI) and other types of dementia (e.g., Alzheimer's disease) are delayed by about five years in bilinguals compared to monolinguals; which they posited were due to the enhanced bilingual brain (Ossher, Bialystok, Fergus, Craik, Murphy & Troyer, 2012; Bialystok, Craik & Freedman, 2007). Although these studies demonstrate a positive effect of bilingualism in the context of pathological aging, it is important to note its possible confounding effect; therefore, the current study will be studying a healthy older adult population.

An Acculturated Sample

Majority of the aforementioned studies, as well as in the whole bilingualism research field, conduct studies utilizing samples with bilinguals who have acquired L2 early, and are high in levels of proficiency and usage. Although the implications of these studies are highly useful, especially for many predominantly balanced bilingual countries, with the increase of globalization and acculturation, more studies should be investigated with predominantly unbalanced bilinguals in order to provide implications for other

countries. Americans are a prime example of this type of sample. Although no census has been gathered on what percentage of the American population are balanced, general statistics suggest that the majority of American bilinguals are imbalanced. According to the American Community Survey Report (2007), 19.7% reported speaking a language other than English at home, with the majority of this population (55.9%) rating their English-speaking ability as "very well." The current study will investigate the experience of bilingualism in the context of an acculturated sample.

Aims and Hypotheses

The purpose of the current study is to examine the impact of the bilingual experience on cognition in bilingual older adults; more specifically, looking at both the individual and collective effects of linguistic bilingual factors on the domains of linguistic processing and executive functioning. The first aim of the study is to test the collective effect of the bilingual experience (age of acquisition, proficiency, past exposure and current usage) on LP and EF. Given the research on the power of environment and experience, we hypothesize that the overall collective bilingual experience will significantly predict LP and EF. The second main aim of the study is to explore the individual effects of each bilingual factor as predictors of performance on each domain. Due to the inconclusive and limited research, we predict that at least proficiency and exposure/usage will be predictors, while all other factors will be exploratory. It is hypothesized that bilinguals with higher levels of proficiency will have lower LP performances and higher EF performances; and bilinguals with more exposure/usage will have lower LP performances and higher EF performances. Lastly,

we will be exploring the possible combined interactional effect of proficiency and exposure/usage has on cognition, predicting worsened LP and enhanced EF performances for higher levels of proficiency, more years of past exposure, and higher current usage.

CHAPTER THREE

MATERIALS AND METHOD

Participants

General Demographics

Participants were 144 healthy older adults (67% female) between the ages of 63 and 78 (M = 69.80, SD = 3.70) who reported being bilingual or multilingual. The sample was 79.7% Caucasian, 8.3% Hispanic, 7.2% African American, 3.7% Asian, and 1.1% "Other". Participants had a mean of 16.40 years of education (SD = 2.89).

Linguistic Demographics

Of the 144 participants, 103 reported speaking two languages (71%), 33 three languages (23%), and eight reported speaking four or more languages (6%). The languages known included a large variety with the most common being Spanish, German, French, Chinese, and Filipino (including various dialects like Tagalo and Visayan). The majority of the participants learned their additional language(s) from either immigrating (N = 47) to the U.S. including the most common: Mexico, Germany, China, and the Philippines; or from emigrating from the U.S. to the most common countries including (N = 28): Japan, Germany, Mexico, Peru, and Pakistan. Although a large number of the multilingual sample immigrated to the U.S., most participants reported English as their dominant language (~98%). In order to obtain a more homogeneous sample, only participants for whom English is their dominant language were included in the analyses. Participants reported that they acquired their first language (English) at birth, the second language at a mean age of 13 (SD = 10.04), and the third language at a mean age of 20 (SD = 11.54). Lastly, proficiency ratings of speaking, reading, and understanding varied

throughout the sample. The average speaking proficiency rating for participants' first language (English) was 8.35 (*SD* = 1.50), understanding (*M* = 8.70, *SD* = 1.32), and reading (*M* = 8.53, *SD* = 1.78). For additional languages speaking proficiency rating was 4.99 (*SD*= 2.98), understanding (*M* = 5.82, *SD* = 2.84), and reading (*M* = 5.40, *SD* = 3.12).

Procedures

General WAHA Longitudinal Study

The Walnuts and Health Aging Study (WAHA) is a two-year longitudinal study investigating the effects of walnuts on healthy aging, including its effects on physical health and cognition. The study was conducted in two separate locations: Loma Linda, California and Barcelona, Spain with the current study utilizing data from the Loma Linda location. The study includes three main stages: the recruitment and screening, randomization, and data collection.

In the recruitment stage, participants were first recruited in the Southern California area by mass mailing and distribution of brochures, and advertising through newspapers, newsletters, posters, website/e-mails, and presentations at churches and senior centers. Individuals interested in participating were enrolled by filling out an initial screening form on the web, phone, or through the mail to further assess their eligibility. Eligibility was assessed by the following: must be (a) 60 to 80 years old; (b) reasonably healthy; (c) read and write English; (d) available every two months to visit Loma Linda University; and must not (e) be extremely obese; (f) have uncontrolled diabetes or hypertension; (g) have suffered a tragic loss in the past year; and (h) be allergic to walnuts. It is important to note criteria (c) in context of the current study. Individuals who

passed the pre-screening and were deemed eligible were given further information about the study and were asked to sign the informed consent form as an acknowledgment of the purpose and requirements of the study. After consent had been given, baseline data of the participants were collected; which included basic demographic information and physical/mental health questionnaires, blood and urine collection, eye exam results, and cognitive assessments.

In the randomization stage, participants were systematically sampled and randomly assigned to either the experimental condition of eating walnuts or to the control condition of a walnut-free diet. Furthermore, to exclude the possibility of other confounding effects of other nuts, all nuts were excluded from the diets of participants assigned to the control condition.

In the data collection stage, which spanned over two years, multiple health assessments were conducted. For example, dietician visits every two months (including anthropometric measurements) and most important to the current study, an extensive battery of cognitive assessments was given pre-condition (baseline) and post- (after the two-year follow up). The battery included a variety of different cognitive assessments in order to assess different cognitive functions including, but not limited to: executive, learning and memory, processing speed, and verbal fluency, as well as screeners for depression and dementia. All assessments, questionnaires, and procedures were reviewed and approved by the Loma Linda University Institutional Review Board.

Current Study

For the current study, participants were interviewed one-on-one to assess their language experience and proficiency profiles. The interviews averaged five to ten minutes for monolinguals, 15 minutes for those who indicated speaking two languages, and <30 minutes for those who indicated speaking more than two languages. The current study utilized the baseline, cross-sectional data of the WAHA study's cognitive assessments previously discussed. Four of the measures were analyzed to assess the cognitive domains of EF and LP.

Measures

Demographic Characteristics

Participants were asked to report their age, sex, race/ethnicity, number of years of education, immigration status, and socioeconomic status (SES). Immigration status was measured by the language experience questionnaire (see Appendix for full questionnaire). Participants were asked whether they immigrated to the U.S. or to another country, as well as year(s) of immigration. Participants that immigrated to the U.S. or to another country were both included in coding "yes" immigrated. Socioeconomic status was assessed by asking participants' annual combined household income prior to retirement.

Bilingual Experience

The Language Experience and Proficiency Questionnaire (LEAP-Q) (Marian, Blumenfeld, & Kaushanskaya, 2007) is a self-reported questionnaire that assesses for a participant's full linguistic background including, but not limited to: language

dominance, culture identification, factors contributing to learning, age of acquisition, levels of proficiency, and exposure to various environments (see Appendix A for full questionnaire). The LEAP-Q was also used to generally assess how many language(s) a participant knows, and then categorize those who responded "only one" as monolinguals, those who responded "two" as bilinguals, and those who responded three or more as multilinguals. It is important to note, that subjective measures of self-reported linguistic experience and proficiency have been supported as valid and effective measures of bilingualism (Marian, Blumenfeld, & Kaushanskaya, 2007; Luk & Bialystok, 2013).

Age of Acquisition

More specifically, the LEAP-Q also assessed for the age of acquisition for each language reported. Participants were asked to provide the age at which they first began to acquire the language in question. For example, participants reported L1 acquisition of language to have started at birth. Age of acquisition is not to be confused with the other similar questions the LEAP-Q asks regarding age of acquired fluency, both in speaking and reading.

Proficiency

Levels of proficiency were also assessed by the LEAP-Q. The questionnaire asks participants to rate their levels of proficiency for each language on a scale from 0 to 10 (0 not at all proficient to 10 being the most proficient) for each provided language. Proficiency is further divided into three variables of level of proficiency including reading, speaking, and understanding (all measured on the same 0 to 10 scale).

Subcomponents of the various linguistic factors (levels in reading, speaking, understanding) were not included due to high correlations between the subcomponents and were instead combined into one overall averaged proficiency score for each language. Overall proficiency scores for each language were calculated by separately averaging all three levels first for L1 and secondly for L2.

Exposure

Participants were also asked to report their past and current exposure to each language. Participants first report their past exposure to a language in the number of years one was exposed to that given language, which is then further divided into three environmental exposures: family, work/school, and living in a country. Current exposure, on the other hand, is measured in percentages by having participants report how much they are currently and on average exposed to each language (must add up to 100%). For example, a person is currently exposed to Spanish in their workplace (60%) and English when he or she goes home (40%). It is important to note and distinguish the difference between these specific bilingual experience variables when considering whether the variables describe an individual's L1, L2, et cetera experience, as previously discussed.

Linguistic Processing

Linguistic processing was assessed using the semantic fluency (Animals) and phonemic fluency (FAS) subtests of the Controlled Oral Word Association Test (COWAT; Butler, Retzlaff, & Vanderploeg, 1991), and the Boston Naming Task (BNT; Kaplan, Goodglass, & Weintraub, 1983). For the COWAT animals test, the participants

were given the semantic category of animals and asked to name as many animals as quickly as possible with a limit of 60 seconds. The COWAT-FAS also gives participants 60 seconds, but for each letter (F, A, and S). Participants are required to name as many words that begin with that letter as quickly as they can. On both subtests, raw scores reflect the total number of correct words participants were able to provide within the time limit.

For the BNT, participants were shown one picture at a time for a maximum of 20 seconds (total of 60 pictures). Participants were required to provide the most common name for each picture and if needed, were given one prompt or phonemic cue. The total number of correct identifications without any cue given was used to assess participants' linguistic processing. Higher scores on the BNT indicated better performance.

Executive Functioning

Executive functioning was measured by two tasks: the Stroop Color-Word Test (Golden, 1978) and the Trails Making Test Part B (TMT-B; Reitan & Wolfson, 1985). The Stroop task consists of a page of color words (i.e., "red", "green", "blue") printed in a different colored ink and require participants to name the color of the ink the word is printed in rather than the word itself. Therefore, the participants must utilize executive controls to ignore the more automatic response of reading the word to instead focus on providing the color of the ink. Participants' performances were measured as the number of correct items completed in 45 seconds. These raw scores were then converted to t-scores with higher t-scores indicating better performance.

The TMT-B task consists of 25 circles including both numbers and letters on a sheet of paper and requires participants to draw a line alternating between numbers and letters and in ascending order (i.e., starting at 1, 1-A-2-B-3-C and so on, until they reach the circle marked "END"). Participants are given a maximum time limit of 300 seconds. Errors are not recorded, but are expected to affect the completion time. Participants' performances were recorded in seconds, with higher scores indicating poorer performance. TMT-B scores, therefore, were reversed to aid interpretation in higher scores then indicating better performance.

Data Analysis

Preliminary analyses, testing and correcting for outliers, bivariate relationships, and testing for assumptions, were first conducted (see Table 1 below for correlations). Outliers and the assumptions of Multiple Linear Regression (MLR) were corrected and adjusted for. A series of hierarchical MLR were conducted to test whether the multiple linguistic factors of the bilingual experience (age of acquisition, current usage, proficiency, and past exposure) are significant predictors of cognition, both of executive functioning and linguistic processing. Control variables of age, sex, education, immigration status, and SES were entered in step one of the model; L1 linguistic factors were entered in step two (L1 proficiency, current usage, past exposure); and L2 bilingual factors were entered in step three, along with interaction effects (L2 proficiency*past exposure and past*current exposure). Model 1 included these variables predicting linguistic processing as a composite and model 2 included variables predicting executive functioning as a composite. Composite scores were generated by first converting the raw

and t-scores of the five cognitive assessments to standardized z-scores based on published norms and then taking the sum of all subtests within each domain: LP (ANIM, FAS, and BNT) and EF (Stroop and TMT-B). Lastly, simple linear regression models were conducted to test whether the bilingual experience also predicted the individual LP an EF subtests. All statistical analyses were performed using SPSS (IBM version 22).

Table 1. Correlations of L2 linguistic factors, cognitive composites, and individual cognitive domains.

	Correlations												
Variable	1	2	3	4	5	6	7	8	9	10	11	12	13
1. L2 Age of Acquisition	-												
2. L2 Proficiency	.38**	-											
3. L2 Current Usage	-.17*	.33**	-										
4. L2 Past Exposure	-.40**	.76**	.24**	-									
5. L2 Proficiency x Past Exposure	-.39**	.79**	.26**	.99**	-								
6. L2 Current Usage x Past Exposure	-.22**	.52**	.70**	.59**	.61**	-							
7. LP Composite	.10	-.20*	-.14	-.19*	-.16	-.22**	-						
8. LP: ANIM	.07	-.16	-10	-.18*	-.14	-.15	.79**	-					
9. LP: FAS	.04	-.15	-.09	-.10	-.08	-.12	.82**	.43**	-				
10. LP: BNT	.16	-.20*	-.26**	-.20*	-.19*	-.37**	.67**	.30**	.41**	-			
11. EF Composite	-.04	.09	-.01	.04	.07	-.06	.10	.01	.16	.04	-		
12. EF: TMT-B	.16	-.14	.12	-.13	-.13	-.01	.37**	.20*	.32**	.33**	-.39**	-	
13. EF: Stroop	.08	-.04	.04	-.05	-.02	-.09	.36**	.15	.38**	.33**	.74**	.34**	-

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

Results

Linguistic Processing

LP Composite

Model 1 investigated the impact of the bilingual experience on overall linguistic processing performance, while controlling for demographic variables and L1 linguistic factors. The bilingual experience was a significant predictor of linguistic processing as a whole, and accounted for 17.2% of the variance in linguistic processing, $F(9, 130) = 3.01$, $p < .01$. L1 proficiency and current usage, L2 past exposure, and the interaction between L2 proficiency and past exposure significantly predicted LP. Linguistic processing was

significantly predicted by L1 proficiency (β = .30, t = 2.67, p < .01); for every additional point of proficiency, LP performance increases by .30 points. L1 current usage also predicted LP (β = .22, t = 2.62, p = .01). L2 past exposure significantly predicted LP (β = -1.00, t = -2.05, p < .01); for every year of exposure to the L2 language environment, LP performance decreases by 1.00 point. LP was also significantly predicted by the interaction between L2 proficiency and past exposure (β = 1.46, t = 2.71, p < .01) with the more proficient one is in L2, the stronger the positive effect of past L2 exposure on LP performance, and with more years of past exposure, the stronger the positive effect of proficiency on LP. All other demographic, L1 (other than L1 proficiency), or L2 variables (age, current usage, and the interaction between current usage and past exposure) were not significant predictors, p's > .05 (see Table 2 below for a summary of results for LP composite and individual subtests).

Table 2. Hierarchical multiple regression analyses predicting linguistic processing outcomes from the bilingual experience.

	LP Composite			ANIM			FAS			BNT		
	β	t	p-value	β	t	p-value	β	t	p-value	β	t	p-value
L1												
Current Usage	.22	2.62	.01*	.32	2.38	.005**	.07	.84	.40	.30	3.64	.85
Proficiency	.25	2.48	.02*	.15	1.52	.13	.24	2.16	.04*	.23	2.14	.01*
Past Exposure	.01	.11	.91	.11	1.32	.19	.05	.51	.61	-.02	-.19	.85
L2												
Age of Acquisition	-.02	-.19	.85	-.05	-.34	.74	-.04	-.40	.69	.07	.80	.43
Current Usage	.10	.79	.43	.15	1.10	.28	.003	.03	.98	.07	.51	.61
Proficiency	-.26	-1.69	.09	-.05	-.34	.74	-.39	-2.66	.009**	-.15	-.95	.35
Past Exposure	-1.00	-2.05	.04*	-1.27	-2.61	.01*	-.64	-1.30	.20	-.34	-.72	.47
Proficiency* Past Exposure	1.46	2.71	.008**	1.20	2.23	.02*	1.10	2.06	.04*	.82	1.55	.12
Current Usage* Past Exposure	-.21	-1.32	.19	-.01	-.04	.97	-.12	-.79	.43	-.42	-2.71	.008**

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

LP Individual Subtests

ANIM Subtest

In testing the effect of the bilingual experience on ANIM, the results indicated that the bilingual experience was a significant predictor of ANIM performance, and accounted for 12.7% of the variance in ANIM, $F(8, 134) = 2.44$, $p < .05$. L1 current usage, L2 past exposure, and the interaction between L2 proficiency and past exposure significantly predicted ANIM. ANIM was significantly predicted by L1 current usage ($\beta = .32$, $t = 2.38$, $p < .01$); for every additional percentage point of L1 current usage, ANIM performance increases by .32 points. L2 past exposure significantly predicted ANIM ($\beta = -1.27$, $t = -2.61$, $p = .01$); for every year of exposure to a language environment, ANIM performance decreases by 1.27 points. ANIM performance was also significantly predicted by the interaction between L2 proficiency and past exposure ($\beta = 1.20$, $t = 2.23$, $p < .05$) with the more proficient one is in L2, the stronger the effect of past L2 exposure is on ANIM performance, and with more years of past exposure, the stronger the effect of proficiency on ANIM. All other variables were not significant predictors, p's > .05.

FAS Subtest

In testing the effect of the bilingual experience on the individual LP subtest of FAS, the results indicated that the bilingual experience was a significant predictor of FAS performance, and accounted for 10.8% of the variance in FAS, $F(8, 134) = 2.03$, $p < .05$. L1 proficiency**,** L2 proficiency, and the interaction between L2 proficiency and past exposure significantly predicted FAS. FAS was significantly predicted by L1 proficiency ($\beta = .24$, $t = 2.16$, $p < .05$); for every additional point of L1 proficiency, FAS performance increases by .24 points. L2 proficiency significantly predicted FAS ($\beta = -.39$, $t = -2.66$, p

< .01); for every additional point of L2 proficiency, FAS performance decreases by .39 points. FAS performance was also significantly predicted by the interaction between L2 proficiency and past exposure (β = 1.10, t = 2.06, p < .05) with the more proficient one is in L2, the stronger the effect of past L2 exposure is on FAS performance, and with more years of past exposure, the stronger the effect of proficiency on FAS. All other variables were not significant predictors, p's > .05.

BNT Subtest

The bilingual experience significantly predicted performance on BNT, and accounted for 20.2% of the variance $F(9, 130) = 3.66$, $p < .001$. L1 proficiency, and the interaction between L2 current usage and past exposure significantly predicted BNT. BNT was significantly predicted by L1 proficiency (β = .23, t = 2.14 p < .05); for every additional point of L1 proficiency, BNT performance increases by .23 points. BNT performance was also significantly predicted by the interaction between L2 current usage and past exposure (β = -.42, t = -2.71, p < .01), with the more one utilizes L2, the weaker the effect of past L2 exposure is on BNT performance, and with more years of past exposure, the weaker the effect of current usage is on BNT. All other variables were not significant predictors, p's > .05.

Executive Functioning

EF Composite

Model 2 investigated whether the bilingual experience predicted overall executive functioning performance. The results indicated that the bilingual experience accounted

for 14.4% of the variance in EF, $F(7, 129) = 3.09$, $p < .01$. Proficiency of L1, proficiency and current usage of L2, and the interactions between L2 proficiency and past exposure and L2 current usage and past exposure significantly predicted EF. Higher proficiency in L1 was associated with higher EF scores ($\beta = .31$, $t = 2.90$, $p < .01$). Higher EF was also significantly associated with higher L2 proficiency ($\beta = -.34$, $t = -2.35$, $p < .05$) and current usage ($\beta = .31$, $t = 2.55$, $p = .01$). The interaction between L2 proficiency and past exposure significantly predicted EF ($\beta = 1.08$, $t = 2.06$, $p < .05$) with the more proficient one is in L2, the stronger the effect of past L2 exposure on EF performance, and with more years of past exposure, the stronger the effect of proficiency on EF. The interaction between L2 current usage and past exposure was a borderline significant predictor of EF ($\beta = -.29$, $t = -1.95$, $p = .05$), with the more current usage, the weaker the effect of past L2 exposure on EF performance, and with more years of past exposure, the weaker the effect of current usage is on EF. All other variables, demographic, L1 variables, or other L2 variables were not significant predictors, p's > .05 (see Table 3 below for a summary of results for EF composite and individual subtests).

Table 3. Hierarchical multiple regression analyses predicting executive functioning outcomes from the bilingual experience.

	EF Composite			Stroop			TMT-B		
	β	*t*	*p*-value	*β*	*t*	*p*-value	*β*	*t*	*p*-value
L1									
Current Usage	.08	.84	.40	.10	1.07	.29	-.02	-.18	.86
Proficiency	.31	2.90	.003**	.13	1.27	.21	.25	2.22	.03*
Past Exposure	.02	.18	.86	.04	.36	.72	.04	.36	.72
L2									
Age of Acquisition	.12	1.34	.18	.09	1.01	.31	.12	1.34	.18
Current Usage	.31	2.55	.01*	.31	2.54	.01*	.19	1.85	.07
Proficiency	-.34	-2.35	.02*	-.04	-.27	.79	-.22	-1.36	.18
Past Exposure	-.55	-1.15	.25	-.79	-1.61	.11	.03	.07	.95
Proficiency* Past Exposure	1.08	2.06	.04*	1.08	2.03	.045*	.19	.34	.73
Current Usage* Past Exposure	-.29	-1.95	.05	-.41	-2.76	.007**	-.05	-.30	.77

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

EF Individual Subtests

Stroop Subtest

Stroop performance was significantly predicted by the bilingual experience, which accounted for 11.4% of the variance $F(7, 133) = 2.44$, $p < .05$. Immigration status, L2 current usage, and the interactions between L2 proficiency and past exposure, and L2 current usage and past exposure were significant predictors of the Stroop task. Immigration status was a significant predictor ($\beta = -.78$, $t = -1.61$, $p < .05$). Immigrants performed, on average, .19 points worse than non-immigrants on the Stroop tasks. Stroop was also significantly predicted by L2 current usage ($\beta = .31$, $t = 2.54$ $p = .01$); for every additional percentage point of L2 current usage, Stroop performance increases by .31 points. Stroop performance was significantly predicted by the interaction between L2 proficiency and past exposure ($\beta = 1.08$, $t = 2.03$, $p < .05$), with the more proficient one is in L2, the stronger effect L2 exposure has on Stroop performance, and with more years of past exposure, the stronger the effect L2 proficiency has on Stroop. Stroop performance was significantly predicted by the interaction between L2 current usage and past exposure ($\beta = -.41$, $t = -2.76$, $p < .01$), with higher L2 usage, the weaker effect L2 past exposure has on Stroop performance, and with more years of past exposure, the weaker the effect L2 current usage has on Stroop. All other variables were not significant predictors, p's > .05.

TMT-B Subtest

The bilingual experience significantly predicted TMT-B performance and accounted for 10.5% of the variance $F(7, 131) = 2.20$, $p < .05$. L1 proficiency was the

only individual significant predictor of TMT-B performance (β = .25, t = 2.22, p < .05); for every additional point of L1 proficiency, TMT-B performance increases by .25 points. All other variables were not significant predictors, p's > .05.

Discussion

Summary of Results

Bilingualism is not just a dichotomous, yes or no variable, it is an experience (Bialystok, 2017). Bilingualism is a complex experience that includes multiple important components, including the age at which you acquired a language, how often that language is utilized, the context of which you learned and used that language, and various other factors. The purpose of this study was to examine the impact of the bilingual experience on cognition in older adults. More specifically, the purpose was to explore the individual and collective effects of L2 bilingual factors (age of acquisition, proficiency, exposure, usage, and the interaction between proficiency and past exposure, and past exposure and current usage) on the domains of linguistic processing and executive functioning while controlling for both demographic and L1 linguistic factors (see Table 4 below for a summary of the results of all models).

Table 4. Summary model results of multiple hierarchical multiple regression analyses predicting cognitive outcomes from the bilingual experience.

Predictor Variable	R^2	*df*	*F*	*p*-value
LP Composite	17.2	9, 130	3.01	.003**
LP Individual Subtests				
ANIM	12.7	8, 134	2.44	.017*
FAS	10.8	8, 134	2.03	.048*
BNT	20.2	9, 130	3.66	.000***
EF Composite	14.4	7, 129	3.09	.005**
EF Individual Subtests				
Stroop	11.4	7, 133	2.44	.022*
TMT-B	10.5	7, 131	2.20	.038*

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

Linguistic Processing

The Collective Bilingual Experience

In regards to our first aim—to examine the collective effect of the bilingual experience on LP and EF—our first hypothesis in regard to LP was supported. The bilingual experience was a predictor of LP and explained a significant portion of LP performance (17.2%); that is, bilinguals' LP performance is largely explained by their overall bilingual experience. This finding is not only consistent with the prior literature on the impact of the bilingual experience on cognition (Bialystok, 2017), but it also emphasizes the need and importance of studying bilingualism as a collective experience rather than as separate, independent variables. For instance, when exploring the individual effects of the bilingual factors on LP performance (aim 2), only some of the factors were found significant (L2 past exposure, and interaction between proficiency and past exposure). Although it is vital information of which specific L2 factors within the

bilingual experience contribute most to LP performance (to be discussed in the next paragraph), researchers run the risk of making general erroneous conclusions that bilingualism does not predict or influence LP performance if looking at individual bilingual factors alone (e.g., if studying AoA; Perani et al., 1998). By studying the experience as a whole, researchers are not only able to better capture the real-world nature and complexity of the experience, but are also able to learn which factors predict and have more influence on LP individually within a bilingual's language experience (see Table 3 for summary of LP results).

LP was not only significantly predicted by the whole bilingual experience, but was only significant when controlling for demographic and L1 linguistic factors (e.g., L1 proficiency, current usage, and past exposure). This finding is key due to clarifying and potentially unlocking the answer to the debate over several null findings and overall mixed body of research. Although an overall consensus of a bilingual LP disadvantage has been accepted, our previous study (Elsen, 2017) found no difference between monolinguals and bilinguals in LP performance when utilizing the same sample. The difference of significance, therefore, may be due to the lack of accounting and controlling for L1 linguistic factors. For instance, within our prior study and in other similar studies on bilingualism and LP, it is possible that no significance was found due to the variance in monolinguals' and bilinguals' language experience (L1 and L2 factors). So, if both a bilingual were to report a higher L1 proficiency than a monolingual, while also reporting a minimal L2 past exposure (negative relationship with LP), it is possible that no significant difference would be found in LP performance between the bilingual and the monolingual. But again, if controlling for L1 factors, a difference is then found, as

discovered in the current study. This is also especially important to consider given our population of older adults, which reported varying difference among L1 and L2 factors.

Individual Factors Within the Bilingual Experience

When testing the impact of the bilingual experience on LP, L1 proficiency and current usage, L2 past exposure, and the interaction between past exposure and L2 proficiency were found to be significant predictors of LP performance. This finding supported our hypothesis, as well as prior research (Fishman & Cooper, 1969). It is once again important to emphasize that these factors were significant only within the context of the model of whole bilingual experience.

When predicting LP from the whole bilingual experience, the study indicated that the two most important factors were how long a bilingual is exposed to their second language (e.g., full immersion)—whether at school, work, home or other environments—and its' interaction with how proficient he/she is in that language (i.e., proficiency; Fishman & Cooper, 1969). The results further indicated that there is a negative relationship between L2 past exposure and LP performance, suggesting a negative impact of bilingualism on LP; which although the relationship between L2 past exposure and LP has been specifically studied, it does support the general trend of the literature that highlights a bilingual LP disadvantage (Mindt et al., 2008). A significant interaction was found between past exposure and proficiency, with the longer one is exposed to a second language, the stronger impact the mastery one achieves has on LP performance. Lastly, although L1 proficiency was utilized as a control variable, its' significance also supports

the importance of studying the full language experience (Bialystok, 2017), including distinguishing the effects of L1 and L2, especially when studying LP.

On the other hand, L2 age of acquisition, proficiency, and current usage were not found to be significant predictors of LP; suggesting that when predicting LP from the bilingual experience, LP is not dependent on when the language was learned (AoA), the mastery of that language, or how often it is currently used independently. These findings may initially appear contrary to the previous research that has supported AoA, proficiency, or usage as significant predictors of cognition (Luk, De Sa & Bialystok, 2011; Pelham & Abrams, 2014; Zied, Phillipe, Karine, Valerie, Ghislaine, & Arnaud, 2004); however, the majority of these studies looked at these variables independently and not within a model of the bilingual experience. It is important to re-emphasize that this does not mean that AoA, proficiency, and usage are not relevant in the bilingual experience, but they are not significant when predicting LP in the context of the full experience that includes past exposure and the interaction between proficiency and past exposure.

A possible explanation for non-significance for AoA and current usage as individual predictors is that they are vaguely conceptualized and do not capture enough information about the bilingual experience; which is also argued by Yang and colleagues in their 2016 study. For example, even if an individual learns L2 at an early age (AoA), he/she may not have engaged in the language with regular frequency since that early AoA, resulting in little to no impact on cognition. On the contrary, if an individual reports high current L2 utility (usage), he/she may not have frequently utilized the language previously, which may also result in little to no impact on cognition. In comparison with

proficiency levels, however, if an individual indicates high levels of proficiency, it suggests a possible prior high utilization and possibly an earlier AoA and high exposure. Proficiency, although not vaguely conceptualized, may have not been a significant individual factor due to its' effect being better accounted for in its' interaction with past exposure; which was shown to be significant. Each bilingual factor appears to impact LP performance (and EF to be discussed later) in an individual, specific way that should be further studied and explored.

A factor of high import in explaining these findings is the population of study (as alluded to before). When reviewing the research and vague operationalizations of bilingualism, the argument in favor of measuring bilingualism as an experience is the inability to fully capture the length of time in which the experience of bilingualism develops (Yang, Hartanto, & Yang, 2016). The older adult bilingual experience better allows for the accounting of the length of time due to it being a summation of many years across their lifespan compared to a young adult's bilingual experience, which only captures the years up to his/her current age with possible changes in bilingualism occurring in later adulthood. In considering brain anatomy, the brain (particularly the white matter) continues to develop into adulthood, so the effect of bilingualism on brain development and function may not fully manifest in younger adulthood (Baptista & Johansen-Berg, 2017). In a number of Bialystok's studies, she supports the impact of bilingualism in older adults by showing how the impact of bilingualism is present in childhood, silenced in adulthood, and most prominent in older adulthood (Bialystok, Klein, Craik, & Viswanathan, 2004; Bialystok, Craik, & Ryan, 2006; Bialystok, Luk, & Craik, 2012; Bialystok, Poarch, Luo, & Craik, 2014). Therefore, exposure (how long you

are exposed to a language environment) would be a better measure of the length/depth of bilingualism in older adulthood than AoA (when you first learned a language) or usage (how much you currently use a language), which does not delineate the active exercise of that language since it was first learned. Yang and her colleagues (2016), and supported by other researchers (Pelham & Abrams, 2014), also allude to these considerations by suggesting the use of "active age of acquisition" or "age of fluency,"—or in the case of the current study, to utilize multiple factors to fully capture the complex bilingual experience—rather than vague conceptualizations of AoA or other commonly utilized independent predictors.

Overall, these findings of these individual factors within the context of the experience (both the significant and non-significant findings) add to the argument of the importance of studying the impact of the bilingual experience. These findings also help us to better interpret and understand the meaning of the significant and non-significant predictors of LP within the context of bilingual experience. We will now discuss both the overall impact of the bilingual experience and the impact of individual factors on the various individual LP subtests; which provides us the opportunity to tease apart which bilingual factors impact specific functions within LP functioning.

LP Subtest: ANIM

As previously discussed, no prior studies have investigated the impact of the bilingual experience or individual bilingual factors on LP performance in general, as well as the specific subtests. Therefore, the following findings were exploratory and provided

insight into the possible relationships that exist between the bilingual experience and its associated factors, and the various LP subtests.

In studying the effect of the overall bilingual experience on the individual LP subtest of ANIM, the bilingual experience explained a significant portion of the variance in ANIM performance (12.7%). Within the bilingual experience, L1 current usage, L2 past exposure and the interaction between L2 past exposure and proficiency were significant predictors of ANIM performance. In order to explain the results and deduct why specific factors predicted ANIM performance, it is important to first understand the nature of the ANIM subtest. As previously discussed under the methods section, ANIM performance was measured by the number of animals a participant could name, in English, in a given category within 60 seconds; in other words, ANIM measures semantic fluency. If ANIM is measuring semantic fluency in English (which was identified as participants' L1 in the current sample), then one may deduct that a participant's L1 current usage is a significant predictor of ANIM performance given the relation between L1 current utilization and L1 semantic fluency. Furthermore, the relationship between L1 current usage and ANIM was positive, suggesting that the more bilinguals currently utilized L1 (the language of which they are being tested in), the better their LP performance is, specifically for the ANIM LP subtest. Although Bialystok and colleagues (2009) attempted to control for the impact L1 may have on LP performance by testing participants in both their languages, and found no difference in LP deficits, they did not specifically control for L1 current utilization. Controlling for L1 in general by testing participants in both languages does not control for the positive impact more current utilization has on improved semantic fluency (ANIM). Further studies should be

conducted to specifically test the impact of L1 current usage and other specific L1 factors on semantic fluency.

L2 past exposure was also a significant predictor of ANIM performance, but instead of showing a negative impact on ANIM, the results demonstrated that as bilinguals reported more exposure to L2, their L1 semantic fluency performance (ANIM) decreased. This finding is supported by the prior findings suggesting LP deficits for bilinguals (Mindt et al., 2008). Although LP deficits are consistently found in the body of literature, researchers have not been able to pinpoint why bilinguals exhibit such deficits in LP. Therefore, the current study provides vital information, recommending L2 past exposure, as well as its' interaction with L2 proficiency, as contributors to decreased LP performance—specifically semantic fluency. These findings also support the weaker links hypothesis (Gollan et al., 2008) and high utility theory (Mindt et al., 2008); which were previously discussed in the literature review. The findings of the next two LP subtests will provide further information of what other possible factors may be contributing and explaining bilinguals' LP deficits.

LP Subtests: FAS

Firstly, the overall bilingual experience significantly predicted FAS performance, and explained 10.5% of its variance. Within the bilingual experience, both L1 and L2 proficiency were significant predictors. This finding is especially important when considering the prior debate/confusion on discrepant findings on a possible bilingual LP disadvantage. For instance, if one were to focus more on L1 proficiency when studying bilingualism and LP performance, one would result in a positive relationship (supported

by the current findings); however, if one were to focus on L2 proficiency, one would result in a negative relationship (also supported by the current findings). It would initially appear as if the two were contradictory findings; however, they are not, but instead more valid information explaining the complexity of the bilingual experience. Our current study demonstrated how L1 proficiency—one's sense of mastery in L1—contributed to enhanced LP functioning, specifically within the FAS subtest; whereas, higher rates of L2 proficiency resulted in poorer LP performance on the FAS subtest and L2 proficiency having a stronger impact when interacting with more years of L2 past exposure. These findings, pose the question of if the findings on proficiency are vital information to explain the discrepancies in the literature, why are they significant factors for FAS and not ANIM (previously discussed). The possible answer can be found in the nature of the subtest and what it measures. Similarly to how ANIM's measurement of semantic fluency may be related to L1 current usage, FAS measures phonemic fluency that may be related to L1 and L2 proficiency; as well as the similar finding (similar to ANIM and LP composite) of the interaction between L2 past exposure and proficiency

LP Subtest: BNT

The bilingual experience, similar to all prior LP tests, significantly predicted BNT performance. Furthermore, the bilingual experience explained a significant proportion of the variance (20.2%) in BNT. Especially when comparing to the other two subtests (10.5% and 12.7%), the bilingual experience is shown to explain the largest proportion of the variance among the LP functions. This is of even more interest, given that within the model, only two factors were significant predictors: L1 proficiency and the interaction

between L2 current usage and past exposure. L1 proficiency again demonstrates a positive relationship with LP, with higher rates of proficiency indicating increased BNT performance; which similar to FAS, is expected given the tests being given in L1. BNT is a test that is known as a LP measurement of of naming/word retrieval. Given that the BNT was conducted in English, a positive relationship is expected between L1 proficiency and BNT performance. . Again, limited studies have been conducted on how specific bilingual factors impact specific cognitive LP tests, and these findings provide an exploratory launching pad for future studies.

Lastly, and in summarization of discussing all the various subtests and their significant individual predictors, it is important to highlight the patterns of which predictors were significant across the various subtests. L1 proficiency was a significant predictor in the overall LP composite, as well as significant of two of the three subtests (FAS and BNT), suggesting L1 proficiency as an overall significant contributor that should be taken into consideration when studying bilingualism and LP performance. The interaction between L2 past exposure and proficiency was also a significant predictor in the overall LP composite, and two of the three subtests (ANIM and FAS); also suggesting it as an overall significant contributor to LP performance. L2 past exposure was also significant for the overall LP composite, but it was only significant for one of three subtests (ANIM). Other factors were significant for only one subtest (e.g., L1 current usage for ANIM and the interaction between L2 current usage and past exposure for BNT), which may suggest their specific contribution to the specific functions of that assessment. Lastly, of the three subtests, the bilingual experience explained the largest proportion of the variance BNT performance (20.2% vs. 10.5% and 11.4%). Overall,

these findings, whether patterns or differences across tests, suggest variability within how the bilingual experience and its associated factors impact LP performance, generally and more specifically. The findings further encourage researchers to better operationalize and more specifically define "LP" and "bilingualism" by utilizing various LP assessments and more bilingual factors.

Executive Functioning

The Collective Bilingual Experience

In regards to the second part of the first aim, the bilingual experience also significantly predicted EF and explained 14.4% of the variance in EF performance, meaning that bilinguals' EF can be explained by their overall bilingual experience (i.e., L2 age of acquisition, proficiency, current usage and past exposure) (see Table 4 for summary of EF results). Similar to the findings on LP, this finding continues to add strength to the argument of the importance and need of studying the bilingual experience as a predictor of cognitive functioning. Although no prior studies have specifically studied the impact that the bilingual experience has on EF, the study contributes to the literature by providing additional new information. A prior study, which utilized the same sample, indicated that bilinguals had an advantage in EF (consistent with the literature). The current study provides the additional information of how the bilingual experience impacts EF performance, and speaks to what specific factors may be contributing to the bilingual advantage (i.e., proficiency, current usage, and multiple interactions).

Individual Factors Within the Bilingual Experience

When testing the impact of the bilingual experience on EF, L1 proficiency, L2 proficiency, current usage, and the interaction between proficiency and past exposure, and current usage and past exposure (borderline significance) were found to be significant predictors of EF performance. It is once again important to highlight that these bilingual factors were only significant when included in the overall model of the whole bilingual experience and not individually.

L1 proficiency, although utilized as a control variable (along with other L1 linguistic factors), was a significant predictor of EF. This finding has numerous implications. For one, it emphasizes the need for a more comprehensive assessment of bilingualism than what is typically utilized in both the research and in the world of education. Instead of assessing and categorizing dichotomously (monolingual vs. bilingual), we should be taking a more comprehensive assessment that includes the various linguistic factors (proficiency, AoA, etc.) for each language reported (in this case, L1 and L2). Additionally, a positive relationship was found between L1 proficiency and EF, meaning that the more mastery one obtains of L1, the more enhanced are one's executive functions. This is not only indirectly supported by the literature (Iluz-Cohen and Armon-Lotem, 2013) but is of particular interest given the contradictory finding for L2 proficiency. A significant negative relationship was found between L2 proficiency and EF, meaning that as mastery of L2 increases, executive functioning decreases. This is a contradictory finding, given that the research indicates that L2 has a positive, and not negative, impact on EF (Zied et al., 2004; Singh & Mishra, 2012; Tse & Altarriba, 2012). A possible explanation for this finding may be that L2 proficiency represents a source of

increased interference in mental control (competing with L1), which then negatively impacts EF. More studies should be conducted to study the specific effects of L1 and L2 proficiency, separately and in comparison of one another, on EF.

L2 current usage was a significant predictor and found to have a positive relationship with EF. This finding is consistent with the literature that supports the high utility theory of EF (Mindt et al., 2008**)**, stating that the more one engages in his/her language, the more the languages compete and the more executive functions the individual utilizes. Lastly, the interaction between L2 proficiency and past exposure also significantly predicted EF, meaning that the more proficient one is in L2, the stronger the effect of past L2 exposure on EF performance, and vice versa. This finding is also consistent with the literature; however, what is of particular interest is that the interaction has a positive relationship with EF, whereas L2 proficiency on its own was found to have a negative relationship. Furthermore, the interaction between current usage and past exposure was found to have a negative relationship (borderline significance). (β = -.29, t = -1.95, p = .05), with the more current usage, the weaker the effect of past L2 exposure on EF performance, and with more years of past exposure, the weaker the effect of current usage is on EF. These findings suggest that the bilingual experience may be even more complex than predicted, demonstrating that specific L1 and L2 factors impact EF in different ways, as well as interact with one another to impact EF differently.

Age of acquisition and past exposure were not significant predictors of EF performance. Non-significance of AoA may again be due to its vague operationalization (Perani et al., 1998), which is supported by AoA being a non-significant predictor in both domains, as well as for each subtest. Along with the possible reasoning of AoA not being

significant, past exposure may also not be significant due to prior studies showing a strong EF bilingual advantage regardless of the "amount" of bilngualism, regardless of age of acquisition or years of past exposure (Perani et al., 1998; Tao, Marzecová, Taft, Asanowicz, & Wodniecka, 2011). For example, in a study conducted by Salvatierra and Rosselli (2010), they argued that current usage is a stronger predictor than AoA or exposure by showing how even late bilinguals (regardless age or how long previously exposed) demonstrated high inhibitory control when engaging in both their languages frequently. The non-significance of past exposure may also be due to its effect being better accounted for within the interaction with proficiency, as well as with current usage; which both interactions were significant.

EF Subtest: Stroop

In studying the effect of the overall bilingual experience on the individual EF subtest of Stroop, the bilingual experience explained a significant portion of the variance in Stroop performance (11.4%). The results also revealed that immigration status, and L2 current usage and both interactions between L2 past exposure and proficiency, and L2 current usage and past exposure were significant predictors of Stroop performance. Firstly, it is not only important to note that immigration status is a significant predictor of Stroop performance (which we will come back to), but also that it was the first and only demographic variable that has been significant thus far (compared to age, gender, education, and income). These non-significant findings of the various demographic variables, is not support by the literature, which highlights these variables as critical confound variables that have significant impacts on cognition—even to the point of some

researchers arguing that these variables explain the mixed results between whether there is bilingual advantage or disadvantage, as previously highlighted in the literature review (Peal & Lambert, 1963).

The answer of why immigration status was the only significant demographic variable is unknown, but this finding does suggest it is important and has a specific impact on EF Stroop performance. The finding that immigration status is a significant predictor is both supported and contrary to the literature, given the body of literature's mixed results. Some researchers have argued that immigration status is a vital confound variable that if not controlled, an erroneous bilingual disadvantage is found (Peal & Lambert, 1963; Guzmán-Vélez & Tranel, 2014), while others have found that whether one does control for it or not, it does not alter the outcomes in any way (Bialystok, Binns, Craik & Ossher, 2004). In the current study, immigration was both significant—which may suggest that it's importance and utility as a control variable is dependent on the specific outcome; e.g., EF Stroop performance—and was also found to have a negative impact on performance, which provides additional information not explored in prior studies. The body of literature should aim to better understand what specific outcomes immigration status impacts and does not impact, and the direction and degree of that possible relationship.

Stroop performance was also significantly predicted by L2 current usage, with an enhanced performance as utilization increased. This finding is supported by the literature, which suggests that there is a connection between higher utilization of bilingualism (of second language) and higher utilization of specific executive functions, including the function of inhibition measured by the Stroop task (e.g., theory of high utility; Mindt et

al., 2008). As previously explained, a bilingual must utilize the executive function of inhibition to inhibit a non-target language in a monolingual setting**.** This impact of L2 current usage on Stroop performance is further impactful when interacting with past exposure; meaning that when a bilingual has more years of past exposure in addition to high current utilization, the stronger the impact is on enhanced EF. This strong impact is also seen for the interaction between L2 past exposure and proficiency. Although this interaction has not been previously studied, it suggests that EF is enhanced when proficiency and past exposure are both at their highest levels. Again, although these interactions have not been studied in the literature, they highlight the importance of studying the bilingual experience as a model, instead of different variables. For instance, if we did not study the impact of the interactions, we may have disregarded L2 past exposure and L2 proficiency as insignificant factors and as having no effect on cognition.

EF Subtest: TMT-B

When studying the impact of the bilingual experience on EF through utilizing the TMT-B task, the results indicated that L1 proficiency was the only individual significant factor. Notably different findings from the prior EF Stroop task, TMT-B is known to measure a different executive function (Stroop: inhibition vs. TMT-B: task-switching). Given a bilingual's need to switch between the two languages, bilinguals have been found to demonstrate higher TMT-B scores than monolinguals (Bialystok & Viswanathan, 2009). The current finding of L1 proficiency demonstrates a positive relationship between L1 proficiency and TMT-B performance, with increased L1 proficiency resulting in increased EF performance. Although prior studies have not been

conducted on which specific linguistic factors impact performance on the TMT-B task, including the impact of L1 proficiency on TMT-B performance, this provides researchers the opportunity to openly begin to explore these relationships.

Lastly, as previously discussed with LP, it is important to explore any possible patterns of significance across the subtests. Unlike LP and the associated subtests, however, there are no similarities between the subtests; which can be explained by the fact the subtests of EF, although both measuring executive functions, drastically differ in which functions they measure (i.e., TMT-B: task switching, Stroop: inhibition). Therefore, whereas L1 proficiency impacts TMT-B performance, it does not significantly impact Stroop performance, and vice versa for the significant predictors of Stroop for TMT-B performance.

Limitations and Future Study

When attempting to explain the findings, both significant and non-significant, the limitations of the study should also be considered. One aspect of the current study that may be suggested as a limitation is the acculturation of the study sample. As previously described, the current study's sample is acculturated, which includes both immigrants/emigrants and "imbalanced" bilinguals (not utilizing both languages equally, and with low L2 usage). Most studies utilize "balanced" bilinguals with equal daily usage throughout their lifespan (e.g., Tamil-English bilinguals in Bialystok, Craik, Klein, & Viswanathan, 2004), even studies conducted in the U.S. or other highly acculturated areas with the argument that these studies are better able to tease apart the impact of bilingualism by studying "pure" bilingualism. Although it may be more difficult to tease

a part the "pure" effects of bilingualism in an acculturated sample (internal validity), studies sacrifice generalizability and application to real-world populations (external validity). Especially when considering the increasing rates of travel, globalization, and the world becoming more acculturated, it is important to study real-world populations, including acculturated samples. The current study, therefore, not only addresses the external validity by studying an acculturated sample, but also addresses internal validity by controlling for certain factors (i.e., demographic and L1 linguistic factors) and breaking apart the effect of bilingualism into the various vital compenents (i.e., AoA, proficiency, past exposure, etc.). Researchers, therefore, should also take into account both internal and external validity by studying the various bilingual factors and the overall bilingual experience in different populations.

Given the complexity of bilingualism and cognition, there is much work to be done for future research in this field. For one, future studies should continue to conduct to investigate each of the individual predictors (demographic, L1 and L2 factors) and map out which specifically impact and predict specific outcomes (not just cognition or general domains, but specific functions measured by specific tests/tasks). It is vital for the body of literature to move away from general dichotomous variables (e.g., bilingual- yes or no?) to taking into account diverse demographic variables (age, education, immigration status, etc.), and the full L1 and L2 language experiences. A possible future study can also be conducted to study the specific impact of the interactions between L1 and L2, which was not looked at in the current study (e.g., how does the interaction between L1 and L2 proficiencies impact LP?). Other future studies can also be conducted to further tease apart the effects of the bilingual experience by further breaking down various L2

factors, such as past exposure can be broken into the different learning environments (e.g., school vs. home) and methods (e.g., language taps vs. movies), and how each may impact cognition differently.

Overall, the history of bilingualism research has focused on the impact of simple dichotomous variables (e.g., monolingualism vs. bilingualism) and its impact on broad, general outcomes (e.g., linguistic processing). These overly simplistic research questions, although needed to launch the research, continue to produce apparent mixed and contradictory findings. Given the now known complexity of the bilingual experience, as well as the complexity of the brain, studies need to be conducted to capture the full diverse experience (including utilizing both balanced and imbalanced bilinguals) in order to clearly distinguish the different effects of bilingualism that depend on the various factors, such as: the cognitive domain of study (LP vs. EF), age group (childhood, adulthood, late adulthood), and the culture/sample of study, including acculturated samples (e.g., Bialystok, Craik, & Luk, 2008).

Summary/Conclusions

Bilingualism, whether argued as advantageous or disadvantageous, is known to have an impact on cognition. Over the many years of research, the collective body of researchers has recognized that the impact of bilingualism depends on various linguistic factors (e.g., AoA, proficiency, etc.). As researchers began to investigate the impact of these factors separately, other research began to suggest the importance and impact of the whole experience. Only a few studies, however, including the current study have established the importance of bilingualism as an experience. The current study

highlighted how the bilingual experience as a whole predicted LP and EF performance in general, as well as for every individual subtest. Although significance for all the cognitive tests is important data, the current study also delineated which specific bilingual factors (and the direction of the relationships) within the experience had an impact on specific functions within LP and EF; suggesting that specific factors within the bilingual experience have a stronger impact than others for specific domains. This study also discovered unexpected non-significant findings; which given the complexity of the bilingual experience may be expected. Yang and her colleagues (2016) argue divergent findings should not be a surprise, but should be expected when studying the complex bilingual experience. As the research on bilingualism continues, researchers should bear in mind that bilingualism is a complex experience—it changes and develops over time, presents differently across sociocultural contexts, and includes a whole and diverse experience (Bialystok, 2017).

REFERENCES

Abutalebi, J. & Weekes, B. S. (2014). The cognitive neruology of bilingualism in the age of globalization. *Behavioral Neurology*, (Article ID 536727), 1-3.

Alvarez, J. A., & Emory, E. (2006). Executive function and the frontal lobes: A meta-analytic review. *Neuropsychology Review*, *16*(1), 17-42. Doi: 10.1007/s11065-006-9002-x.

Ansaldo, A. I., Ghazi-Saidi, L., & Adrover-Roig, D. (2015). Interference control in elderly bilinguals: appearances can be misleading. *Journal of Clinical and Experimental Neuropsychology*, *37*(5), 455-470.

Bak, T. H., Nissan, J. J., Allerhand, M. M., & Deary, I. J. (2014). Does bilingualism influence cognitive aging? *Annals of Neurology*, *75*(6), 959-963. Doi: 10.1002/ana.24158.

Bialystok, E., Binns, M. A., Craik, F., & Ossher, L. (2004). Effects of bilingualism on the age of onset and progression of MCI and AD: Evidence from executive function tests. *Neuropsychology*, *28*(2), 290-304.

Bialystok, E., Craik, F. I. M., Klein, R., & Viswanathan, M. (2004). Bilingualism, aging, and cognitive control: Evidence from the Simon task. *Psychology and Aging, 19*, 290–303.

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

Bialystok, E., Craik, F. I., & Ryan, J. (2006). Executive control in a modified antisaccade task: Effects of aging and bilingualism. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *32*(6), 1341.

Bialystok, E., Craik, F. I., & Freedman, M. (2007). Bilingualism as a protection against the onset of symptoms of dementia. *Neuropsychologia*, *45*(2), 459-464.

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.

Bialystok, E., Craik, F., Green, D. W., & Gollan, T. H. (2009). Bilingual minds. *Psychological Science in the Public Interest*, *10*(3), 89-129.

Bialystok, E., & Viswanathan, M. (2009). Components of executive control with advantages for bilingual children in two cultures. *Cognition*, *112*(3), 494-500.

Bialystok, E., & Barac, R. (2012). Emerging bilingualism: Dissociating advantages for metalinguistic awareness and execruitve control. *Cognition, 122*(1), 67-73.

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

Bialystok, E., Poarch, G., Luo, L., & Craik, F. (2014). Effects of bilingualism and aging on executive function and working memory. *Psychology of Aging, 29*(3), 696-705. Doi: 10.1037/a0037254.

Bialystok, E. (2017), The bilingual adaptation: How minds accommodate experience. *Psychological Bulletin, 143*(3), 233-262.

Blommaert, J. (2010). *The sociolinguistics of globalization*. Cambridge, New York: Cambridge University Press. (xvi, 213).

Brown, G. D. A., &Watson, F. L. (1987). First in, first out: Word learning age and spoken word frequency as predictors of word familiarity and word naming latency. *Memory & Cognition, 15*, 208-216.

Bruin, A., Treccani, B., & Sala, S. D. (2014). Cognitive advantage in bilingualism: An example of publication bias? *Psychological Science, 26*(1), 99-107. Doi: 10.1177/0956797614557866.

Carlson, S. M., & Meltzoff, A. N. (2008). Bilingual experience and executive functioning in young children. *Developmental science*, *11*(2), 282-298.

Carroll, J. B., & White, M. N. (1973). Word frequency and age of acquisition as determiners of picture- naming latency. *Quarterly Journal of Experimental Psychology, 25*, 85-95.

Costa, A., & Sebastián-Gallés, N. (2014). How does the bilingual experience sculpt the brain? *Nature Reviews. Neuroscience*, *15*(5), 336–345.

Daffner, K. R. (2010). Promoting successful cognitive aging: A comprehensive review. *Journal of Alzheimers Disorder, 19*(4), 1101-1122.

Darcy, N. T. (1963). Bilingualism and the measurement of intelligence: Review of a decade of research. *The Journal of Genetic Psychology: Research and Theory on Human Development*, *103*(2), 259–282. doi:10.1080/00221325.1963.10532521.

Dong, Y., & Li, P. (2015). The cognitive science of bilingualism. *Language and Linguistics, 9*(1), 1-13.

Drag, L. L., & Bieliauskas, L. A. (2010). Contemporary review 2009: Cognitive aging.

Journal of Geriatric Psychiatry and Neurology, *23*(2), 75-93.

Draganski, B., Gaser, C., Busch, V., Schuierer, G., Bogdahn, U., & May, A. (2004). Neuroplasticity: Changes in grey matter induced by training. *Nature*, *427*, 311–312.

Ellis, A., & Morrison, C. (1998). Real age-of-acquisition effects in lexical retrieval. *Journal of Experimental Psychology: Learning, Memory and Cognition*, *24*, 515-523.

Elsen, K. (2017). *The effect of language on cognition in an acculturated American sample of healthy older adults* (Master's thesis). Retrieved from https://scholarsrepository.llu.edu/etd/446/.

Fabiani, M. (2012). It was the best of times, it was the worst of times: A psychophysiologist's view of cognitive aging. *Psychophysiology*, *49*, 283-304. Doi: 10.1111/j.1469-8986.2011.01331.x.

Fishman, J.A., & Cooper, R.L. (1969). Alternative measures of bilingualism. *Journal of Verbal Learning & Verbal Behavior*, *8*(2), 276-282.

Fitzgerald, J. (1993). Views on bilingualism in the United States: A selective historical review. *Bilingual Research Journal*, *17*(1), 35-36.

Flege, J. E., Munro, M. J., & MacKay, I. R. (1995). Factors affecting strength of perceived foreign accent in a second language. *The Journal of the Acoustical Society of America*, *97*(5), 3125-3134.

Flege, J. E., Yeni-Komshian, G. H., & Liu, S. (1999). Age constraints on second-language acquisition. *Journal of Memory and Language, 41*, 78–104.

Gold, B. T., Kim, C., Johnson, N. F., Kryscio, R. J., & Smith, C. D. (2013). Lifelong bilingualism maintains neural efficiency for cognitive control in aging. *Journal of Neuroscience*, *33*, 387-396.

Gollan, T. H., & Silverberg, N. B. (2001). Tip-of-the-tongue states in Hebrew–English bilinguals. *Bilingualism: Language and Cognition, 4*, 63–83.

Gollan, T. H., Montoya, R. I. & Werner, G. (2002). Semantic and letter fluency in Spanish–English bilinguals. *Neuropsychology, 16*, 562–576.

Gollan, T. H., Montoya, R. I., Fennema-Notestine, C., & Morris, S. K. (2005). Bilingualism affects picture naming but not picture classifica- tion. Memory & Cognition, 33, 1220–1234.

Gollan, T. H., Fennema-Notestine, C., Montoya, R. I., & Jernigan, T. L. (2007). The bilingual effect on Boston Naming Test performance. *Journal of the International Neuropsychological Society, 13,* 197–208.

Gollan, T., Montoya, R., Cera, C., & Sandoval, T. (2008). More use almost always means a smaller frequency effect: Aging, bilingualism, and the weaker links hypothesis. *Journal of Memory and Language, 58,* 787–814.

Grosjean, F. (2010) Bilingual: Life and Reality, Harvard University Press.

Guzmán-Vélez, E., & Tranel, D. (2014). Does bilingualism contribute to cognitive reserve? *Neuropsychology*, *29*(1), 139-150. doi:10.1037/neu0000105.

Hernandez, A. E., & Li, P. (2007). Age of acquisition: Its neural and computational mechanisms. *Psychological Bulletin, 133*(4), 638.

Johnson, J. S., & Newport, E. L. (1989). Critical period effects in second language learning: The influence of maturational state on the acquisition of English as a second language. *Cognitive Psychology*, *21*(1), 60-99.

Kavé, G, Eyal, N., Shorek, A., & Cohen-Mansfield, J. (2008). Multilingualism and cognitive state in the oldest old. *Psychology and Aging, 23,* 70–78.

Kim KH, Relkin NR, Lee K-M, Hirsch J. (1997). Distinct cortical areas associated with native and second languages. *Nature, 388,* 171–174.

Kirk, N. W., Fiala, L., Scott-Brown, K. C., & Kempe, V. (2014). No evidence for reduced Simon cost in elderly bilinguals and bidialectals. J*ournal of Cognitive Psychology, 26*(6), 640-648.

Kovács, Á. M., & Mehler, J. (2009). Flexible learning of multiple speech structures in bilingual infants. *Science, 325*(5940), 611-612.

Kroll, J.F., Bobb, S.C., Misra, M., & Guo, T. (2008). Language selection in bilingual speech: Evidence for inhibitory processes. *Acta Psychologica, 128,* 416–430.

Lappe, C., Trainor, L. J., Herholz, S. C., & Pantev, C. (2011). Cortical plasticity induced by short-term multimodal musical rhythm training. *PLoS ONE, 6,* e21493. http://dx.doi.org/10.1371/journal.pone.0021493.

Lenneberg, Eric H. (1967). Biological foundations of language. New York: Wiley.

Lezak, M.D. (1995). Neuropsychological assessment. (3rd ed.). New York: Oxford University Press.

Luk, G., De Sa, E., & Bialystok, E. (2011). Is there a relation between onset age of

bilingualism and enhancement of cognitive control? *Bilingualism: Language and Cognition, 14*(4), 588-595. doi:10.1017/S1366728911000010.

Luk, G., & Bialystok, E. (2013). Bilingualism is not a categorical variable: Interaction between language proficiency and usage. *Journal of Cognitive Psychology, 25(5),* 605-621. doi: 10.1080/20445911.2013.795574.

Maguire, E.A., Gadian, D. G., Johnsrude, I. S., Good, C. D., Ashburner, J., Frackowiak, R., & Frith, C. (2000) Navigation-related structural change in the hippocampi of taxi drivers. *Proceedings of the National Academy of Sciences of the United States of America, 97*(8), 4398– 4403. Doi: 10.1073/pnas.070039597.

Marian, V., Blumenfeld, H .K., & Kaushanskay, M. (2007). The language experience and proficiency questionnaire (LEAP-Q): Assessing language profiles in bilinguals and multilinguals. Journal of *Speech Language and Hearing Research, 50,* 940-967. doi:10.1044/1092-4388.

Mayberry R. (1993). First-language acquisition after childhood differs from second-language acquisition: the case of American Sign Language. *J Speech Hear Res, 36,* 1258–1270.

Mindt, M. R., Arentoft, A., Germano, K. K., D'Aquila, E., Scheiner, D., Pizzirusso, M., Sandoval, T. C., & Gollan, T. H. (2008). Neuropsychological, cognitive, and theoretical considerations for evalution of bilingual individuals. *Neuropsychology Review, 18*(3), 255-268. doi: 10.1007/s11065-008-9069-7.

National Institute on Aging. (2007). Why population aging matters: A global perspective. March 15, 2007, *Summit on Global Aging*, hosted by the U.S. State Department in collaboration with the National Institute on Aging. Retrieved from http://www.nia.nih.gov/ResearchInformation/ExtramuralPrograms/BehavioralAndSocialResearch/GlobalAging.htm.

Noble, K. G., Houston, S. M., Kan, E., & Sowell, E. R. (2012). Neural correlates of socioeconomic status in the developing human brain. *Developmental Science, 15*, 516–527.

Ossher, L., Bialystok, E., Craik, F. I., Murphy, K. J., & Troyer, A. K. (2012). The effect of bilingualism on amnestic mild cognitive impairment. *Journals of Gerontology Series B: Psychological Sciences and Social Sciences, 68*(1), 8-12.

Paap, K. R., & Greenberg, Z. I. (2013). There is no coherent evidence for a bilingual advantage in executive processing. *Cognitive Psychology*, *66*, 232–258.

Paap, K. R., & Liu, Y. (2014). Conflict resolution in sentence processing is the same for bilinguals and monolinguals: The role of confirmation bias in testing for bilingual advantages. *Journal of Neurolinguistics, 27,* 50–74.

Peal, E.,& Lambert, W. (1962). The relation of bilingualism to intelligence. *Psychological Monographs: General and Applied, 76*, 1–23.

Pelham, S. D., Abrams, L. (2014). Cognitive advantages and disadvantages in early and late bilinguals. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 40*(2), 313-325.

Perani, D., Paulesu, E., Galles, N. S., Dupoux, E., Dehaene, S., Bettinardi, V., et al. (1998). The bilingual brain: Proficiency and age of acquisition of the second language. *Brain, 121,* 1841–1852.

Perani, D., Abutalebi, J., Paulesu, E., Brambati, S., Scifo, P., Cappa, S. F. & Fazio, F. (2003). The role of age of acquisition and language usage in early, high-proficient bilinguals: An fMRI study during verbal fluency. *Human Brain Mapping, 19*, 170–182.

Peretz, I., & Zatorre, R. J. (2005). Brain organization for music processing. *Annual Review of Psychology, 56*, 89–114.

Pintner, R. (1932) The influence of language background on intelligence tests. *Journal of Social Psychology, 3*, 235-240.

Portocarrero, J. S., Burright, R. G. & Donovick, P. J. (2007). Vocabulary and verbal fluency of bilingual and monolingual college students. *Archives of Clinical Neuropsychology, 22*, 415–422.

Roberts, P. M., Garcia, L. J., Desrochers, A., & Hernandez, D. (2002). English performance of proficient bilingual adults on the Boston Naming Test. *Aphasiology, 16,* 635–645.

Rosselli, M., Ardila, A., Araujo, K., Weekes, V. A., Caracciolo, V., Padilla, M., et al. (2000). Verbal fluency and repetition skills in healthy older Spanish–English bilinguals. *Applied Neuropsychology, 7*, 17–24.

Saer, D. J. (1923). The effect of bilingualism on intelligence. *British Journal of Psychology General Section, 14*(1), 25–38.

Salvatierra, J. L., & Rosselli, M. (2010). The effect of bilingualism and age on inhibitory control. *International Journal of Bilingualism, 15*(1), 26–37. Doi:10.1177/ 1367006910371021.

Baptista, C. S., & Johansen-Berg, H. (2017). *White matter plasticity in the adult brain. Neuron, 96*(6), 1239-1251.

Shin, H. B., & Kominski, R. A. (2007). Language use in the United States: 2007. *American Community Survey Reports.*

Singh, N., & Mishra, R. K. (2012). Does language proficiencymodulate oculomotor control? Evidence from Hindi–English bilinguals. *Bilingualism: Language and Cognition, 15*, 771–81.

Smith, Frank (1923). Bilingualism and mental development. *British Journal of Psychology, 13*(3), 271-282.

Tao, L., Marzecová, A., Taft, M., Asanowicz, D., & Wodniecka, Z. (2011). The efficiency of attentional networks in early and late bilinguals: the role of age of acquisition. *Frontiers in psychology, 2*, 1-19.

Tse, C. S., & Altarriba, J. (2012). The effects of first-and second-language proficiency on conflict resolution and goal maintenance in bilinguals: Evidence from reaction time distributional analyses in a Stroop task. *Bilingualism: Language and Cognition*, *15*(3), 663-676.

United Nations (2013). World population ageing. 2013. *Department of Economic and Social Affairs Population Division.* Retrieved from http://www.un.org/en/development/desa/population/publications/pdf/ageing/WorldPopulationAgeing2013.pdf.

Weber-Fox, C. M., & Neville, H. J. (1996). Maturational constraints on functional specializations for language processing: ERP and behavioral evidence in bilingual speakers. *Journal of Cognitive Neuroscience, 8*(3), 231-256.

Wilson, R. S., Mendes De Leon, C. F., Barnes, L. L., Schneider, J. A., Bienias, J. L., Evans, D. A., & Bennett, D. A. (2002). Participation in cognitively stimulating activities and risk of incident Alzheimer disease. *The Journal of the American Medical Association, 287*(6), 742–748.

Yang, H., Hartanto, A., & Yang, S. (2015). The importance of bilingual experience in assessing bilingual advantages in executive functions. *Cortex, 75*, 237-240.

Yoshioka, J. G. (1929). A study of bilingualism. *The Pedagogical Seminary and Journal of Genetic Psychology*, *36*(3), 473-479.

Zied, K. M., Phillipe, A., Karine, P., Valerie, H. T., Ghislaine, A., & Arnaud, R. (2004). Bilingualism and adult differences in inhibitory mechanisms: Evidence from a bilingual Stroop task. *Brain and Cognition*, *54*(3), 254-256.

Zevin, J. D., & Seidenberg, M. S. (2002). Age of acquisition effects in word reading and other tasks. *Journal of Memory and Language*, *47*, 1–29.

APPENDIX A

LANGUAGE EXPERIENCE AND PROFICIENCY QUESTIONNAIRE

Northwestern Bilingualism & Psycholinguistics Research Laboratory
Marian, Blumenfeld, & Kaushanskaya (2007). The Language Experience and Proficiency Questionnaire (LEAP-Q): Assessing language profiles in bilinguals and multilinguals. *Journal of Speech Language and Hearing Research, 50* (4), 940-967.
Adapted to pencil-and-paper version by Marilyn Logan

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.):

Culture: _____

0 (No identification) 1 (Very low identification) 2 3 4 5 (Moderate identification) 6 7 8 9 10 (Complete identification)

Culture: _____

0 1 2 3 4 5 6 7 8 9 10

No identification | Very low identification — Moderate identification — Complete identification

Culture: _____

0 1 2 3 4 5 6 7 8 9 10

No identification | Very low identification — Moderate identification — Complete identification

Culture: _____

0 1 2 3 4 5 6 7 8 9 10

No identification | Very low identification — Moderate identification — Complete identification

Culture: _____

0 1 2 3 4 5 6 7 8 9 10

No identification | Very low identification — Moderate identification — Complete identification

(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
☐ High School
☐ Professional Training
☐ Some College
☐ College
☐ Some Graduate School
☐ Masters
☐ Ph.D./M.D./J.D.
☐ 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 (**native** **second** **third** **fourth** **fifth**) language.

(1) Age when you…

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

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

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

(3) Please circle your *level of proficiency* in speaking, understanding, and reading in this language:

Speaking

0	1	2	3	4	5	6	7	8	9	10
None	Very low	Low	Fair	Slightly less than adequate	Adequate	Slightly more than adequate	Good	Very good	Excellent	Perfect

Understanding spoken language

0	1	2	3	4	5	6	7	8	9	10
None	Very low	Low	Fair	Slightly less than adequate	Adequate	Slightly more than adequate	Good	Very good	Excellent	Perfect

Reading

0	1	2	3	4	5	6	7	8	9	10
None	Very low	Low	Fair	Slightly less than adequate	Adequate	Slightly more than adequate	Good	Very good	Excellent	Perfect

(4) Please circle how much the following factors contributed to you learning this language:

Interacting with friends

0	1	2	3	4	5	6	7	8	9	10
Not a contributor	Minimal contributor				Moderate contributor					Most important contributor

Interacting with family

0	1	2	3	4	5	6	7	8	9	10
Not a contributor	Minimal contributor				Moderate contributor					Most important contributor

Reading

0	1	2	3	4	5	6	7	8	9	10
Not a contributor	Minimal contributor				Moderate contributor					Most important contributor

Language tapes/self-instruction

0	1	2	3	4	5	6	7	8	9	10
Not a contributor	Minimal contributor				Moderate contributor					Most important contributor

Watching TV

0	1	2	3	4	5	6	7	8	9	10
Not a contributor	Minimal contributor				Moderate contributor					Most important contributor

Listening to the radio

0	1	2	3	4	5	6	7	8	9	10
Not a contributor	Minimal contributor				Moderate contributor					Most important contributor

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

Interacting with friends

0	1	2	3	4	5	6	7	8	9	10
Never	Almost Never				Half of the time					Always

Interacting with family

0	1	2	3	4	5	6	7	8	9	10
Never	Almost Never				Half of the time					Always

Watching TV

0	1	2	3	4	5	6	7	8	9	10
Never	Almost Never				Half of the time					Always

Listening to radio/music

0	1	2	3	4	5	6	7	8	9	10
Never	Almost Never				Half of the time					Always

Reading

0	1	2	3	4	5	6	7	8	9	10
Never	Almost Never				Half of the time					Always

Language-lab/self-instruction

0	1	2	3	4	5	6	7	8	9	10
Never	Almost Never				Half of the time					Always

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

0	1	2	3	4	5	6	7	8	9	10
None	Almost none	Very light	Light	Some	Moderate	Considerable	Heavy	Very heavy	Extremely heavy	Pervasive

(7) Please circle how frequently others identify you as a non-native speaker based on your <u>accent</u> in this language:

0	1	2	3	4	5	6	7	8	9	10
Never	Almost Never				Half of the time					Always