The Lasting Effects of Language Acquisition: Testing Cognitive Abilities after L2 Attrition

Kelly Kendro

A Thesis Submitted in Partial Fulfillment of the

Requirements for the Degree of Bachelor of Arts

with Honors in Cognitive Science

from the University of Michigan

2019

Advisor: Dr. Julie Boland, Departments of Psychology and Linguistics

Second Reader: Dr. Lorenzo García-Amaya, Department of Romance Language and Literatures

This research was funded through a grant from the University of Michigan Honors Program.

Table of Contents

List of Tables

List of Figures

Abstract

Decades of psycholinguistic research have attempted to determine whether a "bilingual advantage" exists for cognitive abilities (e.g., Bialystok & Craik, 2010; Cummins, 1977; for a meta-analysis, see Grundy & Timmer, 2017). More recent work has shifted away from investigating the broader questions of cognition and working memory (WM) to focus on specific domains within those capacities (e.g., Linck, Osthus, Koeth, & Bunting, 2014). Despite the multitude of studies examining differences between monolinguals and bilinguals, individuals who have undergone second language loss (L2 attrition) have often been overlooked in this literature and absent from cognitive task performance comparisons, leaving questions as to what "bilingual advantage" may endure after the attrition process. The current study utilized Amazon Mechanical Turk's TurkPrime platform to recruit and test English monolinguals (n = 29), English-Spanish bilinguals (n = 20), and English speakers with an attrited L2 of Spanish (n = 27) in working memory and cognitive control tasks (digit spans, reading span, numerical Stroop), as well as a survey of language acquisition, contact, and use (modified from Freed et al., 2004). A test of Spanish language knowledge was also administered to the bilingual and attrition groups. Results confirm the existence of an advantage over monolinguals for bilinguals and attriters on the forward digit span task. These findings imply that some language-based enhancement of cognitive capacity exists for bilinguals and L2 learners, which is retained despite loss of conscious language knowledge (L2 attrition). These cognitive expansion effects are posited to occur as a result of the language acquisition process, in order to facilitate the concurrent management of an L1 and an L2. Surprisingly, attriters were found to have an advantage over bilinguals and monolinguals on multiple cognitive tasks, the implications of which are discussed

Keywords: L2 attrition, working memory, cognitive control, bilingual, Spanish, English

Acknowledgements

This research was carried out under the guidance of Dr. Julie Boland, to whom I am incredibly thankful. Her mentorship and encouragement allowed me to explore this topic, and her thoughts regarding the project were instrumental for its realization as an experiment and thesis. Dr. Boland is the reason I will continue studying Psycholinguistics; she believed in me and gave me a chance to explore language processing on multiple fronts.

Dr. Lorenzo-García Amaya and Dr. Nicholas Henriksen have helped shape my thoughts regarding second language acquisition, as well as the many research methods available for testing bilinguals and language learners. Their lab has been crucial to my confidence and experience as a researcher. I am especially appreciative for Dr. García Amaya's insight and recommendations for this paper as its second reader.

I am indebted to the University of Michigan Honors Program, as well the Honors Summer Fellowship program, for its moral and financial support. My outstanding cohort kept me humble, and the program's training and assistance in Summer 2018 were invaluable to my project. Our advisors Megan Taylor and Nita Kedharnath were a source of positivity and encouragement throughout the entire experience. There are no words to describe how grateful I am for Dr. Mika LaVaque-Manty's belief in this project and decision to fund it.

The research process itself has been a huge undertaking, one that has only been completed thanks to the feedback I have received along the way. I thank my research assistant, Tiernan Mackela who helped this project from its first pilot through the editing process. Without her help, I would not have been ready to test participants or able to sift through the massive amounts of data generated. Emily E. Sabo helped me contextualize the Spanish proficiency data, and her input was crucial to the interpretation of those results. Kelly Wright has been beyond supportive both with this project and throughout my undergraduate years, offering help and guidance in so many ways. The teammates in my labs over the years have helped me find my footing and strength as a researcher, as well as providing valuable feedback on my projects— Annika Topelian, Claire Weil, Jocelyn Brickman, Rachel E. Weissler, Rundi Guo, and everyone I've worked with in the Psycholinguistics Lab, Speech Production Lab, and Humanities Collaboratory.

This project went through many changes from its inception to its final result, and I deeply appreciate all of the feedback I received that contributed to its viability and completion. I am beyond grateful to the family members and friends who supported me throughout my undergraduate experience, especially Jessica Thompson, Emily Waldner, Jamie Lackner, and Emily Cox. My roommates, Brianna Wells and Katie Hall, were considerate as I focused deeply on my work.

Finally, this would never have been possible without the moral, intellectual, and linguistic support of Osama Hashem, who has helped and motivated me for the duration of my project and beyond. To everyone named and those I undoubtedly missed, thank you for your part in making this thesis happen.

The author may be reached at kjkendro@umich.edu.

The Lasting Effects of Language Acquisition: Testing Cognitive Abilities after L2 Attrition

Whether from birth or later on, a majority of the world is fluent in at least two languages. Though the exact percentage of bilinguals, trilinguals, and multilinguals is difficult to determine, several estimates put that number at more than half of the global population (Ansaldo, Marcotte, Scherer, & Raboyeau, 2008; Tucker, 1999). Despite this, language acquisition is often still examined in a monolingual context, with second language acquisition occupying a different space in the field. Indeed, the discovery that bilinguals are not “two monolinguals in one person,” but rather a single person possessing both knowledge of multiple languages as well as the cognizance to utilize each language in the appropriate contexts (Grosjean, 1989), was a groundbreaking idea to linguists studying the phenomenon.

The United States defies this worldwide trend. A mere 22% percentage of the US population is bilingual according to the most recent approximations, a number that has nearly doubled since the 1980s (Grosjean, 2018). There is no national foreign language requirement to complete compulsory schooling in the United States, unlike mandates present in other highly bilingual areas including the European Union (Devlin, 2015). In fact, in 2017 only 20% of students in the US educational system were studying one or more foreign languages, compared to a median of 92% in that same year for students in EU countries (Devlin, 2018).

More recently, bilingualism has been studied in the context of cognition. Psychologists and Cognitive Scientists, among others, seek to determine whether cognitive advantages exists for bilinguals and multilinguals when compared to monolinguals, the existence of which may provide an additional reason for monolinguals to prioritize learning foreign languages. An underrepresented yet equally important area to consider during this research, then, is the possibility for lasting cognitive effects present in individuals who have previously studied and attained some level of proficiency in a foreign language but are currently only functionally-monolingual speakers of their native language; these speakers are said to have undergone language attrition, or loss.

The current study administered cognitive tasks to a group of these speakers with an attrited second language, comparing them to monolinguals and bilinguals who completed those same tasks. It sought to determine i) if a bilingual difference exists in those tasks, ii) if any bilingual difference is preserved even after L2 attrition, and iii) if there is any correlation between current second language knowledge and performance on the cognitive tasks.

Background

Before a person can learn a second (or foreign) language, a first language (L1) must be acquired; to understand and investigate second language (L2) acquisition, L1 acquisition must, therefore, also be understood. Barring extreme circumstances, every human learns a language from a young age by listening to the environment in which they live. Infants can acquire the phonology, or sound patterns, of the sounds present in all human languages due to perceiving minute differences in speech production; this remarkable ability is active until about the age of 10 months (Eimas et al., 1971; Werker & Tees, 1992). Some infants learn two or more languages from birth, which results in the process known as Bilingual First Language Acquisition— these infants are bilingual from birth, meaning that they in fact have two "first languages." Others are exposed to a language in some capacity, leading to an understanding of that language without the ability to produce complex utterances. These speakers, called heritage speakers, are classified as individuals proficient in the majority language of their area, who grew up in contact with a language spoken at home or by family (Polinsky, 2011). Bilingualism is defined in this paper as sustained competency in two languages at the intermediate level or above; this definition encompasses both native speakers of two languages as well as those who learned their L2 later in life. Some heritage speakers may consider themselves bilingual despite not having the vocabulary and communicative skills that bilinguals are typically considered to have; this alludes to their confidence in the language, though they may not perform as well as traditional bilinguals in some measures of language knowledge (e.g., written measures).

L2 Acquisition and Language Maintenance

The study of L2 acquisition, used here to refer to the process of nonnative language acquisition (through either "naturalistic" implicit or "structured" explicit learning) by someone in late adolescence or adulthood, makes up the field of Second Language Acquisition (SLA). This phenomenon has largely been studied in primarily monolingual-majority settings in which children are not raised bilingual from birth, though the field has also expanded to include heritage language learning (Ortega, 2009). The acquisition of a foreign language (L3) by a bilingual is studied separately in the rapidly growing field of Third Language Acquisition. Studies in SLA have historically focused on monolingual-level competency in both languages as the standard to which bilinguals and second language learners must aspire (Grosjean, 1989). The importance of SLA as a field cannot be overstated, as studying language acquisition explores questions of cognition and neural plasticity as prevailing changes across the human lifespan, rather than ending after puberty or the maturation of the prefrontal cortex; it is likewise connected to other fields, including: Linguistics, Language Pedagogy, Cognitive Science, Psycholinguistics, Neurolinguistics, and Public Policy.

Just as a person can acquire a language, they may also attrite, or lose, it. Language attrition is understood to be "the non-pathological decrease in a language that had previously been acquired by an individual" (Köpke and Schmid, 2004). The onset and degree of language attrition are widely thought to be influenced by five major factors: typological distance between the L1 and L2, attitude and motivation toward the attrited language, the environment in which the attrited language was acquired, the amount of time elapsed since the last use of the attrited language, and the speaker's highest proficiency level in the attrited language (Weltens and Grendel, 1993). This paper focuses on L2 attrition: the loss of a nonnative language acquired post-childhood. Language attrition has been studied most often in the L1, with linguistic production tasks by Ventureya et al. (2004) and neuroimaging studies by Pallier (2007) providing evidence for complete loss of the language. It must be noted, however, that subsequent work by Oh et al. (2003, 2010) looking at acquisition and "re-acquisition" of a language has found that it is easier for someone with an attrited L1 to master native-like pronunciation than someone with no knowledge of the language, implying that the difficulty in producing the attrited language may be due to a lack of cognitive access to the linguistic information rather than a total loss of language knowledge.

Possible components of language maintenance. In 2010, Bardovi-Harlig and Stringer identified sub-factors for language maintenance within the five categories proposed by Weltens and Grendel (1993): the duration and nature of the L2 instruction, the duration and nature of immersion in an L2 environment, and the duration and nature of reduced input and use of the L2. They also mention age and aptitude as variables that are unique to each learner, while acknowledging that factors pertaining to the speaker's acquisitional L2 knowledge (sociopragmatics, literacy, oral competence, explicit knowledge, and peak attainment) are instrumental when creating a model of L2 attrition. Conversely, it has also been argued that L2 attrition is caused by incomplete L2 acquisition (Montrul, 2002) rather than the factors that are known to contribute to L1 attrition, with the reasoning that L1 acquisition is all but universal while total L2 acquisition is more difficult. It would seem that the “peak language proficiency in the attrited language” variable proposed by Weltens and Grendel encompasses the possibility of incomplete acquisition; in this paper, incomplete acquisition is therefore not considered separately from the other suggested acquisitional factors of attrition.

Much like the presumed factors for language attrition, there exist factors that are suggested to facilitate language acquisition and mastery. The age of learners as they begin to acquire a language is often cited as an integral factor in L2 acquisition, as it is linked to physical and neurological maturation that affect language-learning mechanisms. The existence of some “critical period” for language acquisition was posited over fifty years ago by Eric Lenneberg, who believed that biological mechanisms were available to aid young children in the acquisition of their native language during their first seven years of life (1967). Later linguists (most notably Johnson and Newport, 1989) modified this hypothesis to include some cognitive or neural mechanisms that allowed prepubescent learners to completely acquire a second language; these facilitatory processes were said to not be present in older (post-pubescent) learners, preventing them from fully acquiring L2 morphosyntactic features. However, multiple studies (Ioup et al., 1994; Bongaerts, 1999) have found “exceptional” cases in which later learners reach native-like proficiency in their use of L2 phonology and morphosyntax. The implication that age may have an effect on the degree to which an L2 is acquired, yet not be the most important factor, has led some to instead refer to the hypothesized “critical” period as a “sensitive” period. Despite this shift, L2 acquisition is specifically studied in the context of later learners (i.e., not children) due to their widely observed difficulties in L2 mastery.

Another factor that may contribute to a higher degree of acquisition is the environment in which the language acquisition occurs. Some linguists make a distinction between L2 acquisition and foreign language acquisition, arguing that the latter must take place in a context where the L2 is the majority language while the former merely refers to language acquisition in a classroom setting. However, these criteria become blurred upon the introduction of the study abroad context. “Study abroad” encompasses all experiences in which a person receives instruction using the L2 while in a place that the L2 is widely spoken, allowing for both formal instruction in the L2 and prolonged exposure to the language in a more practical environment. Though research joining SLA with study abroad has produced mixed results (Seliger, 1977; Day, 1985; Higgs and Clifford, 1982), it is generally accepted that studying abroad can be beneficial to L2 acquisition. In this paper, the term “L2 acquisition” is used interchangeably with “foreign language acquisition,” as is “L2 learning” with “foreign language learning.”

In this study, data regarding a variety of language maintenance factors was gathered. Although there may be many elements contributing to the processes of L2 acquisition and attrition, period of disuse was more closely examined as it is a factor unique to the L2 attrition process. In effect, it was considered a predictor for degree of L2 attrition.

Memory and Cognitive Function

The term cognition is broadly used to describe the many functions performed by the mind while managing information. The majority of this data is processed with the mechanisms present in executive function (EF), which encompasses a range of separate operations that collectively determine “purposeful, goal-directed, problem-solving behavior” (Gioia, Isquith, and Guy, 2001). Different aspects of EF are responsible for a myriad of tasks including planning, attention, and feedback incorporation, which come together to learn new information and act accordingly. Cognitive control and working memory are two capacities used to manage the information available to an individual which are associated with EF.

Cognitive control. Though difficult to completely define due to its many facets, cognitive control is thought to be a component of EF that modulates the various aspects a person may "control" as they determine both their intake from and responses to a stimulus (Mackie, Van Dam, & Fan, 2013). It further assists in the suppression of irrelevant information and maintained attention of important information, as well as the ability to carry out multiple lines of thought at one time (i.e., multitasking). Bilinguals additionally have a "language control," which determines which of their two languages must be accessed and utilized at any given time (Emmorey, Luk, Pyers, & Bialystok, 2008).

Cognitive control may be tested by using tasks such as the Stroop task (Stroop, 1935), which allows switching and suppressive cognitive mechanisms to be tested. In the classic version of the task, participants are asked to look at a list of words (the names of colors) and respond by naming the color in which the word is written, rather than reading the word itself. A non-linguistic iteration of this task using digits rather than words can also be used, typically when testing monolinguals and bilinguals; a numerical Stroop may involve counting, reporting a specific (e.g., typologically biggest or smallest, numerically largest or smallest) digit, or simply stating how many digits appear. In a study carried out by Hernández, Costa, Fuentes, Vivas, & Sebastián-Gallés (2010), a bilingual advantage over monolinguals was found in a numerical Stroop task: bilinguals were faster, showed a higher facilitatory effect (for incongruent trials), and showed a smaller interference effect (for incongruent trials).

Types of memory. Memory can be divided into two general capacities: Long-Term Memory (LTM), which keeps information for an indefinite amount of time, and Short-Term Memory (STM), which stores information for a much shorter amount of time, thought to be 30 seconds or less (Atkinson & Shiffrin, 1968; Posner, 1966). Several studies have confirmed the distinct capacities of LTM and STM, noting that LTM is intact in cases when components of STM are impaired (e.g., Basso, Spinnler, Vallar, & Zanobio, 1982; Warrington, Logue, & Pratt, 1971; Hanley, Young, and Pearson, 1991), as well as cases in which LTM impairment not affecting STM (e.g., Cave & Squire, 1992; Wilson & Baddeley, 1988); however, knowledge must first be held in STM before reaching LTM (Atkinson and Shiffrin, 1968). In addition to these information-storage domains, there is a separate type of "memory" called Working Memory (WM), which significantly overlaps with STM, that is used to immediately process information. Psychologist Alan Baddeley defines WM as an assumed capacity that functions as "a temporary storage system under attentional control that underpins our [ability] for complex thought" (2007). WM has a limited capacity, famous theorized to be "seven, plus or minus two" (Miller, 1956), though subsequent research suggests that this capacity varies based on the nature of the task's demands (Daneman & Carpenter, 1980; Wickens, 1984). Crucially, WM aids in the acquisition of what will be later stored in both STM and LTM as "a broader system typically involving attentional control and allowing the manipulation of information held in short-term storage" (Baddeley, 2007). Included in WM are various functions related to instantaneous and continuous processing related to novel information, including updating, storage, recall, and selection.

Models of working memory. Despite what is already known about WM, there exist many WM models with varying amounts of structure shared. Three overarching WM frameworks, illustrated in this section, are prevalent in the study of L2 acquisition: domain-specific single-resource models, domain-specific multiple-resource models and domain-free connectionist models.

Domain-specific multiple-resource models. Baddeley's model of working memory (see Figure 1) is perhaps the most widely known. Along with Graham Hitch, he originally posited that within WM exist three components providing distinct but limited functions: the central executive, a phonological loop, and a visuo-spatial sketchpad (1974). Baddeley later expanded on this model in 2000 (see Figure 2) to include a fourth component, an episodic buffer, which existed on the same hierarchical level (i.e., below the central executive) as the phonological loop and the visuo-spatial sketchpad. The phonological loop contains a phonological store, which contains the individual phonemes heard, and an articulatory rehearsal mechanism, which repeats that information before it is retrieved to combat its erasure due to the presence of new stimuli. The visuo-spatial sketchpad stores similar information that is related to visual and spatial dimensions to create and manipulate a "mental image" while thinking. Baddeley's later addition, the episodic buffer, acts as a go-between to combine information stored in the phonological loop and visuo-spatial sketchpad, as well as on a larger scale as a mechanism to link WM and LTM. Lastly, the central executive oversees all of these processes to use the gathered information and choose an appropriate reaction.

Verbal ability in working memory, most often tested by the reading span task developed by Daneman and Carpenter (1980), is thought to depend on aspects of both the phonological loop and the visuo-spatial sketchpad. In 1996, Waters and Caplan proposed their own new dimensions to verbal resources (i.e. syntactic, semantic, and storage-based components) in WM. Based on a series of experiments using tasks from the Daneman and Carpenter reading span battery, they determined that minor linguistic changes to stimuli greatly impacted task performance. The pair concluded that there must be some verbal WM system in which multiple modules (including storage) work together rather than one broad "verbal" component. They believe that there are many resources that can be depleted as these functions are carried out in the broader domains of WM rather than some single resource that is distributed across all dimensions of working memory, as is present in domain-specific single-resource models.

Domain-specific single-resource model. Just and Carpenter (1992) studied a different aspect of working memory: storage capacity. They specifically focused on the complex role of WM in language comprehension, arguing that it is completely housed in the central executive capacity proposed by Baddeley and Hitch and not aided by a phonological loop. The Just and Carpenter model rests on the existence of a limited amount of "activation" present in WM, which encompasses the mind's ability to dedicate resources to WM systems. This activation may be allocated to one task or many, though the total amount of potential activation never changes; when a task is not allocated enough activation, the task's performance is impeded. They reasoned that both the visuospatial sketchpad and the phonological loop execute and facilitate their functions by relying heavily on storage and processing (activation), which in turn relies on the individual's storage capacity (total amount of potential activation). Devoting too much activation to storage hinders processing, just as devoting too much activation to processing hinders storage; this model is referred to as "single-resource" as the total amount of available activation must account for WM processes in every domain.

Domain-free connectionist models. Unlike the aforementioned discussed views, connectionist models of working memory as described by Cowan (2005) do not consider storage and processing to be completely separate functions. In these models, WM is instead counted as the part of LTM devoted to attentional control, the mechanism determining which information that is accepted for the LTM store. These models consider WM capacity to represent the amount of attention allocated to a task; components of other WM models, such as the phonological loop and visuo-spatial sketchpad, temporarily store limited amounts of information before WM transfers it to the unlimited LTM storage capacity.

Language Knowledge and Cognition

Working memory and cognitive control have been studied in several populations with varying amounts of language knowledge, including monolinguals, bilinguals, heritage speakers, L2 learners, and language attriters. The majority of work comparing populations has occurred between bilingual and monolingual speakers, while heritage speakers and L2 learners have been sparsely studied. The results of these investigations are often contradictory from one study to the next, as variations in methodology can cause minute differences in the cognitive functions being studied. Further complicating these questions is the unpleasant truth that language-based cognitive differences between bilinguals and heritage speakers are understudied; therefore, it is not yet known how bilinguals and heritage speakers may perform differently on cognitive tasks. These field-wide issues notwithstanding, patterns generally indicate that language knowledge may have a positive effect on cognition.

Cognitive differences in bilinguals. Various studies have shown significant differences between bilinguals and monolinguals in performance on cognitive tasks, though these effects do not uniformly demonstrate a bilingual or monolingual advantage (see also *Task effects and language knowledge*, below). In a 2017 meta-analysis of studies involving children (aged 14 and younger), young adults (aged 14-22), and older adults (aged 35-70), Grundy and Timmer found an overall positive effect of bilingualism for WM ($r = .2$); they propose that the effect may be attributed to higher demands on WM capacity in bilinguals, which gradually expands that capacity. However, this bilingual advantage was only found when bilinguals were given tasks in their L1; bilingual performance on WM tasks in the L2 was worse than the performance by monolinguals. The paper further suggests that language knowledge directly and positively affects WM capacity, though this finding varies with the age of the participants (see also *Age*, below).

Cognition of heritage speakers. The cognitive effects of heritage language knowledge have been sparsely studied and highly speculative, leading to questions about the nature of heritage language knowledge and its connection with cognition in an auditory domain. Bolger and Zapata (2011) refer to the components of WM that are present during processing as "language mode" and assert that a cross-modal design (i.e., involving both visual and aural dimensions) is necessary to test these capacities due to potentially diminished or nonexistent heritage language abilities for heritage speakers in one sensory domain or the other. In short, they believe that heritage speakers with higher auditory comprehension capabilities in their heritage language may perform better than monolinguals on WM tasks using auditory stimuli due to their experience with multiple languages, whereas the same effects may not be found in tests involving reading comprehension or written production. With this account heritage speakers may not perform differently than monolinguals with WM tasks such as reading span, which involves a written component, while digit span tasks, which are all but completely auditory in nature, may show some advantage for heritage speakers that is associated with their language knowledge.

Torres (2013) investigated processing and inhibitory control in heritage speakers, finding a slight advantage for heritage speakers in inhibitory tasks but similar effects of task complexity in heritage speakers when compared to L2 learners. These results indicate that, to the extent possible, heritage speakers must be studied separately from monolinguals, bilinguals, and L2 learners in order to understand how the differences in language knowledge and acquisition cognitively manifest in this group.

L2 learners and cognition. Heritage speakers are not the only group with limited knowledge of a second language. A variety of studies have investigated the relationship between cognition and language knowledge in those who are currently attempting to become bilingual at a later stage in life: L2 learners. The pattern of language knowledge as an indicator for some superior cognitive performance in bilinguals over monolinguals holds in studies involving L2 learners as well. Furthermore, studies of working memory during L2 acquisition (see a review in Sagarra, 2012) support WM as a predictor for language comprehension and production. Some studies have incorporated cognitive tasks in both the L1 and the L2 (e.g., Alptekin & Erçetin, 2010; see *Task effects and language knowledge*), finding some language-specific effects that support cognitive changes occurring alongside language acquisition.

Language loss. Language attrition is not solely a matter of forgetting. Ecke (2004) gives many other factors that may affect or trigger attrition, namely: repression and suppression, distortion, decay, retrieval failure or slowing, interference, cue-dependent retrieval, and loss of access to a self-contained cognitive system for language. Language attrition has only begun to be studied in conjunction with cognition, almost exclusively in the context of attrited L1, to decipher the cognitive mechanisms underlying the process. Köpke (2007) opines that memory may be at the core of language attrition. In the case of working memory, specifically as a capacity for processing but not necessarily producing language, she (drawing on the ideas of Anderson, 2003) posits that the central executive (as proposed by Baddeley and Hitch, 1974) may be overriding the inhibitory response honed by bilinguals in an attempt to better function in the non-attrited language. The study of language attrition is unique in that it provides further evidence for language-based changes in cognition— perhaps in even more compelling ways than results from studies involving bilinguals, as language attrition can provide evidence for altered cognitive abilities due to language abilities rather than appearing alongside that language knowledge. However, such few data exist regarding cognitive abilities after attrition that it is nearly impossible to make predictions about how working memory and cognitive control are affected by L2 attrition: are the same changes present in bilinguals and attriters?

Additional factors. Linguistic knowledge is not be the only reason for cognitive differences among individuals. In order to more clearly observe group differences among bilinguals, monolinguals, and attriters, these additional factors must be measured and, to the extent possible, controlled across the three groups. These factors that may influence language-associated performance on these tasks include age, socioeconomic status (SES), the tasks used, and stage of acquisition.

Age. Performance on working memory tasks has been linked to age-related changes in multiple groups. The "bilingual difference" showing significant disparities in WM between bilinguals and monolinguals has most consistently been found in children and older adults. Bilingual children often demonstrate cognitive advantages (for a meta-analysis of comparative cognitive performance in bilinguals and monolinguals, see Adesope, Lavin, Thompson, & Ungerleider, 2010) when compared to their monolingual peers. These effects led Hakuta (1986) to write:

> [S]tudies suggest the following conclusion: take any group of bilinguals who are approximately equivalent in their L1 and L2 abilities and match them with a monolingual group for age, socioeconomic level, and whatever other variables you think might confound your results. Now, choose a measure of cognitive flexibility and administer it to both groups. The bilinguals will do better.

This view is supported by research conducted on children looking at cognitive performance. Bialystok, Martin, & Viswanathan (2005) found significant differences in reaction time on a conflict task, with the bilingual participants responding much more quickly than their monolingual counterparts. Similarly, Bialystok (2003) found higher levels of cognitive and attentional control in bilingual children when compared to their monolingual counterparts. Diaz (1985) saw a positive correlation between degree of L2 knowledge in bilingual children and their performance on cognitive tasks of verbal and nonverbal ability; this finding is supported in the previously mentioned L2 learners.

Differences in cognitive task performance are rarely found in young adult bilingual and monolingual groups. Bialystok et al. (2005) hypothesized that WM differences in bilinguals and monolinguals were not salient in this population due to that age group functioning at “peak” cognitive function. Grundy and Timmer (2017) further added to Bialystok’s view, positing that either a linear increase in WM performance would occur across an individual’s lifespan as (L2) language knowledge is acquired, or that bilingual and monolingual children would show the largest difference in performance on WM tasks due to the heavy cognitive load imposed by early language acquisition. After reviewing studies that controlled for potential confounds including socioeconomic status and performance on measures of intelligence, they concluded that the latter is more likely, and the results presented indicate that these expansion effects may positively correlate with L2 knowledge (and, potentially, use).

The processing benefits enjoyed by younger adults appear to plateau between the ages of 20 and 30, later gradually declining until the age of 60 (Bialystok et al., 2005). WM then likely remains stagnant for a majority of the lifespan: Dobbs and Rule (1989) discovered two declines in WM performance in aging adults: one occurring between the ages of 60 and 69, and the other occurring after the age of 70.

Socioeconomic status. Another factor that potentially effects performance in cognitive tasks is an individual's socioeconomic status. In a study of bilingualism and executive functioning (including working memory and cognitive control), Calvo and Bialystok (2014) found significant effects of children's SES on language skills and cognitive performance. Though bilingual children performed better on cognitive tasks, they suffered on language measures; SES was positively correlated with performance on the verbal and executive function tasks. These SES effects were found across both language groups in children of the same race and ethnicity.

Task effects and language knowledge. Despite the widespread use of many cognitive tasks in psycholinguistic experiments, varied results cast doubt on what mechanisms they are actually targeting. Nevertheless, tests of working memory and cognitive control have looked at populations with similar language knowledge (i.e., L2 learners of varying proficiency) and differing language knowledge (i.e., monolinguals and bilinguals). This paper focuses on four cognitive tasks, namely reading span, forward digit span, backward digit span, and numerical Stroop.

Task descriptions. The reading span test (RST), originally created by Daneman and Carpenter (1980), tests WM storage and processing. The task requires participants to read sentences, which become progressively longer, aloud. Waters and Caplan modified the RST in 1996 by asking the participants to silently read the sentences (which undisputedly involves semantic processing) and make judgments on the plausibility of each sentence, a change that has led to the task being used to study cognitive aspects associated with reading (see *Effects of language knowledge*).

Digit span tasks, in which participants hear an incrementally-increasing string of numbers and must correctly recall each digit, probe phonological storage in WM. In the forward digit span task, participants simply repeat each string as they heard it; in backward digit span tasks, they repeat each string in the reverse order. Digit spans may be reported verbally or through written production. It is unclear if these tasks are probing the same WM mechanisms; Li and Lewandowsky (1995) posited that backwards digit span may actually involve visuo-spatial components of WM due to participants' backward, but not forward, digit span performance being affected due to changes in visuospatial components of the task. This was later supported by the work of St. Clair-Thompson & Allen (2013).

The Stroop (1935) task originally featured the names of colors written in both black ink (control condition) and multicolored ink (experimental condition), asking participants to read the words in black ink and state the color of the words in multicolored ink. When the names of the colors and the color of the ink did not match (incongruent), participants had slower reaction time. This effect can also be found in task variations that involve numbers rather than letters: some versions focus on physical size of the numbers (e.g., Paivio, 1975), while others focus on the number of digits present (e.g., Foreman et al., 1989).

Effects of language knowledge. It is still unclear whether second language knowledge has a positive, negative, or null effect on measures of working memory. Mixed results are found even using the same tasks, though this may be because the tasks are rarely standardized across experiments.

Digit span tasks have shown both a bilingual advantage and no group effects. Using a standardized measure, the Comprehensive Test of Phonological Processing (CTOPP; Wagner, Torgesen, & Rashotte, 1999), Kaushanskaya et al. (2011) and Kaushanskaya (2012) found a bilingual advantage whilst employing both forward and backward digit span. Conversely, Cole and Pickering (2010) used a separate measure of forward digit span and found no group effect, and Ratiu and Azuma (2015) similarly found no bilingual advantage over monolinguals in forward or backward digit span tasks.

Digit spans have also been used to test L2 learners, finding mixed results: Harrington and Sawyer (1992) used the forward digit span and the RST with intermediate L2 learners and found weak correlations between the digit span tasks and RST along with weak correlations between digit span performance and L2 reading comprehension (despite strong correlations between RST and L2 reading comprehension). Conversely, Kormos and Safar (2008) used a backwards digit span task to measure WM in a population of beginner L2 learners and found a statistically significant link between that task and performance on L2 proficiency measures which tested guided production, listening comprehension, reading comprehension, and spoken ability. Furthermore, they found no significant correlation between a non-word repetition task (thought to activate the phonological loop) and backwards digit span performance, signaling that different mechanisms are in use during each task.

Stroop (1935) tasks are widely used to test cognitive control. A bilingual iteration has been found in two separate iterations of the test: the conventional color-word version (Bialystok, Craik, and Luk, 2008), and a non-linguistic version using numbers (Hernández et al., 2012). The nonlinguistic Stroop task offers more compelling evidence for a bilingual advantage in cognitive control rather than one solely related to language processing.

As a language-based test, the Reading Span task has been used extensively in studies of L2 knowledge and working memory. Ransdell et al. (2006) used the RST to test bilingual and monolingual participants, resulting in bilinguals outperforming monolinguals. These results are consistent with later work from Biedroń and Szczepaniak (2012), who used a standardized RST measure, the Polish Reading Span (PRSPAN; Biedroń and Szczepaniak, 2012; adapted from Engle et al., 1999) to also find a bilingual advantage.

Studies involving reading span tasks and L2 learners have had more varied outcomes. Leeser (2007) used the Waters and Caplan RST (1996) to test beginner L2 learners of Spanish, discovering that WM (high, medium, and low performance) positively correlated with familiarity effects in L2 reading processing and comprehension. Likewise, Alptekin & Erçetin (2010) identified a positive correlation between RST performance and L2 reading comprehension; their study, however, included an RST in both the L1 and the L2. They ultimately found a stronger correlation between the L2 RST scores and L2 comprehension and a high correlation between L1 and L2 RST performance, indicating that (1) the cognitive mechanisms used to respond in the RST task are used in language processing, and (2) those same mechanisms are used for the RST task in both languages. Payne and Ross (2005) employed a non-word repetition task and an RST similar to the 1996 Waters and Caplan version in their study of casually guided written production in intermediate L2 learners. They found that better performance on the non-word repetition tasks was associated with an overall higher oral proficiency, while no strong correlations existed between oral proficiency and the RST. Curiously, participants with lower non-word repetition scores tended to produce larger quantities of the L2 in the guided production task (a chatroom setting) than in free spoken production (a classroom setting), and the reverse was true for higher- span participants; this indicates that WM does play some role in both the nature and extent of language production.

Research Questions

The current study aims to replicate cognitive differences between bilinguals and monolinguals in working memory and cognitive control. It also seeks to determine whether undergoing L2 attrition will result in participants performing more similarly to the bilingual group or the monolingual group. It will additionally attempt to determine whether the process of language acquisition (past the first language) has a permanent effect on these mechanisms, or if current L2 knowledge is a significant factor in attriters' cognitive performance.

It is hypothesized that a bilingual advantage will exist for some, perhaps all, performance on cognitive tasks, though this may be difficult to fully investigate if heritage speakers are found to be present in the bilingual group. It is further hypothesized that attriters will perform better than monolinguals on some cognitive tasks. Lastly, it is hypothesized that the advantage will also be present for L2 attriters and that current L2 knowledge will be positively correlated with attriter performance on both the Spanish proficiency measure and, to some extent, performance on cognitive tasks.

If some sort of lasting effect is found, it implies that the expansion effects of the increased cognitive load during early language acquisition, discussed by Grundy and Timmer (2017), also occur during later language acquisition (i.e., past the hypothesized "critical period"). This implication would be bolstered by any attrition-monolingual difference. However, if the group of L2 attriters performs similarly to the monolingual group, it suggests that the benefits and costs in cognitive processes experienced by bilinguals is somehow tied to the retention and management of L2 knowledge— though these potential group effects may be nonexistent or severely reduced if the bilingual group does, in fact, contain heritage speakers.

Method

Participants

Thirty monolingual speakers of English and 30 bilingual speakers of Spanish participated in the experiment, along with 30 native speakers of English who had attrited L2 knowledge of Spanish. All participants self-reported their language history and knowledge. Though heritage speakers were not recruited, heritage speakers who considered themselves bilinguals may have reported themselves as bilingual and, thus, participated as members of the bilingual group; due to the necessary written components of all working memory and cognitive control tasks (see *Cognition of Heritage Speakers*), the presence of these participants may lead to less clear data for comparisons with the bilingual group.

Participants were recruited via the Amazon Mechanical Turk (MTurk) TurkPrime system. MTurk is an online service designed to help quickly gather information. Information requesters pay "workers" a small fee to complete tasks (named Human Intelligence Tasks, or "HITs") such as answering surveys, writing short responses, and giving feedback for advertisements. Requesters have the ability to accept or reject workers after reviewing their submissions, thus controlling the quality of their responses. Demographic information is also collected from the workers, including gender, nationality, and age. Previous analyses of data generated through MTurk has indicated that the results are reliable as compared to in-person experiments, indicating that MTurk is a valid method of obtaining data for Social Science research (Buhrmester, Kwang, and Gosling, 2011).

TurkPrime (Litman, Robinson, and Abberbock, 2016) is a platform that integrates and expands upon the MTurk service, and its intended use is the acquisition of empirical research data. TurkPrime has criteria regarding workers, including their number of completed HITs and their overall percentage of approved HITs, which can be used to target the most conscientious workers. The current study only accepted workers who had completed more than 100 HITs and had an approval rating (meaning that they submitted usable data in accordance with the HIT parameters) of 95% or higher. The same demographic information is collected as with MTurk, though requesters may set additional or custom parameters as a filter for the target worker demographic. All workers were compensated $9 for their participation, a higher rate than the average $6.50 per hour earned via TurkPrime.

Per self-reported data in the pre-experimental TurkPrime screening and the administered language contact survey, the monolingual English speakers had no contact with any language other than English, the bilingual speakers were proficient in Spanish and English with an English Age of Acquisition (AOA) of 7 or earlier, and the group with attrited knowledge of Spanish had not significantly interacted with the Spanish language (defined as reading, speaking, writing, or intentional listening) in one year or more. All participants were between the ages of 35 and 55 (monolingual mean = 43.1; bilingual mean = 40.2; attriter mean = 41.5). The bilingual group on average had a Spanish AOA of 3.28 (SD = 5.64) and were native speakers of English, and the attriters on average had a Spanish AOA of 15.11 (SD= 7.44) and had not had any contact with the language in 10.45 years (SD = 7.17).

Procedure

The entire study was run through Qualtrics, a link to which was included in the TurkPrime HIT. Participants digitally signed informed consent forms before proceeding with the experiment, which, for attriters and bilinguals, consisted of all six tasks and was completed in the following order: forward digit span, reading span task, numerical Stroop, backwards digit span, Spanish proficiency measure, RLCP. Monolinguals completed tasks in the same order, though they did not complete a Spanish proficiency measure due to their reported lack of exposure to the language. Two of the four tasks, namely forward and backwards digit span, employed stimuli found in the Digit Span subtests from the Second Edition of the Comprehensive Test of Phonological Processing (CTOPP-2; Wagner, Torgesen, Rashotte, & Pearson, 2013). For each task, participants were given English instructions explaining the task; they then completed three practice trials for that task. Practice and experimental trials were clearly designated as such. All cognitive tasks were performed in English, regardless of group, due to a desire to standardize the tasks across all three groups and concerns about the higher cognitive load that Spanish tasks may impose on L2 attriters and unbalanced bilinguals who were dominant in English.

Digit spans. In both digit span tasks, participants heard a string of numerical digits, which increased in size throughout the duration of the task and had to enter each digit into a separate text entry box via the keyboard. In the forward iteration of the task, participants entered the digits into the boxes in the same order that they were heard; in the backwards iteration, participants entered the digits in the reverse order. Audio files played automatically, and the audio controls were hidden on the webpage. Additionally, a timed delay was introduced on the Qualtrics page to ensure that the participant was not inputting their responses as the audio played; this delay was 5000ms more than the length of the audio clip for each trial. Each audio file was on a separate page that required a "next" arrow to be clicked before the task would proceed. Both digit spans were scored based on correct responses, and the number of digits present in the trial in which the participant made an error was considered the participant's digit span.

Reading span. During the reading span task, which was based on the version of Daneman and Carpenter's 1980 measure that was created by Waters and Caplan (1996), participants read a series of sentences (each containing between four and eight words; adapted from Stone and Towse, 2015) and judged on the next page whether they were logical or illogical. At the end of a block, participants were asked to recall the final word in each sentence (which ranged between 1 and 4 syllables long) and enter each word into a separate text entry box via the keyboard. Blocks ranged between three and six sentences, and three blocks of the same size appeared consecutively before a group of blocks containing an additional sentence would appear. Blocks were clearly labeled “New Sentence Block” and “End of Block” in large, bolded red text, and the data entry portion occurred between blocks. The reading span task was designed to end when the participant either incorrectly produced or did not produce a trial word at the end of the block. The logicality judgments were not used to determine reading span. The stimuli used can be found in *Appendix A*.

Numerical Stroop. This numerical Stroop task (adapted from Foreman et al., 1989) was created for the present experiment. Each digit shown in the experimental trials was 1, 2, 3, or 4; the digits, likewise, appeared one, two, three, or four times. Participants had to determine the number of digits appeared on the screen, choosing from the four multiple choice options to indicate their answer. There were forty trials (20 congruent). Mouse click timing and number of clicks were recorded and used along with answers to determine accuracy, though participants were asked not to change their initial answers.

Spanish proficiency measure. After finishing all four cognitive tasks, participants in the bilingual and attrition groups completed an evaluation of their Spanish knowledge (*Appendix B*; full translation in *Appendix C*). Twenty-four multiple-choice questions from the reading comprehension section of the DELE (*Diplomas de Español como Lengua Extranjera*) exam’s model B1 (low-moderate proficiency) level, created by the Instituto Cervantes (2012), were used as a measure of participants’ language knowledge. The chosen questions were in “multiple choice” format, measuring reading comprehension and ability, and no typed data entry was required. Participants opened a PDF file containing the questions in another tab, and the answers were replicated on the Qualtrics page for them to select. All parts of this test were in Spanish, including instructions.

Language survey. Lastly, participants completed a survey (Appendix D) in English to determine the methods by which they acquired their Spanish knowledge and demographic information. This survey was a more extensive version of the Freed et al. (2004) Language Contact Profile, which was modified for this experiment (christened the Revised Language Contact Profile, or RLCP), gathering information relating to language acquisition rather than focusing on current language use. These modifications also allowed for data collection concerning four of the five areas hypothesized to most deeply affect language attrition (excluding typological distance, which was controlled), ensuring that the data gathered could be used to search for trends along those metrics.

Retrieval of Demographic Information

Non-linguistic demographic information including age, gender, race and ethnicity, current socio-economic status (SES), and childhood SES were gathered using the RLCP. Participants used a sliding bar (from 35 to 55) to indicate their age. A text entry box was provided to enter in the participant's gender identity, eliminating any potential biases such as a missing option or a stigmatization of gender identity (e.g., an "other" option). Current and childhood SES were recorded using an 11-point Likert scale, which ranged from *Extremely Poor* (0) to *Extremely Wealthy*. Participants identified their race and ethnicity by choosing from a list of options (Hispanic/Latino, Black/African-American, Native American/American Indian, Asian/Pacific Islander, White/Caucasian) or specifying a different identity in a text entry box. Additionally, participants were asked to list by means of a text entry box any US counties in which they had resided, the type of high school they attended, and any formal experience with Psychology or

Linguistics. Participants in the attrition group answered an additional question regarding the length of time that had passed since their last meaningful interaction with Spanish (length of disuse).[1]

The RLCP was intended to serve as a measure from which one could assess the likelihood of any bilingual having heritage language knowledge. It asked questions about age of Spanish acquisition, along with parent and grandparent knowledge of Spanish. Additionally, participants indicated their time spent in Spanish-speaking countries, as well as any explicit (formal) language acquisition occurring in five distinct timeframes based on the US education system: early childhood (0-5 years old), elementary school (5-10 years old), middle school (11-13 years old), high school (14-17 years old), and adulthood (18+ years old).

Participant Exclusion

Originally, 30 participants for each experimental group were recruited for a total of 90 participants in the study. Participant data were later excluded due to a variety of factors, resulting in analyzed responses from 29 monolinguals (10 males, 19 females), 20 bilinguals (9 males, 11 females), and 27 attriters (6 males, 21 females). Exclusion was determined on the basis of technical issues during the experiment and participant responses to demographic and language questions on the RLCP; responses to the RST logicality judgements were also considered.

Exclusion based on responses to RLCP. Responses to the survey questions necessitated that seven participants from the bilingual group and one participant from the attrition group be moved to the monolingual group due to their indicated lack of Spanish knowledge. Likewise, six 1 Five participants had difficulty with this question, submitting instead their most recent type of

[1] Five participants had difficulty with this question, submitting instead their most recent type of interaction or recounting only a non-significant interaction. These participants were coded as having a period of disuse of 1 year, the lowest possible period of disuse allowed with the screening parameters.

interaction or recounting only a non-significant interaction. These participants were coded as having a period of disuse of 1 year, the lowest possible period of disuse allowed with the screening parameters. participants from the monolingual group actually did possess attrited Spanish knowledge; however, their data was completely excluded from analysis as they did not complete the Spanish proficiency measure.

Exclusion based on responses to cognitive tasks. No participants were excluded on the basis of their responses to the logicality judgments present in the Reading Span task, as each participant scored above the 80% threshold (M = 97.6%, SD = 1.44), which was equal to incorrectly answering 12 questions. No participants were excluded based on performance in the Spanish proficiency measure.

Exclusion based on external factors. Three participants were removed from the monolingual group due to potential attrition of a second language that was not Spanish. A further five participants (3 bilingual, 2 attrition) were excluded due to technical error during the experiment, which included the audio files not playing on their browser and the Spanish test file not loading.

Scoring

Due to potential difficulties in understanding the digit and reading span tasks, errors that were clearly due to comprehension (e.g., typing “block” during the reading span, or typing all numbers of the digit span round into one box) were not counted for the first round of trials. Such errors were uncommon but present in the dataset.

For both forward and backwards digit span tasks, participants were assigned a “digit span” number based on the number of digits in the string of the trial in which they first made an error. Instances in which participants included the entire string of numbers rather than a single digit in the box were scored for accuracy of the string. The difference in participants' digit span scores was also recorded for analysis.

The RST provided three metrics for analysis: participants' reading span, total performance, and answers to the logicality judgments. To determine whether a response to a trial would be accepted as correct in the RST, orthographic text entry mistakes (such as "cams" instead of "cans") were counted as correct, as were instances in which participants typed the whole sentence instead of simply the final word. Each participant's reading span, assigned by finding the number of sentences in the trial in which they first made an error, was also recorded. In addition, incorrect answers to the task were aggregated and analyzed by group.

The numerical Stroop task was scored based on correctness of each trial. The response time for each trial was also collected, which was collapsed into an average response time across all trials, an average response time across correct trials, and an average response time across incorrect trials. The response time per trial was averaged. As there was no way to prevent participants from changing their answers, any trial with multiple mouse clicks was marked incorrect and the first mouse click was used to determine the response time; participants' data was individually examined to determine the number of mouse clicks used to indicate a correct answer for each person.[2] Further, congruency and incongruency were analyzed within both the correctness score and the response time averages.

Data Analysis

A 95% confidence interval was used when performing analyses in this experiment. However,

[2] One participant in the bilingual group used the keypad to enter in all responses to the Numerical Stroop task, rather than a key click. Her data was not used in further analyses of response time, though her answers were included. Incorrect scores for the participant's data were determined using the Interquartile Rule for Outliers, through an Excel analysis, to determine outliers in her personal dataset, which were subsequently marked as incorrect.

due to the small populations present in this study, as well as the general difficulty in replicating results on these cognitive tasks due to variations in materials across studies, it was 2 One participant in the bilingual group used the keypad to enter in all responses to the Numerical Stroop task, rather than a key click. Her data was not used in further analyses of response time, though her answers were included. Incorrect scores for the participant's data were determined using the Interquartile Rule for Outliers, through an Excel analysis, to determine outliers in her personal dataset, which were subsequently marked as incorrect. determined that marginally significant results ($p < .1$) would also be reported. Data were analyzed using IBM SPSS Statistics (2017) and Microsoft Excel (2016). Linear regression models and analyses of covariance (ANCOVAs) were carried out in SPSS. Excel provided Chi- Square goodness of fit tests, mean and standard deviation data for group performance, correlation data between variables, and one-way univariate analyses of variance (ANOVAs) for participant variables. Excel was later used to perform one-tailed t-tests based on ANOVA results.

One-way ANOVAs were used to test all participant variables (across groups), investigating whether a difference would be found between monolinguals and bilinguals. If the ANOVA result was found to be significant or approaching significance, one-tailed t-tests were performed between the monolingual and bilingual groups. If the monolingual-bilingual t-test found that the groups were different ($p < 0.1$), a second t-test was performed between the bilingual and attrition groups. If the monolingual-bilingual t-test found no statistical difference, a second t-test was performed between monolinguals and attriters.

Variables. Six participant variables were identified for all three groups: gender, ethnicity, age, childhood SES, current SES, and group (monolingual, bilingual, or attrition). Three additional participant variables were identified, though they were not present for all three groups:

AOA of Spanish (only present in the bilingual and attrition groups), Spanish proficiency (only present in the bilingual and attrition groups; determined by DELE performance) and period of L2 disuse (only present for the attrition group). Four primary dependent variables were identified for analysis (forward digit span performance, backwards digit span performance, numerical Stroop performance, and reading span) along with eight secondary dependent variables (overall average reaction time for numerical Stroop, numerical Stroop average reaction time for congruent trials, numerical Stroop average reaction time for incongruent trials, performance for congruent numerical Stroop trials, performance for incongruent numerical Stroop trials, overall performance on RST, responses to RST logicality judgments, and the change in each participant's performance between forward and backwards digit span tasks).

RST was analyzed both compositely and for span achieved to look for the differences described by Waters and Caplan (1996). Numerical Stroop was analyzed both compositely and based on congruency only, in an attempt to account for potential additional cognitive load imposed by incongruent trials; RST logicality judgments were also compared to examine any effects of added cognitive load imposed by the task itself. Individual participant performance on forward and backward digit span was analyzed by finding the change (difference) between backward digit span and forward digit span.

Results

It was predicted that, despite the general difficulty in findings these group effects, bilinguals would outperform monolinguals in task performance on some primary dependent variables,. It was thought that childhood socioeconomic status and age may to have some effect on task performance regardless of group. Socioeconomic status was thought to somewhat positively affect working memory performance, aligning with the work of Calvo and Bialystok (2014).

Conversely, age was expected to be negatively correlated with performance on cognitive tasks, and especially on response time for those tasks, based on the findings of Bialystok et al. (2005).

Demographic Information

All participants submitted demographic information in the RLCP (see Table 1), including socioeconomic status (SES), gender, and age. Bilinguals and Attriters additionally reported their AOA of Spanish, and Attriters reported their last significant interaction with Spanish. They reported average SES during childhood on an 11-point Likert scale, with 0 representing "extremely poor" and 10 representing "extremely wealthy", with means of 3.9 (moderate-low) for monolinguals, 4.7 (moderate) for bilinguals, and 3.9 (moderate-low) for L2 attriters. Average current SES for participants was 4.6 for monolinguals, 4.3 for bilinguals, and 4.4 for L2 attriters.

Acquisition data from the bilingual group was also analyzed to determine the likelihood of some heritage speakers being present. It was found that a majority (75%) of participants in the bilingual group had learned both Spanish and English from birth due to a familial connection to the language, with 66% of those speakers receiving formal Spanish education during at least one academic year. These results suggested that some speakers may be heritage speakers, but that they may also have at least some literacy in Spanish.

Bilingual proficiency. All members of the bilingual group were self-reportedly proficient in both English and Spanish. Despite a low AOA of Spanish and English, the Spanish proficiency scores from the DELE showed only a slight group advantage over those in the attrition group; the numerical advantage approached significance, $t(34) = -1.16$, $p = .12$. This may be the result of "bilinguals" in fact having knowledge of Spanish as a heritage language (and, therefore, lower literacy in Spanish), consistent with findings from Torres (2013) involving heritage speaker performance on the same proficiency measure.

Performance on Cognitive Tasks

Replication of a bilingual-monolingual difference. In general, the sporadic bilingual-monolingual differences reported in past literature were difficult to replicate (see Table 2), aligning with the broader ambiguous results of past studies. A one-way ANOVA approached significance for Forward Digit Span, $F(2, 73) = 1.95$, $p = .15$. Due to the prediction that bilinguals would have a larger span than monolinguals on this task, a less conservative one-tailed t-test was performed on the monolingual and bilingual data for this task. As predicted, bilinguals ($M = 7$, $SD = 1.556$) outperformed monolinguals ($M = 6$, $SD = 2.026$) for span achieved (see Figure 3), $t(46) = 1.88$, $p = .033$. No statistically significant difference was found between bilinguals and monolinguals for the other primary and secondary dependent variables.

Support for a preserved bilingual difference. A one-tailed t-test was performed between monolingual and attriters' performances on forward digit span. It found a marginally significant performance difference between attriter, $M = 6.81$, $SD = 1.9$, and monolinguals $t(53) = 1.88$, $p = .065$.

Language knowledge as a factor in cognitive performance. To examine the possible effect of language knowledge on these results, Spearman correlational analyses were used to investigate whether a relationship existed between cognitive performance and current language knowledge. No significant correlations were found between any dependent variables and performance on the Spanish proficiency measure (i.e., current Spanish knowledge; see Figure 4) in the bilingual or attrition groups, suggesting that current language knowledge did not have an effect on working memory or cognitive control.

Language disuse is thought to contribute to language attrition. To obtain a more robust understanding of how the absence of L2 knowledge may affect results from the attrition group (as well as the participants' degree of attrition), period of disuse was also included in correlational analyses to determine whether it may have an effect on performance on cognitive tasks. Results of the Spearman correlations using period of disuse as a variable for the attrition group indicated a moderate (negative) correlation with: forward digit span, $r(26) = -.49$, $p < .0001$; overall numerical Stroop performance, $r(26) = -.32$, $p = .03$; and performance for congruent trials in the numerical Stroop task, $r(26) = -.36$, $p = .016$.

Further comparative performance. Despite the sole significant difference between monolingual and bilingual performance on the cognitive tasks, the attrition group was found to have unanticipated results when compared to the other groups (see Table 3). Three more one-way ANOVAs approached significance, though no statistical difference was found between monolinguals and bilinguals: score on congruent trials of the numerical Stroop task, and logicality judgment performance on the RST, and total scores on the RST. Further t-tests revealed that attriters outperformed monolinguals on logicality judgment performance on the RST (see Figure 5), $t(53) = .234$, $p = .01$, while other tests showed marginally significant results, with attriters outperforming monolinguals on congruent numerical Stroop trials (see Figure 6), $t(53) = 1.38$, $p = .086$, and total score on the RST (see Figure 7), $t(53)$, $= 1.3$, $p = .098$.

Multiple Linear Regression models were carried out using current Spanish proficiency (i.e., performance on the DELE) as a covariate. No tests showed significance across both the bilingual and attrition groups, though Spanish Age of Acquisition and current proficiency were moderately correlated in the bilingual group, $r(19) = .49$, $p < .0000001$.

Other Findings

An attempt was made to control for participant variables that may affect performance on cognitive tasks, though it was only partially successful (Table 1). Three participant variables were further investigated to establish whether they significantly affected the results: socioeconomic status, age, and period of disuse. If no effects were found, participant performance was presumed to be linked to language knowledge rather than the potentially confounding variables.

Effect of childhood SES. Calvo and Bialystok (2014) suggested that higher socioeconomic status may be associated with improved cognitive performance. It was hoped that SES would be statistically similar across all three groups due to all data being collected from the MTurk "community", though self- reported data from participants was also analyzed.

A one-way ANOVA showed no significant differences between childhood SES between groups, $F(2, 73) = 2.02$, $p = 0.13$, or current SES among groups, $F(2,73) = 0.14$, $p = .868$. As childhood SES approached significance, one-tailed t-tests were performed on the data; this analysis indicated that the bilingual and attrition groups were statistically different, $t(30) = 1.31$, $p = .02$, as well as the bilingual and monolingual groups, $t(30) = 1.31$, $p = .019$. Bilinguals reported the highest childhood SES, followed by monolinguals. Attriters reported the lowest childhood SES. ANCOVAs showed no effect of childhood or current SES on performance for any cognitive tasks.

Age effects. Many studies have found effects of age on cognitive abilities when testing bilinguals and monolinguals (see *Age*). ANCOVAs were performed in an effort to detect whether participant variables significantly affected cognitive performance. In addition, linear regression models were created also using participant variables as predictor variables. No effect was found for the three WM tasks: forward digit span, $F(18) = 0.959$, $p = .52$; backward digit span, $F(18) = 1.32$, $p = .175$; and reading span $F(18) = 1.44$, $p = .149$. The effect of age on the cognitive control task, numerical Stroop, approached significance, $F(18) = 1.55$, $p = .107$.

Effect of period of L2 disuse in attriters. As previously discussed, period of disuse holds a unique place as a factor for L2 attrition; this variable was further studied in conjunction with both participant and dependent variables in the attrition group. A linear regression model found that there was a significant effect of attriter age on period of disuse. After further examination using period of disuse as a predictor variable for cognitive tasks, it was determined that period of disuse was a significant predictor of performance on measures of working memory and cognitive control. For the attrition group, disuse predicted forward digit span performance, b = -.131, t(26) = -2.83, p = .009, as well as significantly explaining some of the variance found in the task, R2 = .243, F(1, 225) = 8.01, p = .009. Likewise, disuse explained some variance in RST scores, R2 = .494, F(1, 25) = 8.064, p = .009, and was a significant predictor of task performance, b = -.397, t(26) = -2.84, p = .009. Finally, congruent task performance for numerical Stroop was marginally significantly predicted by period of disuse, b = 19.25, t(26) = -1.96, p = 0.61, which also explained some task variance, R2 = .365, F(1, 25) = 3.84, p = 0.61.

Task overlap. Pearson correlations were performed across all primary dependent variables to look for overlap on tested cognitive capacities (see Table 4). A moderate correlation was found between backwards and forward digit Span results, r(75) = .397, p = .002, which was expected due to the similar nature of the tasks. More surprisingly, a nearly identical moderate correlation was discovered between forward digit span and reading span, r(75) = .399, p = .003, yet not backwards digit span and reading span, which were less correlated, r(75) = .285, p < .00001.

AOA effects in the bilingual group. Four members of the bilingual group learned Spanish as adolescents (see Table 5). T-tests were used to examine for potential differences between these later bilinguals and both monolingual participants and other members of the bilingual group.

In comparison with the rest of the bilingual group, the later bilinguals outperformed the early bilinguals in a majority of the cognitive tasks, with a statistically significant difference found for four dependent variables: forward digit span ($M = 8.25$), $t(3)$, $= -2.54$, $p = .02$, reading span ($M = 5.75$), $t(3) = -3.41$, $p = .002$, performance on numerical Stroop ($M = 95.63$), $t(3) = -2.98$, $p = .005$, and performance on correct trials for numerical Stroop ($M = 96.25$), $t(3) = -2.69$, $p = .01$,. Additionally, they outperformed the majority of the early bilinguals on the Spanish proficiency measure ($M = 57.3$), $t(3) = -3$, $p = .01$, which supports the notion that many participants in the bilingual group were, in fact, heritage speakers.

One-tailed t-tests also revealed that later bilinguals outperformed monolinguals on three primary dependent variables, namely: forward digit span achieved, $t(4) = -5.03$, $p = .003$; reading span achieved, $t(4) = -3.09$, $p < .001$; and numerical Stroop performance, $t(4) = -3.69$, $p = .01$. Later bilinguals also showed a statistically advantage on one secondary dependent variable, congruent numerical Stroop trials, $t(4) = -2.88$, $p = .02$. Lastly, a marginally significant advantage for the later bilingual group was found over monolinguals on backward digit span achieved, $t(4) = -1.62$, $p = .09$, and incongruent trials of the numerical Stroop task, $t(4) = -1.91$, .06.

Reading Span Task error analysis. Participants were tasked with remembering the last word of each sentences in a set for the RST, and their answers were gathered via text entry box. This method of data collection allowed for errors beyond the incorrect digits found in the digit span tasks, and they were subsequently analyzed in order to decipher what clues they may contain regarding language processing during cognitive tasks in each group.

All incorrect answers from the RST were analyzed to determine whether patterns occurred across groups. All errors were included in this analysis, including typos and spaces left blank.

Figure 8 shows the error distribution for all three groups, while Figure 9 shows the distribution of linguistic errors across the groups.

For the monolingual data, 14.4% (n = 251) of the total RST trials (n = 1740) were errors. The distribution of errors showed varied reasons for the responses: 48% (n = 121) were blank responses, 19% (n = 47) were typos, 11% (n = 28) had no relation to the target word, 14% (n = 36) of productions were semantically related to the target word, 7% (n = 17) of productions were phonologically related to the target word, and 1% (n = 2) of productions were both semantically and phonologically related to the target.

For the bilingual data, 27% (n = 324) of the total RST trials (n = 1200) were errors. The distribution of errors showed the same error types as the monolingual data, though at different rates: 50% (n = 162) were blank responses, 8.3% (n = 27) were typos, 31.2% (n = 101) had no relation to the target word, 7.7% (n = 25) of productions were semantically related to the target word, 2.1% (n = 7) of productions were phonologically related to the target word, and 0.6% (n = 2) of productions were both semantically and phonologically related.

Finally, in the attrition data, 9.6% (n = 156) of the total RST trials (n = 1620) were errors. The distribution of errors showed varied reasons for the responses: 39.1% (n = 61) were blank responses, 18.6% (n = 29) were typos, 9.6% (n = 15) had no relation to the target word, 22.4% (n = 35) of productions were semantically related to the target word, 9% (n = 14) of productions were phonologically related to the target word, and 1.3% (n = 2) of productions were both semantically and phonologically related to the target.

These errors were all analyzed with Chi Square goodness-of-fit tests. Despite the apparent dissimilarities between bilingual linguistic error distributions and the monolingual and attrition linguistic error distributions, the goodness-of-fit results indicated that monolingual, bilingual and attriter data were statistically similar. Conversely, when overall error distribution was considered, the test indicated that monolingual errors were statistically different from bilinguals, X2 (2, n = 324) = 376.96, p <.01, and attriters, X2 (2, n = 156) = 83.46, p <.01.

Discussion

This study sought to answer three questions: if a monolingual-bilingual difference exists for performance on these tasks of working memory and cognitive control, how attriters perform in comparison to the monolingual and bilingual participants, and how current L2 knowledge affects attriter performance. As hypothesized, a bilingual-monolingual difference was found for forward digit span, with bilinguals achieving a higher span than monolinguals. No other cognitive tasks showed a difference in performance for these groups. Furthermore, attriters were found to outperform statistically similarly to bilinguals in forward digit span achieved, outperforming monolinguals and aligning with their hypothesized performance. Finally, attriter performance was not tied to current L2 knowledge for any task, a finding inconsistent with the original hypothesis. These results are consistent with the idea that some sort of expansion effect occurs due to the increased cognitive demand of language acquisition, and they provide support for the presence of these effects occurring even in later L2 acquisition.

Differences in Bilingual and Monolingual Performance

In the initial one-way ANOVAs, the only difference in monolingual and bilingual task performance was found for Forward Digit Span. A statistical significance was confirmed via one-tailed t-test. This result was not completely unexpected, as replicating findings of a difference between the groups on cognitive tasks has been historically difficult. Of potential interest, however, is that this finding was not replicated with backwards digit span performance; this may indicate that some cognitive mechanisms used for backwards digit span and forward digit span operate uniquely from each other within WM. These findings are consistent with the work of St. Clair-Thompson & Allen (2013), who presented evidence for the backwards digit span task activating parts of the visual-spatial sketchpad along with the phonological loop, unlike forward digit span (for which performance instead relied wholly on processing that occurs in the phonological loop).

Additionally, the later learners in the bilingual group were found to have performances that were, statistically, superior to monolingual participants on four cognitive tasks— forward digit span, reading span, numerical Stroop, and correct trials for numerical Stroop. In such a small sample size of later learners, however, these results cannot be taken as representative of all later learners and must instead be confirmed or rejected with further study.

Finally, the differences found in monolingual and bilingual performance do not support the findings of Calvo and Bialystok (2014). Though childhood SES significantly differed between the bilingual and monolingual groups, no correlation was found with the verbal working memory task (RST) or any other dependent variables. This discrepancy may be explained by the difference in participant age between the current study, which tested older adults, and the 2014 Calvo and Bialystok study, which tested children. This variation in population may imply that whatever effect that SES has on child working memory is not preserved in adults; however, it may instead be that SES is not actually a factor performance on all verbal working memory tasks.

Preservation of a Language-Based Difference

Later learners, however, showed better performance than early bilinguals when compared to monolinguals for other dependent variables; again, these findings are interesting but must be treated with caution due to the small sample size of later bilinguals.

Other comments on results from the attrition group. Attriters outperformed both bilinguals and monolinguals on multiple cognitive measures that were investigated as secondary dependent variables: RST logicality judgments, total score on the RST, and score for congruent trials of the numerical Stroop task. Whilst considering a model that contains both the structure of Baddeley's revised model of working memory (2000) and the "activation" resource present in the domain-specific single-resource model hypothesized by Waters and Caplan (1996), these results indicate that some higher activation is present in L2 attriters.

This unique cognitive advantage for the attrition group rather than the bilingual group (or both bilinguals and attriters) may be explained by some higher activation capacity afforded by acquiring L2 knowledge which remains even when that knowledge is gone— a permanent cognitive change occurring with language acquisition, impacting memory and processing abilities. This appears to be a novel hypothesis, one that is directly contradictory to suggestions that of superior bilingual cognitive control occurring as a result of simultaneous language management and access (Bialystok, 1999) or greater use cognitive mechanism providing constant inhibitory control (e.g., Festman, Rodriguez-Fornells, and Münte, 2010).

Covariate Analysis

Age as a predictor of cognitive control. The age group effects found in other studies were not replicated, as age did not significantly affect correctness in performance. However, age was found to be a significant covariate (with a negative correlation) for numerical Stroop response time, as well as for both congruent and incongruent trials on the same task. This effect was seen in all three experimental groups.

Disuse as a predictor of cognitive performance. Longer periods of disuse were moderately negatively correlated with multiple measures of working memory and cognitive control, namely forward digit span, total numerical Stroop score, and performance for congruent trial of the numerical Stroop task. Period of disuse was found to be a predictor of performance on these tasks. These results imply some cost found in areas of verbal working memory and cognitive control occurring alongside language attrition.

Proficiency as a predictor of working memory performance. Current Spanish proficiency in the bilingual and attrition groups was found to correlate with some of the dependent variables, though the groups differed by task. Current bilingual Spanish proficiency was predicted by their age of acquisition of Spanish, though this only accounted for about 25% of their performance on the DELE. Current Spanish knowledge also significantly affected attriter performance on incongruent trials of the numerical Stroop task. The bilingual group had current Spanish knowledge as a significant predictor of overall numerical Stroop performance.

Unexpected Findings

The results of the RST error analysis showed no two groups performing similarly for overall errors, yet all groups were statistically the same when only linguistic errors (i.e., semantically and/or phonologically related) were considered. Curiously, however, the bilingual group had more errors than both the monolingual and the attrition groups, yet they made fewer semantic errors. This suggests some linguistic benefit enjoyed by bilinguals, though there may be some overall cost in memory or attention to detail.

Presumed heritage speakers in the bilingual group. Performance on the Spanish proficiency measure was unexpectedly low, a finding that may be explained by a large number of heritage speakers in the group. Heritage learners often do not perform well on written measures of language knowledge due to exposure to the heritage language that is largely verbal in nature. Likewise, they may perform poorly on grammaticality measures of the heritage language due to exposure to colloquial varieties of speech rather than the standardized, "correct" version of the language.

Some of the proficiency findings in the bilingual group are consistent with heritage speaker performance on portions of the DELE task (see Torres, 2013; Linck & Weiss, 2011). Nevertheless, group effects were found within the bilingual group, suggesting that heritage speakers may have language-based cognitive changes similar to those found in non-heritage speaker bilinguals.

Implications

Attriters compared to monolinguals. The bilingual advantage found in the forward digit span task remained for the attrition group, with both groups outperforming monolinguals, the findings of which provide this study's strongest evidence found for a permanent change to cognitive abilities occurring due to the acquisition of L2 knowledge. The results for this task, along with the lack of a correlation between current L2 knowledge and forward digit span achieved in the attrition group, support a change in cognitive abilities that is not contingent on L2 knowledge but rather having managed the simultaneous use of two languages at some point. These effects were not found in other tasks, though a bilingual-monolingual difference was also absent; the results of other tasks are therefore inconclusive but are not inconsistent with this explanation.

Superior attriter performance. Attriters unexpectedly outperformed both monolinguals and bilinguals on multiple cognitive measures. Current language knowledge did not appear to have an effect on these results, though period of disuse was associated with performance on dependence variables. Situating these findings within Just and Carpenter's (1992) model, they imply that a larger capacity or a greater amount of activation is available in Working Memory for bilinguals, and activation that remains even after conscious language knowledge. This "expanded" activation may be more evident in later language learners: rather than simultaneous bilinguals' early development of greater cognitive capacity to handle the increased cognitive demand of managing a second language, late learners could experience a permanent "stretching" of some cognitive capacity (e.g., Just and Carpenter's 1992 model's storage and processing capacities, or the visuo-spatial sketchpad and phonological loop present in Baddeley and Hitch's 1974 model) to accommodate the growing cognitive load.

This view is bolstered by the data from late bilinguals, who outperformed both the current bilinguals and the monolinguals on multiple measures. These findings may indicate that cognitive differences between groups may be more prominent with later acquisition of an L2 (rather than being linked to a low AOA), and support a relationship between cognitive advantages and some L2 knowledge that may or may not currently be sustained.

Limitations

This study was limited in scope. The test groups were small, which was amplified as data had to be excluded. For this reason, typical group differences may not have been found. The discrepancy in group size (i.e., 27 monolingual participants and 20 bilingual participants) may have also contributed. Any presence of heritage speakers in the bilingual group may have also contributed to these effects not being found (Torres, 2013), for multiple reasons: not only are bilingual-monolingual differences already difficult to find, but heritage speakers also typically perform well on cognitive tasks using oral and aural dimensions while no tasks in this study incorporated those aspects (Bolger & Zapata, 2011). In addition, heritage speakers may also have an incomplete acquisition of the heritage language or have undergone some attrition of that heritage language, leading to questions about the true extent of their language knowledge.

Of additional importance is the poorly defined difference between bilinguals and heritage speakers. Bilinguals are said to have a myriad of qualities, which often overlap with those attributed to heritage speakers. Are heritage speakers bilingual? Perhaps a more crucial question to ask is if heritage speakers and bilinguals have been studied together under a broad “bilingual” category in previous literature. This study, of course, can only speculate on the presence of heritage speaker respondents, though their responses on other demographic information related to language acquisition do point to this being the case.

The method of data collection also limited this study. TurkPrime was used due to its apparent reliability of data, as well as the ease and speed of data collection. However, unanticipated complications arose. Multiple participants initially had difficulty with the digit span and reading span tasks, something that might have been remedied with an in-person proctor present. As previously discussed, one participant found a keyboard shortcut in answering the Numerical Stroop, which led to difficulty in examining that data. There was a wide variety in completion times for the full experiment (including the DELE), which ranged from 43.28 minutes to 153.75 minutes (with a mean of 72.37 minutes). Also mentioned earlier were the unexpected technical difficulties that arose, which a proctor may have been able to avoid or correct. Finally, there is no way to definitively state whether participants wrote down answers to aid them in later completion of the WM tasks (i.e., sentence-final words for the RST and numbers for the digit span tasks).

Future Research

Future studies involving L2 attrition and working memory must include longitudinal data, testing learners before exposure to the L2 (monolinguals), at the “peak” of their language exposure (bilinguals), and much later after attrition is thought to have occurred to determine whether the results of this study are replicable or due to individual differences. Furthermore, it may also be beneficial to include participants of different age groups: young adults (between the ages of 20 and 35), older adults (between the ages of 55 and 70), and elderly adults (older than 70).

This study has unearthed new data regarding the nature of cognition as it changes due to the acquisition of language knowledge, as well as potential evidence for language being domain-general. As such, it is important that the study be replicated and modified in controlled environments in order to definitively understand the underlying mechanisms that affect performance on these tasks. It would be helpful to carry out future iterations of the experiment in person rather than online, which will greatly reduce the comprehension and technical errors present in the current study. Additional or different language proficiency measures, such as elicited imitation tasks and free production, may be able to determine both the true extent of a speaker's L2 knowledge and if heritage speakers perform substantially differently from bilinguals on cognitive tasks. Standardization of the population is also necessary to control for elements such as the L2 variety spoken by bilingual participants and the attitudes toward the L2 in the tested community. Finally, the L2 attriter performance findings must both be replicated and studied along with L1 attriters, both those who attrited a bilingual L1 and those who attrited an L1 while using an L2, to determine when those cognitive changes occur in conjunction with language loss.

References

Alptekin, C., & Erçetin, G. (2010). The role of L1 and L2 working memory in literal and inferential comprehension in L2 reading. *Journal of Research in Reading*, *33*(2), 206 219.

Anderson, M. C. (2003). Rethinking interference theory: Executive control and the mechanisms of forgetting. *Journal of Memory and Language*, *49*(4), 415–445.

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

Atkinson, R.C. & Shiffrin, R.M. (1968). Human memory: A proposed system and its control processes. In Spence, K.W & Spence, J.T. *The Psychology of Learning and Motivation*. 2. New York: Academic Press. pp. 89–195.

Baddeley, A. (2000). The episodic buffer: a new component of working memory? *Trends in Cognitive Sciences*, *4*(11), 417–423.

Baddeley, A. (2007). *Working Memory, Thought, and Action*. Oxford, United Kingdom: Oxford University Press, Incorporated.

Baddeley, A. D., & Hitch, G. (1974). Working Memory. In *Psychology of Learning and Motivation, 8*, 47–89. Elsevier.

Bardovi-Harlig, K., & Stringer, D. (2010). Variables in Second Language Attrition: Advancing the State of the Art. *Studies in Second Language Acquisition, 32*(1), 1–45.

Basso, A., Spinnler, H., Vallar, G., & Zanobio, M. E. (1982). Left hemisphere damage and selective impairment of auditory verbal short-term memory. A case study. *Neuropsychologia, 20*(3), 263–274.

Bialystok, E. (1999). Cognitive Complexity and Attentional Control in the Bilingual Mind. *Child Development, 70*(3), 636-644.

Bialystok, E. (2006). Effect of Bilingualism and Computer Video Game Experience on the Simon Task. *Canadian Journal of Experimental Psychology*, *60*(1), 68–79.

Bialystok, E., & Craik, F. I. M. (2010). Cognitive and Linguistic Processing in the Bilingual Mind. *Current Directions in Psychological Science, 19*(1), 19–23.

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

Bolger, P. A., & Zapata, G. C. (2011). Psycholinguistic Approaches to Language Processing in Heritage Speakers. *Heritage Language Journal, 8*(1), 29.

Bongaerts, T. (1999). Ultimate Attainment in L2 Pronunciation: The Case of Very Advanced Late L2 Learners. In *Second Language Acquisition and the Critical Period Hypothesis*, 133-159. Routledge.

Buhrmester, M., Kwang, T., & Gosling, S. D. (2011). Amazon's Mechanical Turk: A New Source of Inexpensive, Yet High-Quality, Data? *Perspectives on Psychological Science, 6*(1), 3–5.

Calvo, A., & Bialystok, E. (2014). Independent effects of bilingualism and socioeconomic status on language ability and executive functioning. *Cognition, 130*(3), 278–288.

Cave, C. B., & Squire, L. R. (1992). Intact verbal and nonverbal short-term memory following damage to the human hippocampus. *Hippocampus, 2*(2), 151–163.

Cowan, N. (2005). *Working Memory Capacity*. New York, NY: Psychology Press.

Cummins, J. (1977). Cognitive Factors Associated with the Attainment of Intermediate Levels of Bilingual Skills. *The Modern Language Journal, 61*(1–2), 3–12.

Daneman, M., & Carpenter, P. A. (1980). Individual differences in working memory and reading. *Journal of Verbal Learning and Verbal Behavior, 19*(4), 450–466.

Day, R. R. (1985). The Use of the Target Language in Context and Second Language Proficiency. In *Input in Second Language Acquisition*. Rowley, MA: Newbury House Publishers, Inc.

Devlin, K. (2015). “Learning a foreign language a ‘must’ in Europe, not so in America”. Retrieved from http://www.pewresearch.org/fact-tank/2015/07/13/learning-a-foreign language-a-must-in-europe-not-so-in-america/

Devlin, K. (2018). “Unlike in US, most European students learn a foreign language”. Retrieved from http://www.pewresearch.org/fact-tank/2018/08/06/most-european-students-are learning-a-foreign-language-in-school-while-americans-lag/

Diaz, R. M. (1985). Bilingual Cognitive Development: Addressing Three Gaps in Current Research. *Child Development, 56*(6), 1376–1388.

Dobbs, A. R., & Rule, B. G. (1989). Adult age differences in working memory. *Psychology and Aging, 4*(4), 500–503.

Ecke, P. (2004). Language attrition and theories of forgetting: A cross-disciplinary review. *International Journal of Bilingualism, 8*(3), 321–354.

Eimas, P. D., Siqueland, E. R., Jusczyk, P., & Vigorito, J. (1971). Speech Perception in Infants. *Science, 171*(3968), 303–306.

Emmorey, K., Luk, G., Pyers, J. E., & Bialystok, E. (2008). The Source of Enhanced Cognitive Control in Bilinguals: Evidence from Bimodal Bilinguals. *Psychological Science, 19*(12).

Festman, J., Rodriguez-Fornells, A., & Münte, T. F. (2010). Individual differences in control of language interference in late bilinguals are mainly related to general executive abilities. *Behavioral and Brain Functions, 6*(5), 1–12.

Freed, B. F., Dewey, D. P., Segalowitz, N., & Halter, R. (2004). The Language Contact Profile. Studies in Second Language Acquisition, 26(2), 349–356.

Gioia, G., Isquith, P., & Guy, S. (2001). Assessment of executive functions in children with neurological impairment. In R. Simeonsson & S. Rosenthal (Eds.), *Psychological and developmental assessment: Children with disabilities and chronic conditions* (pp. 317 356). New York: The Guildford Press.

Grosjean, F. (1989). *Neurolinguists, beware! The bilingual is not two monolinguals in one person. Brain and Language*, 36(1), 3-15.

Grosjean, F. (2018). "The Amazing Rise of Bilingualism in the United States." Retrieved from https://www.psychologytoday.com/us/blog/life-bilingual/201809/the-amazing-rise bilingualism-in-the-united-states

Grundy, J. G., & Timmer, K. (2016). Bilingualism and working memory capacity: A comprehensive meta-analysis. *Second Language Research*, *33*(3), 325–340.

Hakuta, K. (1986). *Mirror of Language: The Debate on Bilingualism*. New York, NY: Basic Books, Inc.

Hanley, J. R., Young, A. W., & Pearson, N. A. (1991). Impairment of the visuo-spatial sketch pad. *The Quarterly Journal of Experimental Psychology, 43*(1), 101–125.

Harrington, M., & Sawyer, M. (1992). L2 Working Memory Capacity and L2 Reading Skill. *Studies in Second Language Acquisition*, 14(1), 25.

Hernández, M., Costa, A., Fuentes, L. J., Vivas, A. B., & Sebastián-Gallés, N. (2010). The impact of bilingualism on the executive control and orienting networks of attention. *Bilingualism: Language and Cognition, 13*(3), 315–325.

Higgs, T. V., & Clifford, R. (1982). The Push Toward Communication. In Higgs, T. (Ed.), *Curriculum, competence, and the foreign language teacher*, 51–79. Skokie, IL: National Textbook Company.

Instituto Cervantes (2012). *Diplomas de Español como Lengua Extranjera: Modelo B1*. Retrieved from https://examenes.cervantes.es/es/dele/preparar-prueba

Ioup, G., Boustagui, E., Tigi, M. E., & Moselle, M. (1994). Reexamining the Critical Period Hypothesis: A Case Study of Successful Adult SLA in a Naturalistic Environment. *Studies in Second Language Acquisition*, *16*(1), 73–98.

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.

Just, M. A., & Carpenter, P. A. (1992). A capacity theory of comprehension: Individual differences in working memory. *Psychological Review, 99*(1), 122–149.

Köpke, B. (2007). Language attrition at the crossroads of brain, mind, and society. In B. Köpke, M. S. Schmid, M. Keijzer, & S. Dostert (Eds.), *Language Attrition: Theoretical Perspectives,* 9–37. Amsterdam: John Benjamins Publishing Company.

Köpke, B., & Schmid, M. S. (2004). “Language attrition: The next phase.” In M. S. Schmid, B. Köpke, M. Keijzer, & L. Weilemar (Eds.), *First language attrition: Interdisciplinary perspectives on methodological issues*, 1–43. Amsterdam, Netherlands: John Benjamins.

Kormos, J., & Sáfár, A. (2008). Phonological short-term memory, working memory and foreign language performance in intensive language learning. *Bilingualism: Language and Cognition, 11*(2), 261–271.

Leeser, M. J. (2007). Learner-Based Factors in L2 Reading Comprehension and Processing Grammatical Form: Topic Familiarity and Working Memory. *Language Learning, 57*(2), 229–270.

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

Linck, J. A., & Weiss, D. J. (2011). Working Memory Predicts the Acquisition of Explicit L2 Knowledge. In *Implicit and Explicit Language Learning*, 101-114.

Linck, J. A., Osthus, P., Koeth, J. T., & Bunting, M. F. (2014). Working memory and second language comprehension and production: A meta-analysis. *Psychonomic Bulletin & Review, 21*(4), 861–883.

Litman, L., Robinson, J., & Abberbock, T. (2016). TurkPrime.com: A versatile crowdsourcing data acquisition platform for the behavioral sciences. *Behavior Research Methods*, *49*(2) 433–442.

Mackie, M.-A., Van Dam, N. T., & Fan, J. (2013). Cognitive Control and Attentional Functions. *Brain and Cognition, 82*(3), 301–312.

Miller, G. A. (1956). The magical number seven, plus or minus two: some limits on our capacity for processing information. *Psychological Review, 63*(2), 81–97.

Montrul, S. (2002). Incomplete acquisition and attrition of Spanish tense/aspect distinctions in adult bilinguals. *Bilingualism: Language and Cognition, 5*(1), 39–68.

Oh, J. S., Au, T. K. F., & Jun, S. A. (2010). The nature of childhood language memory: Korean adoptees learning Korean as adults. *Journal of Child Language, 37*(5), 1123–1132

Oh, J. S., Jun, S.-A., Knightly, L. M., & Au, T. K. (2003). Holding on to childhood language memory. Cognition, 86(3), B53–B64.

Ortega, L. (2009). *Understanding second language acquisition*. London: Hodder EducationPallier, C. (2007). Critical periods in language acquisition. In Köpke, B., Schmid, M. S., Keijzer, M., & Dostert, S. (Eds.), *Language attrition. Theoretical perspectives*, 155 168.

Payne, J. S., & Ross, B. M. (2005). Synchronous CMC, Working Memory, and L2 Oral Proficiency Development. *Language Learning, 9*(3), 35–54.

Polinsky, M. (2011). Reanalysis in Adult Heritage Language. *Studies in Second Language Acquisition, 33*(2), 305–328.

Posner, M. I. (1966). Components of Skilled Performance. *Science, 152*(3730), 1712–1718.

Ratiu, I., & Azuma, T. (2015). Working memory capacity: Is there a bilingual advantage? *Journal of Cognitive Psychology*, *27*(1), 1–11.

Seliger, H. W. (1977). Does Practice Make Perfect?: A Study of Interaction Patterns and L2 Competence. *Language Learning, 27*(2), 263–278.

St. Clair-Thompson, H. L., & Allen, R. J. (2013). Are forwards and backwards digit recall the same? A dual task study of digit recall. *Memory and Cognition, 41*, 519–532.

Stone, J., & Towse, J. (2015). A Working Memory Test Battery: Java-Based Collection of Seven Working Memory Tasks. Retrieved from http://doi.org/10.5334/jors.br

Stroop, J. R. (1935). Studies of interference in serial verbal reactions. *Journal of Experimental Psychology, 18*(6), 643–662.

Torres, J. R. (2013). Heritage and Second Language Learners of Spanish: The Roles of Task Complexity and Inhibitory Control (Dissertation). Georgetown University, Washington D.C.

Tucker, G. R. (1999). A global perspective on bilingualism and bilingual education. In *Language in our Time: Bilingual Education and Official English, Ebonics and Standard English, Immigration and the Unz Initiative* (Georgetown University Round Table on Languages and Linguistics), 332–341.

Ventureyra, V. A. G., Pallier, C., & Yoo, H.-Y. (2004). The loss of first language phonetic perception in adopted Koreans. *Journal of Neurolinguistics, 17*(1), 79–91.

Wagner, R. K., Torgesen, J. K., Rashotte, C. A, & Pearson, N. A. (2013). Comprehensive Test of Phonological Processing: Second Edition. Austin, TX: Pro-Ed, Inc.

Warrington, E. K., Logue, V., & Pratt, R. T. C. (1971). The anatomical localisation of selective impairment of auditory verbal short-term memory. *Neuropsychologia, 9*(4), 377–387.

Waters, G. S., & Caplan, D. (1996). The Measurement of Verbal Working Memory Capacity and Its Relation to Reading Comprehension. *The Quarterly Journal of Experimental Psychology, 49*(1), 51–79.

Weltens, B & Grendel, M. (1993). Attrition of Vocabulary Knowledge. In Schreuder, R., & Weltens, B. (1993). *The Bilingual Lexicon*. Amsterdam: J. Benjamins.

Werker, J. F., & Tees, R. C. (1992). The Organization and Reorganization of Human Speech Perception. *Annual Review of Neuroscience, 15*(1), 377–402. Retrieved from

Wickens, C. D. (1984). Processing Resources in Attention. In *Varieties of Attention*, 63–98. Orlando, FL: Academic Press.

Wilson, B., & Baddeley, A. (1988). Semantic, episodic, and autobiographical memory in a postmeningitic amnesic patient. *Brain and Cognition, 8*(1), 31–46.

Table 1.

Demographic information gathered from the RLCP

Group	Measure	Mean	Standard Deviation
Monolingual[a]			
	Age	43.103	5.233
	Childhood SES	3.931	1.462
	Current SES	4.551	1.975
	English AOA	0	0
Attrition[b]			
	Age	41.481	6.034
	Childhood SES	3.926	1.439
	Current SES	4.444	1.968
	English AOA	0	0
	Spanish AOA	15.407	7.459
	Spanish Proficiency (from DELE)	8.407	4.7
	Period of Disuse	10.444	7.175
Bilingual[c]			
	Age	40.2	4.034
	Childhood SES	4.7	1.559
	Current SES	4.25	1.916
	English AOA	0	0
	Spanish AOA	3.1	5.72
	Spanish Proficiency (from DELE)	9.85	3.801

a. n = 29, 19 females
b. n = 27, 21 females
c. n = 20, 11 females

Table 2.

Mean[a] Task Performance by Group

Task		Monolingual	Attrition	Bilingual
Digit Spans				
	Forward[b]	6.0 (2.026)	6.8 (1.902)	7.0 (1.556)
	Backward[b]	5.4 (2.261)	5.9 (2.006)	6.2 (2.419)
	Difference[c]	-0.586 (2.228)	-0.926 (2.183)	-0.8 (2.526)
RST				
	Simple RST[d]	4.07 (1.51)	3.96 (1.604)	4.35 (1.755)
	Total Score[e]	87.7 (13.89)	91.9 (9.611)	88.8 (16.10)
	Logicality[e]	97.1 (2.622)	98.5 (1.979)	97.3 (2.374)
Numerical Stroop				
	Total Score[e]	88.6 (8.9)	91.2 (8.902)	88.6 (8.9)
	Congruent Score[e]	88.5 (10.52)	92.4 (7.25)	88.5 (10.52)
	Incongruent Score[e]	88.8 (9.983)	90.2 (9.038)	88.8 (9.983)
	Response Time[f]	1309.4 (450.2)	1257.2 (348.4)	1309.4 (450.2)
	Congruent Time[f]	1116.3 (382.2)	1218.2 (337.7)	1116.3 (382.2)
	Incongruent Time[f]	1243.5 (615.4)	1294.4 (378.4)	1243.5 (615.4)

a. Performance value signifies group mean, with group standard deviation in parentheses.
b. Possible digit span scores ranged from 2 to 9
c. Difference found by subtracting individual performance on forward digit span from backward digit span.
d. Possible reading span scores ranged from 2 to 6.
e. A score of 100 indicates correct performance on all trials.
f. Total time displayed is in milliseconds.

Table 3.

Significant and marginally significant between-group task results

Task	Monolingual-Bilingual	Monolingual-Attrition	Bilingual-Attrition
Forward Digit Span	**0.03292033**	**0.07148998**	0.3577988
Total RST Score	0.39986074	**0.09855455**	0.23097337
RST Logicality Judgments	0.40137677	**0.01145288**	**0.0299702**
Congruent Numerical Stroop Score	0.48561489	**0.08656457**	**0.08153648**

Note: Bold values indicate $p < .1$

Table 4.

Correlations[a] (R-values) between Primary Dependent Variables

Task	Forward Digit Span	Backward Digit Span	Numerical Stroop
Backward Digit Span	**0.4**	-	-
Numerical Stroop	*0.16*	0.06	-
Reading Span	**0.4**	*0.29*	*0.29*

a. Weak correlations (0.1 to 0.3) are italicized. Moderate correlations (0.31-0.71) are bolded.

Table 5.

Demographic information for later L2 learners in the bilingual group[a]

Measure	Mean	Standard Deviation
Age	42.25	5.188
Childhood SES	3.75	1.5
Current SES	3.5	2.516
English AOA	0	0
Spanish AOA	13.75	1.708
Spanish Proficiency (from DELE)	13.75	2.754

a. n = 4, 4 females

Table 6.

RST error distribution and probabilities[a]

	Attrition	Bilingual
Observed Total Errors[b]	156	324
Expected Total Errors[b]	234	173
Observed Linguistic Errors[c]	34	34
Expected Linguistic Errors[c]	51	71

a. P-values are indicated in parenthesis following error distribution.
b. Unrelated errors, typos, blank entries, semantic errors, phonological errors, and errors both semantic and phonological in nature
c. Semantic errors, phonological errors, and errors both semantic and phonological in nature

Note. $\chi^2 = 4.55^*$, df =2, $^*p < .05$

Figure 1.

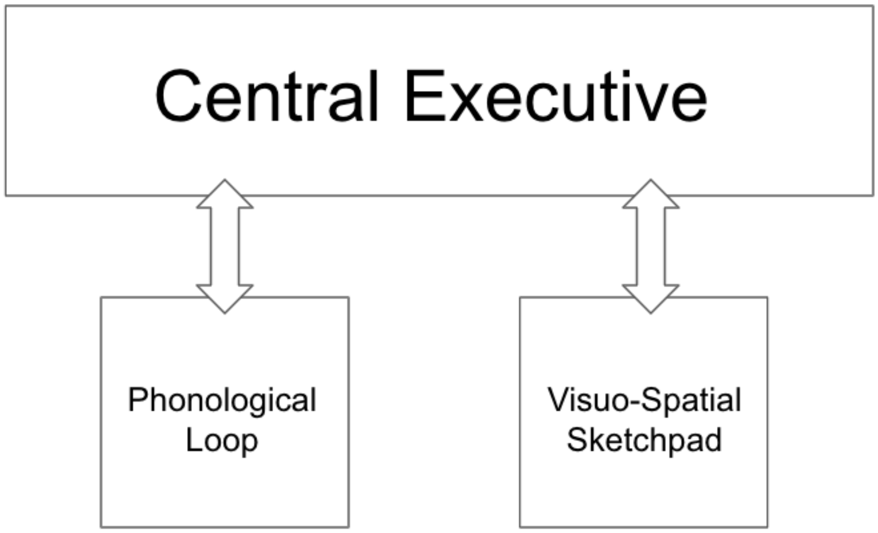


Figure 1. Original Model of Working Memory as proposed by Baddeley and Hitch (1974).

Figure 2.

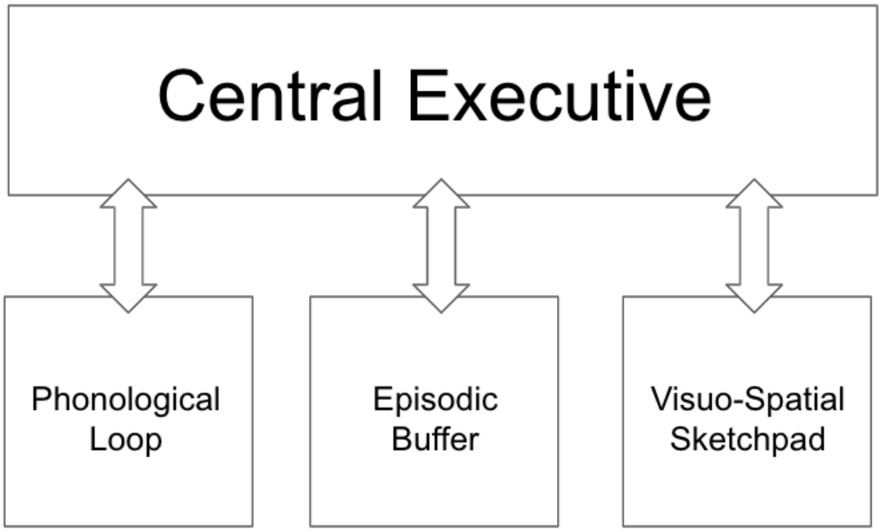


Figure 2. Revised Model of Working Memory as proposed by Baddeley (2000).

Figure 3.

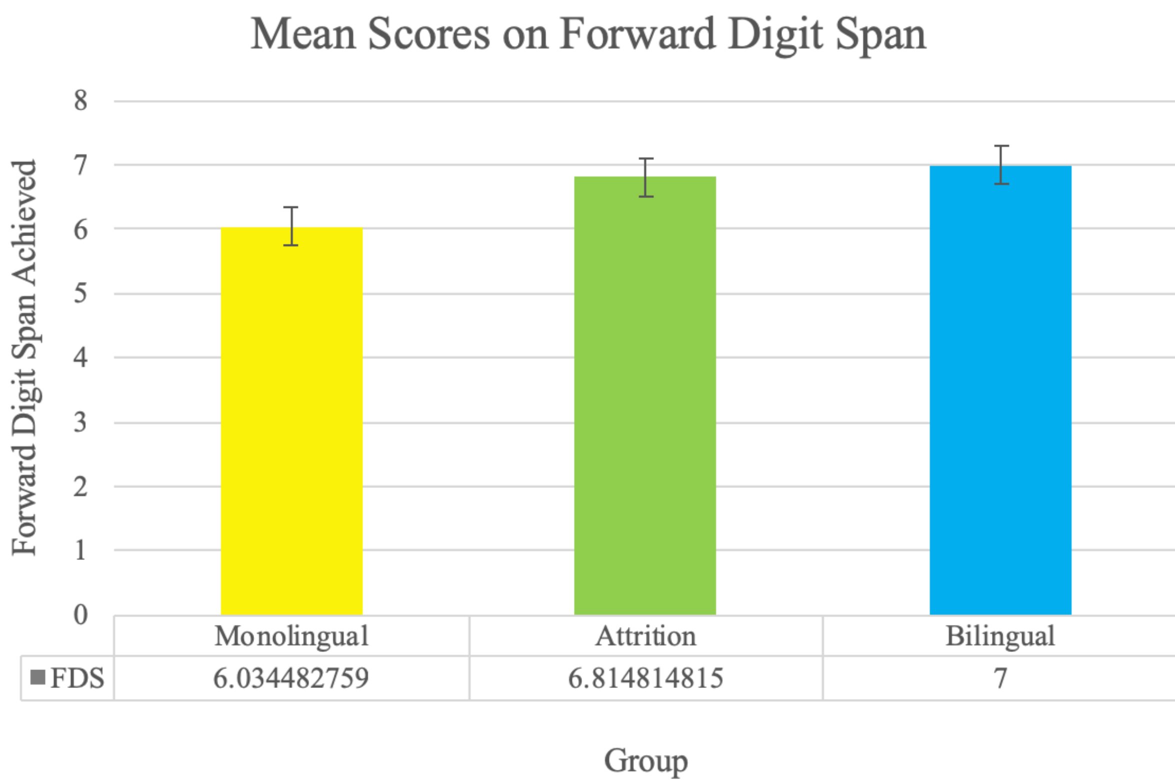

Mean Scores on Forward Digit Span
Forward Digit Span Achieved
8
7
6
5
4
3
2
1
0
Monolingual
Attrition
Bilingual
FDS
6.034482759
6.814814815
7
Group

Figure 4.

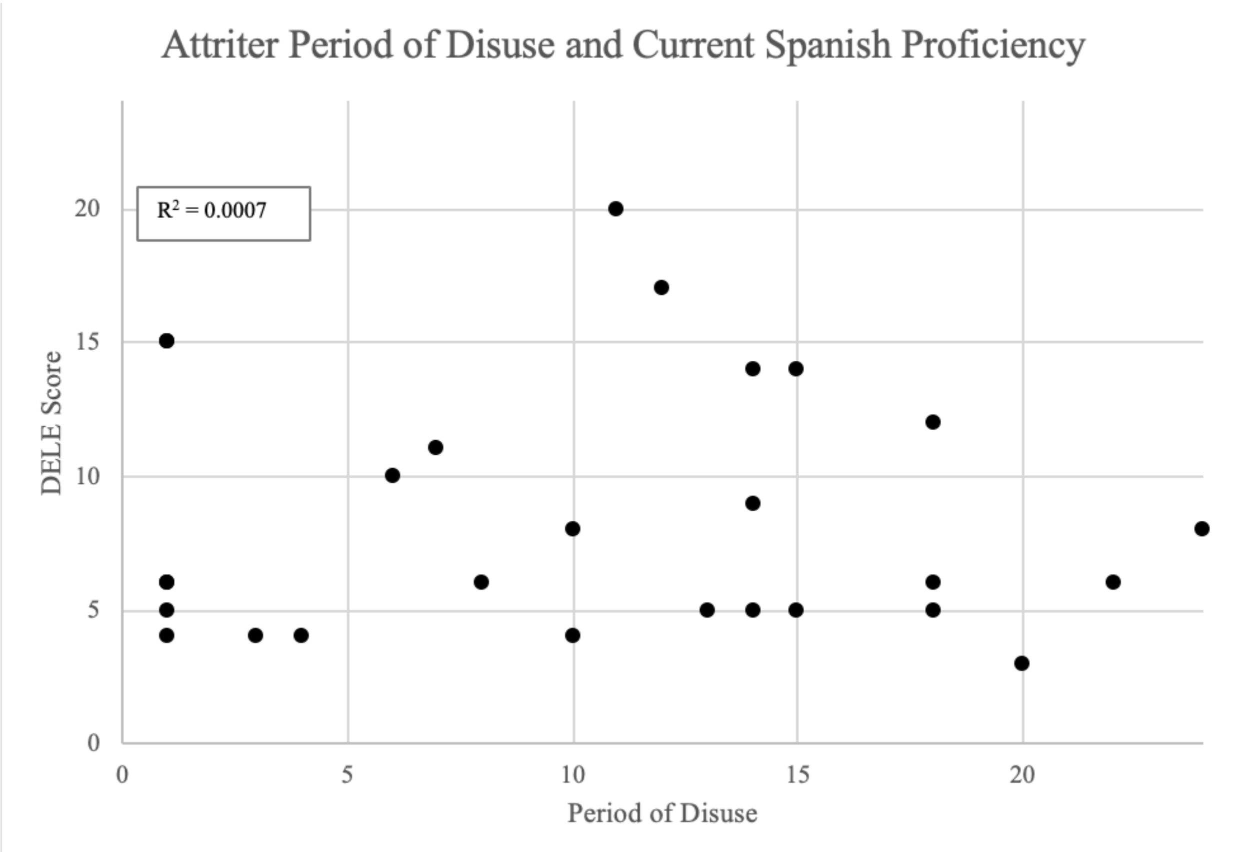

Attriter Period of Disuse and Current Spanish Proficiency
R² = 0.0007
DELE Score
0
5
10
15
20
Period of Disuse
0
5
10
15
20

Figure 5.

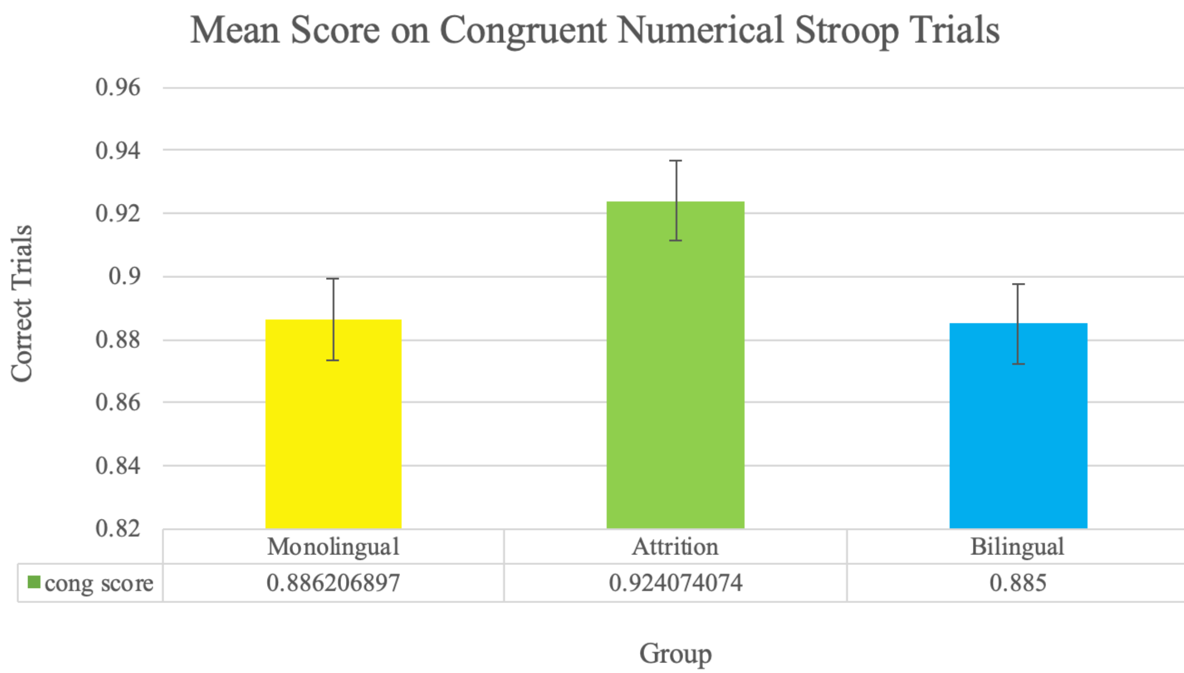

Mean Score on Congruent Numerical Stroop Trials
0.96
0.94
0.92
0.9
0.88
0.86
0.84
0.82
Correct Trials
Monolingual
Attrition
Bilingual
cong score
0.886206897
0.924074074
0.885
Group

Figure 6.

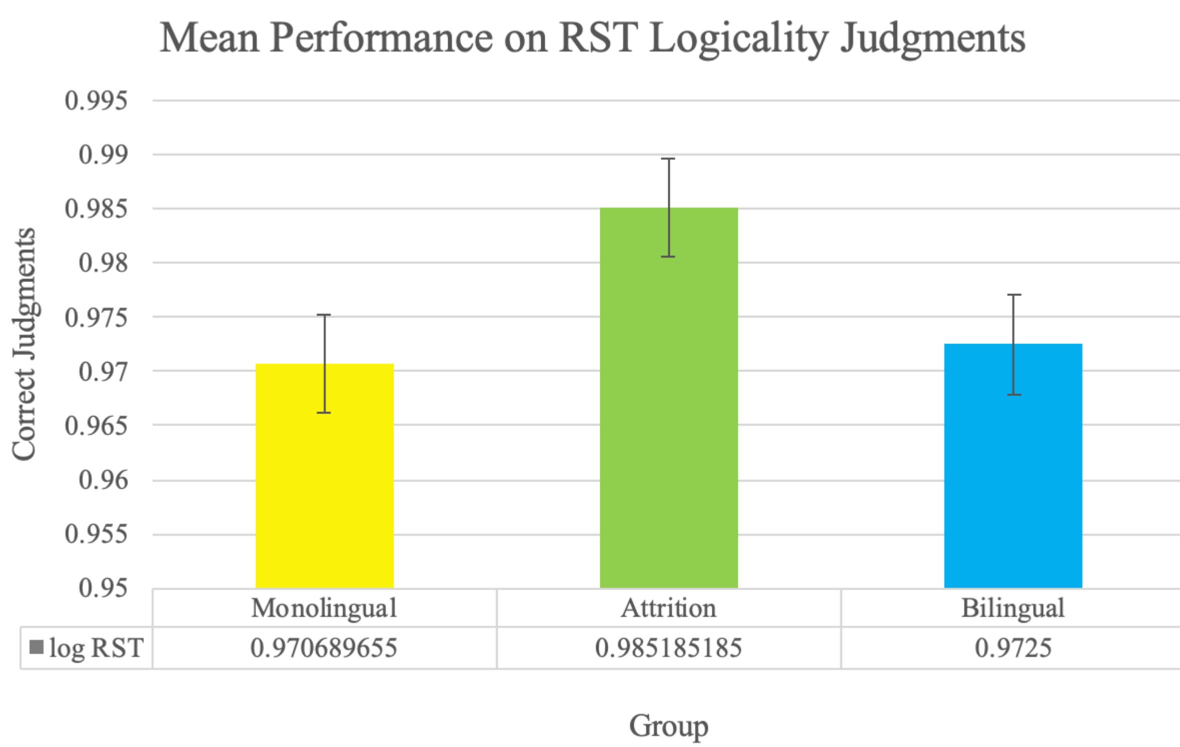

Mean Performance on RST Logicality Judgments
0.995
0.99
0.985
0.98
0.975
0.97
0.965
0.96
0.955
0.95
Correct Judgments
Monolingual
Attrition
Bilingual
log RST
0.970689655
0.985185185
0.9725
Group

Figure 7.

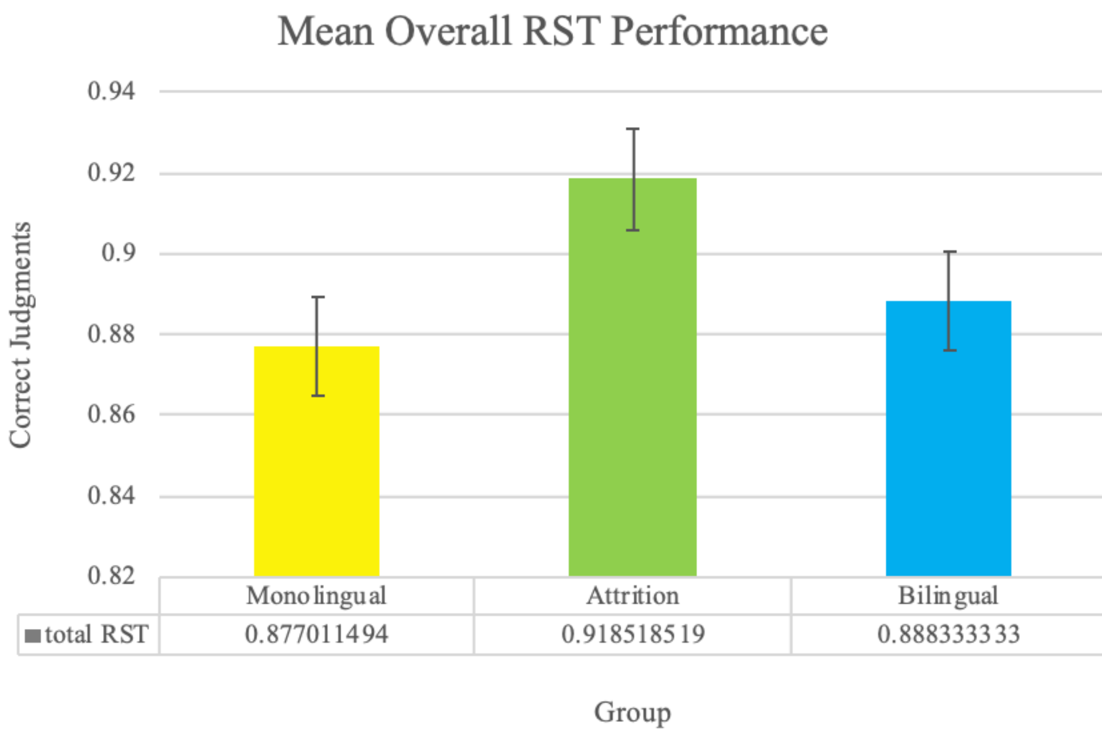

Mean Overall RST Performance
0.94
0.92
0.9
0.88
0.86
0.84
0.82
Correct Judgments
Monolingual
Attrition
Bilingual
total RST
0.877011494
0.918518519
0.888333333
Group

Figure 8.

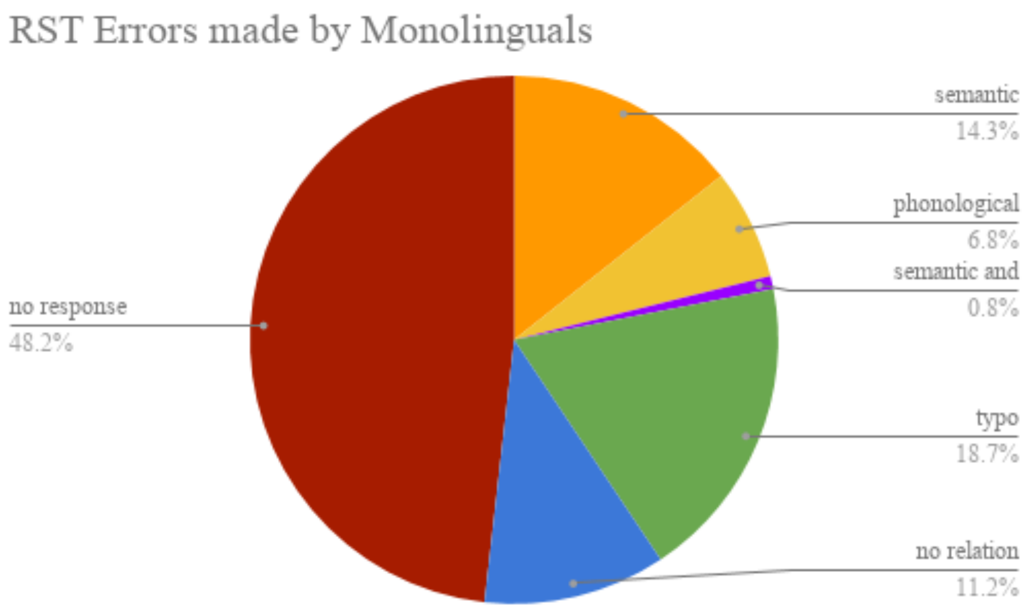

RST Errors made by Monolinguals
semantic
14.3%
phonological
6.8%
semantic and
0.8%
typo
18.7%
no relation
11.2%
no response
48.2%

Figure 9.

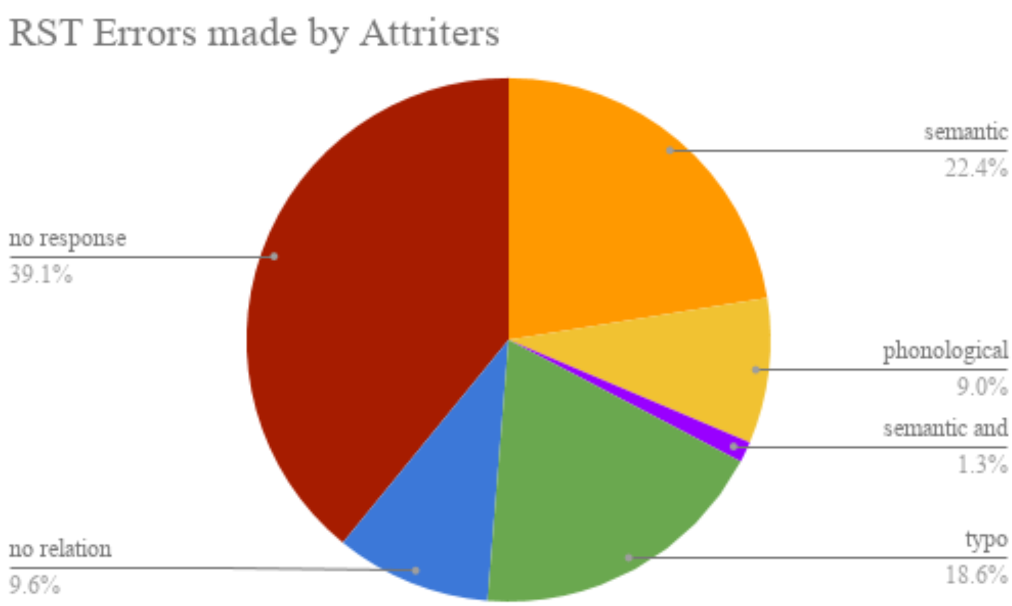

RST Errors made by Attriters
semantic
22.4%
no response
39.1%
phonological
9.0%
semantic and
1.3%
no relation
9.6%
typo
18.6%

Figure 10.

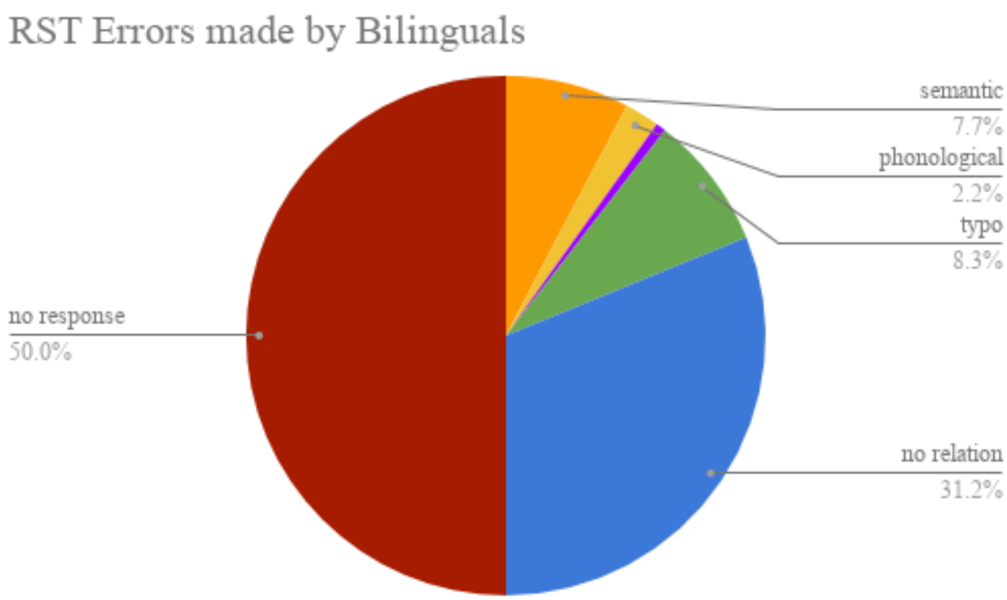

RST Errors made by Bilinguals
semantic
7.7%
phonological
2.2%
typo
8.3%
no response
50.0%
no relation
31.2%

Figure 11.

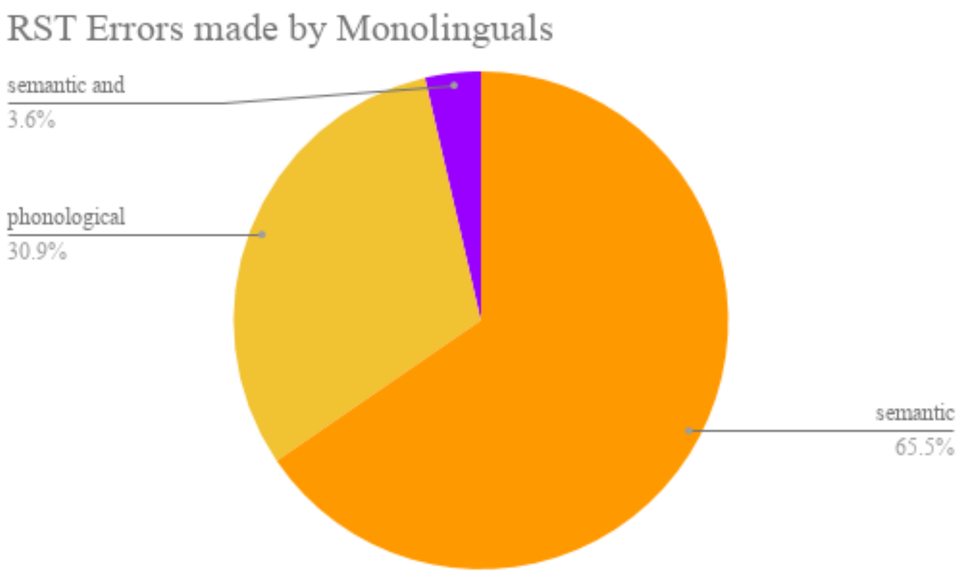

RST Errors made by Monolinguals
semantic and
3.6%
phonological
30.9%
semantic
65.5%

Figure 12.

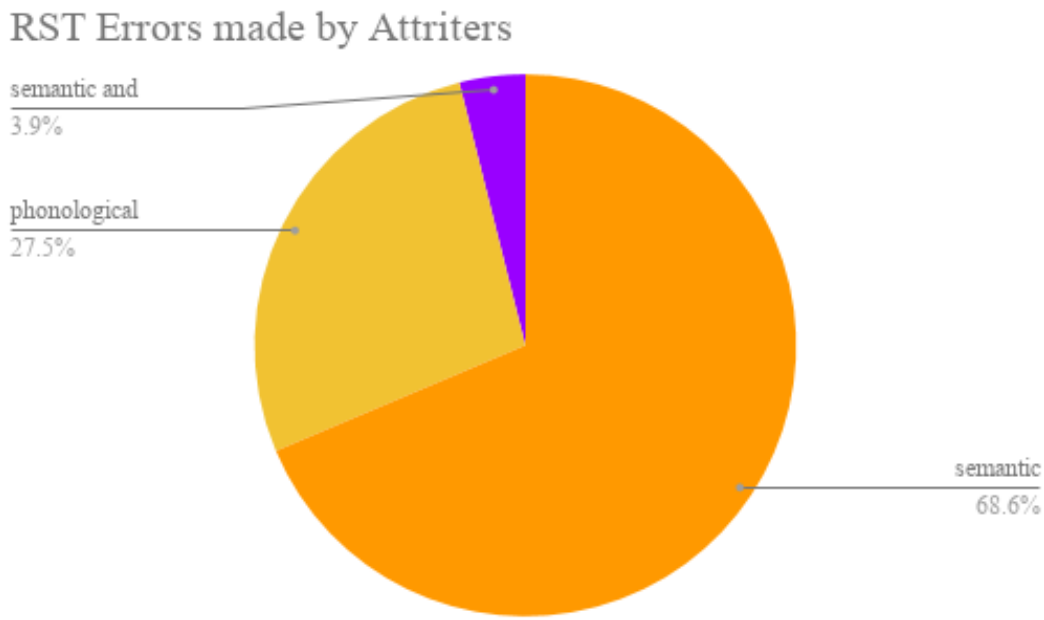
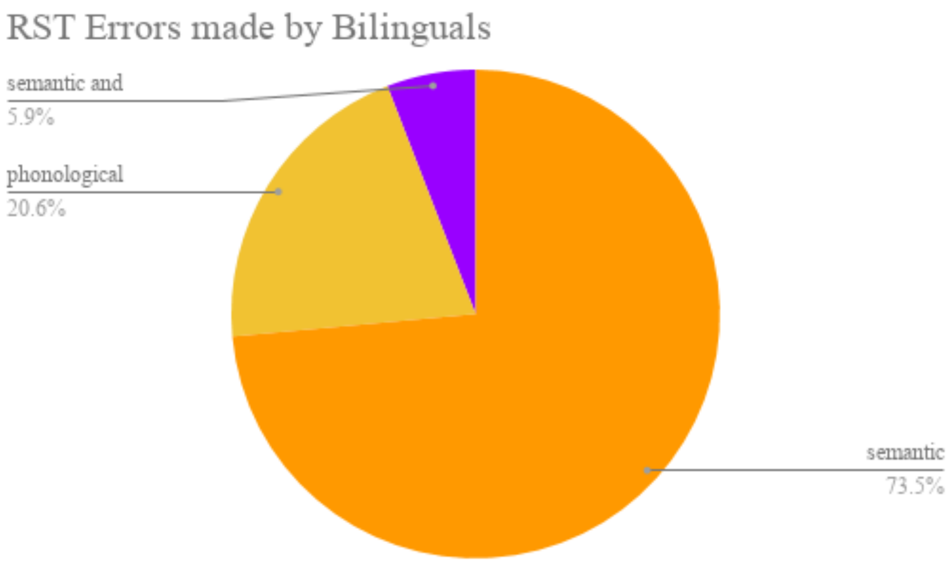

RST Errors made by Attriters
semantic and
3.9%
phonological
27.5%
semantic
68.6%

Figure 13.


RST Errors made by Bilinguals
semantic and
5.9%
phonological
20.6%
semantic
73.5%

Appendix A

Stimuli from RST

The sentences used in the Reading Span Task can be found below. All sentences were taken from Stone and Towse (2015), with minor changes to make the sentences grammatical and accessible to a larger audience of American English speakers.

There were fifteen total sentence blocks in the RST. The blocks were designed to appear in clusters containing the same number of sentences, with that number incrementally increasing by one (from blocks of two sentences to blocks of six sentences). Each block was preceded by a screen reading “New Sentence Block” in large, red, bolded letters. Another screen containing large, red, bolded letters appeared at the end of the set of sentences, reading “End of Block.” After each block, participants were given the instruction to “Please type the last word of each sentence [they] saw in the block,” with a number of spaces equal to the number of sentences that the block contained.

Illogical sentences appear italicized. There were slightly fewer logical sentences (n = 28) than illogical sentences (n = 32). Sentences were distributed randomly throughout the task.

Block 1

A freezer keeps your food warm.

A toaster can drive a cart.

Block 2

Donkeys live in trash cans.

You can boil water in a saucepan.

Block 3

A squirrel likes to eat soup.

A crocodile is colored blue.

Block 4

An onion is a fruit.

If you are hungry you eat food.

Your nose is on your arm.

Block 5

Ice cream feels very hot.

A feather is very light.

You wear socks on your feet.

Block 6

There are two hundred letters in the alphabet.

The color of a banana is yellow.

Sand is very sharp.

Block 7

I can smell with my nose.

A magician performs magic.

You keep clothes in a dresser.

A house is made of bricks.

Block 8

You eat your dinner with a spade.

A pineapple is colored pink.

A shark can run a race.

To make tea you use a teapot.

Block 9

A car has four wheels.

Heavy is the opposite of short.

A rainbow is made of rubber.

A pavement is made of plums.

Block 10

Schools have a playground.

The opposite of long is short.

A flower has petals.

Clouds appear on the fridge.

You can use an umbrella if it rains.

Block 11

A suitcase is made of jelly.

A boat likes to eat potato chips.

A trampoline is made of butter.

The number after two is three.

I can see with my eyes.

Block 12

Fish can play the guitar.

Thomas is a name for a boy.

A book is a musical instrument.

A birthday cake had candles.

Horses go to the supermarket.

Block 13

Your teeth are in your mouth.

A king wears a crown.

There are forty months in a year.

A biscuit is made of wood.

Boots are made of milk.

Always wear your seatbelt in a car.

Block 14

Pigs live on the moon.

The number after four is five.

Stone is very hard.

Rockets fly in outer space.

You can hear with your ears.

You tell the time with a calculator.

Block 15

If you are thirsty you take a drink.

You drink water from a plate.

You wear a hat on your foot.

Rainbows are black and white.

A dog bakes a cake.

The earth has three moons.

Appendix B

Stimuli from Spanish Proficiency Measure

The following is a reproduced excerpt from the reading comprehension test of the *Diplomas de Español como Lengua Extranjera* (DELE; "Certification of Spanish as a Foreign Language"), distributed by the Instituto Cervantes. Participants in the bilingual and attrition groups took this test as a measure of Spanish proficiency.

Participants were provided a PDF file of the questions, and the answer sheet was reproduced in on Qualtrics. Each *tarea* ("task"; set of related questions) appeared on a separate page. Horizontal lines denote task divisions. Instructions are italicized.

Tarea 1

Instrucciones: Usted va a leer seis textos en los que unas personas hablan de los programas de televisión que suelen ver y diez textos que informan sobre programas de televisión. Relacione a las personas (1-6) con los textos que informan sobre los programas (A-J). HAY TRES TEXTOS QUE NO DEBE RELACIONAR. Marque las opciones elegidas en la Hoja de respuestas.

Personas y Descripciones

0. Aurora: Me encantan los culebrones que ponen después de comer. Aunque la gente diga que este tipo de series no tienen mucha calidad, a mí me relajan muchísimo.
1. Isabel: Soy una gran aficionada a los programas de divulgación científica. Me interesan sobre todo los programas que hablan del universo.

2. Óscar: Me gusta mantenerme informado de lo que está ocurriendo en cada momento, pero no me conformo solo con una opinión. Por eso los debates son mis programas favoritos.
3. Tina: Soy muy competitiva y por eso me apasionan los concursos. Los sigo incluso por Internet, porque en muchos de ellos puedes participar a través de las redes sociales.
4. Adrián: Soy aficionado al buceo y me encantan los animales, así que no me pierdo los documentales que te ayudan a descubrir la espectacular fauna marina.
5. Eva María: Desde que tuve a Carla, apenas tengo tiempo para ver la televisión. Lo único que puedo ver son los dibujos que echan mientras le doy la merienda.
6. David: Quiero transmitir a mis alumnos de secundaria la importancia de estar concienciado con los problemas medioambientales. Y una manera de hacerlo es viendo programas que traten de estos temas.

Opciones

A. **¡Artzooka!** Este programa desarrolla habilidades manuales de manera lúdica y sencilla. El presentador, Bruno, explica a los niños cómo pueden hacer obras de arte con material de desecho que hay en cualquier lugar de su casa. En el próximo capítulo aprenderemos a hacer unas simpáticas marionetas.

B. **El escarabajo rojo**. Esta semana el programa estará dedicado al agua, el elemento considerado por muchos expertos como el petróleo del tercer milenio. Un reportaje que analiza en profundidad los pros y los contras de la privatización del agua con expertos en la materia.

C. **Redes**. En el próximo capítulo, Vlatko Vedral, físico de la Universidad de Oxford, explicará a Eduard Punset cómo los objetos subatómicos pueden estar en más de un sitio a la vez y cómo dos partículas situadas en extremos opuestos de una galaxia pueden compartir información instantáneamente.

D. **La fuerza del destino**. Adolfo logra hablar a escondidas con Matilde y aclarar los malentendidos. Ella le confiesa que está esperando un hijo. Para salvar la hacienda de la ruina, Humberto obliga a su hija, Matilde, a casarse con el adinerado Mendoza. Cuando Matilde le cuenta a Adolfo los planes de su padre, estos deciden huir juntos.

E. **59 segundos**. Cinco expertos en diversos ámbitos disponen de 59 segundos para exponer sus puntos de vista y responder a las cuestiones planteadas en la mesa del plató. Destaca la labor de Mario Casado, que actúa como moderador del programa. El programa se puede seguir en directo por la web, donde los internautas pueden participar a través de las redes sociales.

F. **La sirena Rita.** Rita, la sirena, se da cuenta de que algunos animales del mar están enfermando. La culpa la tiene una bacteria maligna. Veremos cómo, en su lucha por salvar el océano, Rita y el cangrejo Sebastián enseñan a los más pequeños de la casa a respetar el medio ambiente.

G. **El buscador de historias.** Este programa describe la realidad de manera cercana con un lenguaje coloquial y próximo que crea empatía con el espectador. El hilo conductor es un reportero, y cada programa recoge un solo tema que se expone desde varios puntos de vista.

H. **Que pase el siguiente.** El reconocido presentador Carlos Soriano es el encargado de conducir el programa y formular las preguntas a los jugadores. Soriano estará acompañado de actores, cantantes, magos y gente del espectáculo, que a través de distintos números sorprenderán al público y a los espectadores.

I. **Origen.** Hace cinco años una agencia espacial descubrió la posibilidad de vida extraterrestre en nuestro Sistema Solar. Para recolectar muestras, puso en órbita una nave tripulada que alcanzó el objetivo, pero, al regresar a la Tierra, la nave se perdió en la selva de América Central. Así arranca este largometraje, que recibió numerosos premios por sus efectos especiales.

J. **La inteligencia del pulpo.** El pulpo es una de las especies más complejas de los océanos. Y también estamos ante la inteligencia más avanzada de todo lo que no respira aire en este planeta. Una clase de inteligencia distinta, extraña, que a veces es capaz de poner los pelos de punta e invitarnos a soñar. O a tener pesadillas.

Tarea 2

Instrucciones: Usted va a leer un texto sobre las joyas de concha en el México prehispánico. Después, debe contestar a las preguntas (7-12). Seleccione la respuesta correcta (a/b/c). Marque las opciones elegidas en la Hoja de respuestas.

EL MISTERIO DE LAS JOYAS DE CONCHA

Al igual que la turquesa, las plumas de aves exóticas y el oro, la concha (lo que conocemos como concha de mar) era un material precioso en el México prehispánico (anterior a la conquista y colonización españolas). Así lo prueban los cientos de piezas elaboradas con diversos tipos de conchas recuperadas en las distintas excavaciones a lo largo de todo el país: solo en las excavaciones que se realizan desde 1978 en la zona arqueológica del Templo Mayor de Tenochtitlan se han recuperado más de 2.300 objetos hechos con concha. Las piezas, que han ido apareciendo en diferentes excavaciones, eran depositadas en las tumbas como ofrendas funerarias para recrear el inframundo acuático.

Para los mexicas, así como para las diversas culturas de Mesoamérica, la concha tenía una connotación sagrada, pues al ser un elemento acuático se asociaba con ese líquido esencial en el desarrollo de la vida. Además, por lo difícil que resultaba su obtención, era considerada un material de lujo, al que, por ejemplo en Tenochtitlan, solo tenía acceso la clase gobernante.

El arqueólogo Adrián Velázquez Castro busca desde hace quince años las huellas de las herramientas empleadas por los artesanos prehispánicos en la elaboración de los objetos de concha. Y es que, a pesar de la gran cantidad de piezas recuperadas, no se han encontrado hasta ahora en la zona del Templo Mayor de Tenochtitlan restos de ningún taller o del área de producción de estos adornos.

Velázquez empezó a trabajar en la clasificación de la colección de objetos de concha del Templo Mayor, pero su interés por conocer las formas de elaboración de estas piezas lo llevó a crear un proyecto de arqueología experimental que se convertiría, con el tiempo, en un taller de fabricación de la concha. Con este taller se pretende conocer, mediante la reconstrucción de las piezas antiguas con conchas modernas, las técnicas con las que se trabajó este material en la época prehispánica. Gracias al taller se ha podido saber, por ejemplo, que la producción del Templo Mayor fue muy estandarizada (se utilizaron la misma técnica y los mismos materiales), fue controlada por la clase gobernante y estuvo enfocada, casi exclusivamente, a la creación de objetos ornamentales.

Al principio el taller se limitó a estudiar la colección de objetos de concha del Templo Mayor, pero poco a poco se extendió, y ya lleva realizados más de setecientos experimentos con otros objetos de concha del México prehispánico. «En gran parte gracias al trabajo de estudiantes de arqueología, tenemos ya un buen número de colecciones estudiadas, que van desde el norte de México hasta la zona maya, desde las etapas más tempranas, durante el período formativo, hasta el posclásico tardío, con la conquista española», comenta Adrián Velázquez Castro.

7. Según el texto, las piezas hechas con concha del México prehispánico...

a) aparecen a partir de la conquista española.

b) se limitan a la zona de Tenochtitlan.

c) se han hallado en los enterramientos.

8. En el texto se dice que los mexicas atribuían a la concha cierto carácter sagrado porque...

a) la relacionaban con el agua.

b) resultaba difícil de encontrar.

c) era un símbolo de poder.

9. En el texto se nos informa de que el arqueólogo Adrián Velázquez...

a) lleva 15 años investigando cómo se trabajaba la concha.

b) halló un taller para la fabricación de la concha.

c) descubrió los utensilios para trabajar la concha.

10. Según el texto, en el taller experimental impulsado por Adrián Velázquez...

a) se clasifican los tipos de concha encontrados.

b) se trabaja la concha con nuevas técnicas.

c) se reconstruyen los objetos hallados con conchas actuales.

11. Según el texto, en el Templo Mayor de Tenochtitlan la producción de los objetos de concha...

a) se realizaba con varios procedimientos.

b) se destinaba a las autoridades.

c) se centraba en la elaboración de adornos.

12. En el texto se informa de que actualmente los estudios del taller de manufactura de la concha...

a) se basan en la colección del Templo Mayor.

b) incluyen todo el período prehispánico.

c) analizan piezas posteriores a la conquista española.

Tarea 3

Instrucciones: Usted va a leer tres textos en los que unos padres nos hablan de la organización de la fiesta de cumpleaños de sus hijos. Relacione las preguntas (13-18) con los textos (A, B o C). Marque las opciones elegidas en la Hoja de respuestas.

A. Pablo

Debía decorar el salón para el cumpleaños de mi hijo pequeño, pero mi presupuesto era bajo y no resultaba fácil. De repente se me ocurrió: ¡cubrir las paredes con carteles! Todo lo que les guste a los niños está bien: sus actores y cantantes favoritos de TV, los personajes de los dibujos animados, etc.

En una de las paredes del salón puse un gran papel blanco que la cubría entera para que los niños hicieran sus propias creaciones con pinturas al agua, ya que estas se lavan fácilmente. Fue un éxito rotundo. Los niños disfrutaron mucho dejando volar su imaginación y manchándose las manos y la pared sin que ningún adulto les riñera. Al final, cada pequeño recibió un premio como recompensa a su esfuerzo creativo.

B. Ana

Creo firmemente que hay que ser respetuoso con el medio ambiente. Por eso decidí organizar un cumpleaños un poco diferente a lo que estaba acostumbrada, aunque eso representara un mayor esfuerzo y gasto. Empecé con el tema de las invitaciones. Usé Internet en lugar de invitaciones de papel, así ahorré papel y dinero.

Luego también compré vasos y platos reutilizables en vez de comprarlos de papel. Para la decoración, rechacé la idea de usar globos, que a menudo explotan antes de que finalice la fiesta. En su lugar, utilicé papel reciclado para hacer flores y carteles e hice sombreros de fiesta que los niños colorearon con pinturas y les sirvieron de disfraz.

C. Nicolás

Mi hijo tiene seis años. A esa edad los niños tienen una energía agotadora y, cuantos más niños hay, más energía parecen tener. Por eso hice caso a mis padres, que viven en una urbanización, y celebré el cumpleaños en su casa. Para evitar las quejas, pedí permiso a todos los vecinos.

Celebramos el cumpleaños en la zona comunitaria ajardinada de la urbanización, lo que me permitió organizar actividades que en el salón de casa hubiera sido complicado llevar a cabo. Por ejemplo, contraté a unos payasos que lograron entretener un buen rato a los niños. También organizamos una fiesta de disfraces, y al final los críos votaron el disfraz más original, el más divertido..., y entregamos un obsequio a cada uno de los niños.

Preguntas:

13. ¿Qué persona dice que celebraron la fiesta al aire libre?

14. ¿Qué persona dice que en la fiesta hubo un espectáculo?

15. ¿Qué persona dice que organizar el cumpleaños le supuso más trabajo del habitual?

16. ¿Qué persona dice que disponía de poco dinero para los adornos?

17. ¿Qué persona dice que su idea triunfó entre los niños?

18. ¿Qué persona dice que hubo un concurso en la celebración?

Tarea 4

Instrucciones: Lea el siguiente texto, del que se han extraído seis fragmentos. A continuación lea los ocho fragmentos propuestos (A-H) y decida en qué lugar del texto (19-24) hay que colocar cada uno de ellos. HAY DOS FRAGMENTOS QUE NO TIENE QUE ELEGIR. Marque las opciones elegidas en la Hoja de respuestas.

LA HISTORIA DE LA @ (ARROBA)

Es posible que usted crea que la arroba es un invento propio de la «era Internet», un símbolo creado para dar forma a las direcciones de correo electrónico. Sin embargo, su origen es mucho más antiguo. 19.______________________. En cuanto al símbolo @, esa especie de «a» encerrada en un círculo, se sabe que tiene sus orígenes en la Edad Media, y que era utilizado por los encargados de copiar libros en latín, por supuesto a mano.

20.______________________. Parece lógico que fuera una forma de ahorrar trabajo cuando se tenían que escribir decenas de veces cientos de páginas. Uno de los documentos más antiguos en el que aparece el símbolo @ es una carta enviada desde Sevilla a Roma por un mercader italiano en 1536. 21.______________________. En la carta puede leerse lo siguiente: «Así, una @ de vino, que es 1/13 de un barril, vale 70 ducados». En ese contexto, representaba sin duda una unidad de medida. Con el paso del tiempo, la arroba dejó de utilizarse de forma generalizada, aunque se siguió usando en algunos lugares. 22. ______________________. Solía aparecer en medio de la descripción de una operación: «15 cajas @ 5 dólares», que venía a significar '15 cajas a 5 dólares cada caja'. Tiene sentido, ya que en inglés «@» se dice «at», que significa 'a' (y también 'en', 'de' y 'hacia'). 23. ___________________. La relación de la «@» con el correo electrónico es muy posterior. Data de 1971, cuando el ingeniero Ray Tomlinson, creador del correo electrónico, buscaba un signo que sirviese para separar el nombre de la persona de la dirección de destino. 24._____________________. En los últimos años, para evitar la discriminación por género, se está extendiendo la costumbre de utilizar la «@» como recurso gráfico para integrar en una sola palabra las formas masculina y femenina de los sustantivos y adjetivos. Con este signo, que incluye en su trazo las vocales «a» y «o», se consigue economizar y evitar el repetitivo «–o/-a».

Fragmentos:

A. Ellos escribían «@» uniendo las letras «a » y «d » para formar la preposición «ad», que en castellano significa 'hasta'.

B. En aquel momento uno de los pocos signos disponibles en los teclados era el de la «@»; por eso lo eligió.

C. Por ejemplo, el símbolo se mantuvo en Estados Unidos, donde se empleaba en las facturas para referirse al precio de un producto.

D. Esto hizo que cuando se inventó la máquina de escribir el símbolo de la arroba se incluyera en su teclado.

E. Entonces la «@» empezó a aparecer en las cartas oficiales redactadas en latín antes del nombre de su destinatario.

F. La mayoría de los historiadores aceptan que la palabra arroba proviene del árabe roub, que significa ‘cuarta parte’.

G. Y, como el teclado de los ordenadores es una evolución de los de aquellas máquinas, la arroba también se encuentra en ellos.

H. En dicho escrito se detalla la llegada de tres barcos provenientes de América cargados de tesoros.

Appendix C

English Translation of the DELE

The following is a reproduced excerpt from the reading comprehension test of the *Diplomas de Español como Lengua Extranjera* (DELE; "Certification of Spanish as a Foreign Language"), distributed by the Instituto Cervantes. Participants in the bilingual and attrition groups took this test as a measure of Spanish proficiency.

Participants were provided a PDF file of the questions, and the answer sheet was reproduced in on Qualtrics. Each *tarea* ("task"; set of related questions) appeared on a separate page. Horizontal lines denote task divisions. Instructions are italicized.

Tarea 1

Instructions: You are going to read six texts in which people talk about the television progras that they like to watch and ten texts that talk about television programs. Match the people (1-6) with the texts that talk about each program (A-J). THERE ARE THREE TEXTS THAT WILL NOT BE USED. Mark yout choices on the Response Sheet.

People/Descriptions:

0. Aurora: I love the soap operas that are on after I eat. Although people say there isn't much quality in these shows, they really help me relax.
1. Isabel: I'm a big fan on science outreach programs. I'm interested in programs that talk about the universe.
2. Óscar: I always like to stay informed about what is happening, but I'm not satisfied with only one perspective. That's why my favorite programs are debates.

3. Tina: I'm very competitive, and that's why I'm passionate about contests. I even follow them on the internet because in a lot of them, you can participate through social media.
4. Adrián: I'm a fan of diving and I love animals, so I always catch the documentaries about discovering marine fauna.
5. Eva María: Since I had Carla, I've barely had time to watch TV. The only thing I can see are the drawings they drop while I'm giving them snacks.
6. David: I want to get across the importance of being aware of environmental problems to my students. One way to do that is watching programs that deal with these issues.

Options:

A. **¡Artzooka!** This program develops motor skills in a fun and easy way. The presenter, Bruno, explains to children how they can make works of art with waste material that is anywhere in their house. In the next episode, we will learn to make nice puppets.

B. **El escarabajo rojo** (*The Red Beetle*). This week the program will be dedicated to water, what is considered by many experts to be the oil of the third millennium. A report analyzes in depth the pros and cons of the privatization of water with experts in the field.

C. **Redes** (Networks). In the next chapter, Vlatko Vedral, physicist at the University of Oxford, will explain to Eduard Punset how subatomic objects can be in more than one place at a time and how two particles located at opposite ends of a galaxy can share information instantly.

D. **La fuerza del destino** (Destiny's Force). Adolfo manages to talk secretly with Matilde and clarify misunderstandings. She confesses that she is expecting a baby. To save the hacienda from ruin, Humberto forces his daughter, Matilde, to marry the wealthy Mendoza. When Matilde tells Adolfo of her father's plans, they decide to flee together.

E. **59 segundos** (59 Seconds). Five experts in different areas have 59 seconds to present their perspectives and answer the questions raised at the table. Highlights the work of Mario Casado, who acts as moderator of the program. The program can be followed live on the web, where Internet users can participate through social networks.

F. **La sirena Rita** (Rita the Mermaid). Rita the mermaid realizes that some sea animals are getting sick, due to toxic bacteria. We see how, in their struggle to save the ocean, Rita and Sebastian the crab teach the even the youngest children how to respect the environment.

G. **El buscador de historias** (The History Searcher). This program depicts the past with colloquial and accessible language to help the viewer form connections. A reporter guides each episode, which focuses on a single topic that is considered from several points of view.

H. **Que pase el siguiente** (Next Please). Well-known presenter Carlos Soriano moderates the program and asks the players questions. Soriano is accompanied by actors, singers, magicians and entertainers, who surprise the audience and viewers alike with different acts.

I. **Origen** (Origin). Five years ago, a space agency discovered the possibility of extraterrestrial life in our Solar System. To collect samples, he put a manned ship into orbit. It reached the target, but upon returning to Earth, the ship was lost in the Central American jungle. So starts this feature film, which received numerous awards for its special effects.

J. **La inteligencia del pulpo** (The Octopus's Intelligence). Octopi are one of the most complex species in the ocean and are the most intelligent creatures that does not breathe air on this planet. They have a different, strange type of intelligence that makes our hair stand on end and invites us to dream…or gives us nightmares

---

Tarea 2

Instructions: You will read a text about shell jewelry in pre-Hispanic Mexico. Then, you must answer the questions (7-12). Select the correct answer (a / b / c). Mark your responses on the Answer Sheet.

THE MYSTERY OF THE SHELL JEWELRY

Same as turquoise, feathers of exotic birds, and gold, shells (which we know as seashells) were a precious material in pre-Hispanic Mexico (before the conquest and Spanish colonization). The hundreds of pieces found, made with different types of shells found in separate excavations throughout the country, prove this: in excavations carried out since 1978 alone, more than 2,300 objects made with shells have been recovered in the archeological zone near the Templo Mayor of Tenochtitlan. The pieces, which have been appearing in different excavations, were put in tombs as funeral offerings to recreate the aquatic underworld.

For the Aztecs, as well as the diverse cultures of Mesoamerica, shells had a sacred significance: as an aquatic object, it was associated with an essential component in the development of life. Since it was difficult to obtain, it was also considered a luxury material that only the ruling class had access to (for example, in Tenochtitlan).

For fifteen years, archaeologist Adrián Velázquez Castro has been looking for traces of the tools used by pre-Hispanic artisans to create objects with shells. This is something that, despite the large number of pieces recovered, until now no workshop or production place of these adornments has been found near the Templo Mayor of Tenochtitlan

Velázquez started to work on the classification of a collection of shell objects from Templo Mayor, but his interest in how these pieces were made led him to create an experimental archeological project that would eventually become a shell manufacturing workshop. In this workshop, he tries to familiarize himself with the techniques with which this material was manipulated in the pre-Hispanic era through the reconstruction of ancient pieces with modern shells. Thanks to the workshop, it is now known, for example, that the production of the Templo Mayor was very standardized (the same technique and materials were used), it was controlled by the ruling class, and it was almost exclusively focused on the creation of ornamental objects.

Initially the workshop was limited to studying the collection of shell objects from Templo Mayor, but little by little this was broadened, and it has now carried out more than seven hundred experiments with other shell objects from pre-Hispanic Mexico. "Thanks in great part to the work of archaeological students, we have already studied a good number of collections that range from the north of Mexico to the Mayan zone, from the earliest stages to the formative period, up to the late postclassic period of the Spanish conquest," comments Adrián Velázquez Castro.

7. According to the text, the pieces made with shells from pre-Hispanic Mexico...

a) started to appear during the Spanish conquest.

b) were limited to the Tenochtitlan area.

c) have been found in graves.

8. In the text, it is said that the Aztecs attributed a certain sacred significance to the shell because…

a) it was related to water.

b) it was hard to find.

c) it was a symbol of power

9. In the text we are told that the archaeologist Adrián Velázquez…

a) has been investigating how shells were used for 15 years.

b) found a workshop where shell objects were made.

c) discovered the tools used to work with shells.

10. According to the text, in Adrián Velázquez's workshop...

a) the types shells that are found are classified

b) the shells are analyzed with new techniques.

c) objects found with shells are reconstructed.

11. According to the text, the production of shell objects in the Templo Mayor of Tenochtitlan...

a) was achieved with various procedures.

b) was intended for leaders.

c) focused on making adornments.

12. The text informs us that current studies about shell manufacturing workshops…

a) are based on the Templo Mayor collection.

b) include the entire pre-Hispanic period.

c) analyze pieces made after the pre-Hispanic conquest

Tarea 3

Instructions: You are going to read three texts in which some parents tell you about planning their child's birthday party. Match the questions (13-18) with the texts (A, B, or C). Mark your choice on the response sheet.

A. Pablo

I had to decorate the room for my little son's birthday, but I had a small budget and it wasn't easy. Suddenly, it occurred to me: cover the walls with posters! Everything that children like would be there: their favorite actors and singers from TV, cartoon characters, etc.

I put a big white paper on one of the room's walls, covering it entirely, so that the children create their own pictures with water-based paint, which was easily washed off. It was a resounding success. The children really enjoyed letting their imagination run wild and getting their hands and the wall messy with no adult stopping them. At the end, each child received an award for their creative effort.

B. Ana

I firmly believe that we must be respectful of the environment. That's why I decided to organize a birthday party that was a little different from what I was accustomed to, though it was more effort and more expensive. I started with the invitations. I used the internet instead of printing them, saving paper and money.

Then. I also bought reusable cups and plates in place of buying paper ones. For decorations, I chose not to use balloons as they often pop before the party ends. Instead, I used recycled paper to make flowers, posters, and party hats that the children colored as pictures (and served as a way of transforming them).

C. Nicolás

My son is six. At this age, children have exhausting amounts of energy, and they seem to have more energy the more children there are. That's why I listened to my parents, who live in a housing development, and celebrated my son's birthday at our house. To avoid complaints, I asked their neighbors for permission ahead of time.

We celebrated his birthday in the housing development's community garden, which allowed me to organize activities that would have been difficult to do in the living room. For example, I hired some clowns who were able to entertain the children for a good amount of time. We also had a costume competition, and at the end the children voted on which costume was the most original, the most fun, etc., and we gave a small gift to each child.

Questions:

13. Which person says that they celebrated the party outside?

14. Which person says that the party was a spectacle

15. Which person says that organizing the party was more work than usual?

16. Which person says that they didn't have much money for decorations

17. Which person says that their idea was a hit with the kids?

18. Which person says that there was a competition at the celebration?

Tarea 4

Instructions: Read the following text, from which six sentences have been removed. Then read the eight proposed sentences (A-H) and decide where in the text (19-24) each of them should be placed. THERE ARE TWO SENTENCES THAT WILL NOT BE USED. Mark your responses the Answer Sheet.

THE HISTORY OF THE @ (AT SIGN)

It's possible that you may think that the "@" sign was the Internet era's own invention, a symbol created to guide emails to the right destination. However, it has a much older origin.

19.______________________. The "@" symbol, a type of "a" within a circle, is known to have originated in the Middle Ages and was used by those who copied books into Latin by hand. 20.______________________. It logically seems that this was a way to work more quickly, as hundreds of pages had to be written dozens of times. One of the oldest documents in which the "@" symbol appears was a letter sent from Seville to Rome in 1536 by an Italian merchant. 21.______________________. In the letter, the following can be read: "So, one @ of wine, which is 1/13 of a barrel, is worth 70 ducats." In this context it represents, without a doubt, a unit of measure. As time passed, the "at" sign stopped being widely used, only continuing to be used in some places. 22. ______________________. It used to appear in the middle of a transaction: "15 boxes @ 5 dollars," which came to mean "15 boxes at 5 dollars per box." It makes sense, as in English "@" already meant "at" (and could also be used as "in," "of," and "towards"). 23. ____________________. The relationship between "@" and email came much later. It dates from 1971, when the engineer Ray Tomlinson, creator of email, was looking for a symbol that could serve as a way to separate the person's name from the originating address. 24.______________________. In recent years, to avoid discrimination by gender, the custom of using "@" as a graphic resource to integrate both masculine and feminine gendered nouns and adjectives into a single word is spreading. With this symbol, which includes both "a" and "o" vowels, one can succinctly avoid the repetitive "-o/-a".

Sentences:

A. They wrote "@" joining the letters "a" and "d" to form the preposition "ad", which means "until" in Spanish.

B. He chose it because, at that time, "@" was one of the few keyboard symbols available.

C. For example, the symbol was kept by the United States, where it was used in invoices to refer to the price of products.

D. This caused the “at” sign to remain on the keyboard when the typewriter was invented.

E. Then the “@” began to appear before the name of the recipient on official letters written in Latin.

F. Most historians accept that its Spanish name “*arroba*” comes from the Arabic “roub,” which means “fourth part”.

G. Since computers are “evolutions” of these machines, the “at” sign can also be found on them.

H. This document details the arrival of three ships, loaded with treasures, coming to America.

Appendix D

Revised Language Contact Profile

The following survey, adapted from Freed et al.'s additional modifications (2004) to the original Language Contact Profile (Seliger, 1977; later modified by Day, 1985, & Freed, 1990). It is referred to as the Revised Language Contact Profile (RLCP) and used to study language acquisition rather than current use of a language. Demographic information is also gathered.

Divider lines in this appendix denote divisions of blocks in the survey, as no more than three individual questions appeared on the webpage at the same time. Indented lines indicate a question that only appeared if a previous question was answered affirmatively. Response types are indicated in the text by number and/or letter, with a key appearing at the end of the survey; multiple choice answers are further specified.

RLCP Start

Every effort will be made to keep the responses that you give in this questionnaire will be kept confidential. An identification number will be used in place of your name when referring to your responses in publications.

The information that you provide will help us to better understand language contact, learning, and acquisition patterns. Your honest and detailed responses are greatly appreciated.

Use of Spanish

1. Do you now, or have you ever, spoken Spanish?[1]

2. Do your grandparents speak Spanish?[1]

3. Do your parents speak Spanish?[1c]

____

4. Did you receive formal Spanish education in elementary school (grades K-5, approximately ages 5-10)?[1]

5. If so, which year did you start learning Spanish?[2a]

____

6. Did you receive formal Spanish education in middle school (grades 6-8, approximately ages 11-13)?[2]

- ◦ Yes
- ◦ No
- ◦ Other[3]

7. If so, which year did you start learning Spanish?[3a]

____

8. Did you receive formal Spanish education in high school (grades 9-12, approximately ages 14-18)?[2]

- ◦ Yes
- ◦ No
- ◦ Other[3]

9. If so, which year did you start learning Spanish?[3a]

____

10. What type of high school did you attend?[2]

- ◦ Public
- ◦ Private Religious

- Charter
- Satellite
- Online
- Boarding
- Independent
- Private (Nonreligious)
- Homeschool
- Other[3]

---

11. Did you receive formal Spanish education post-high school?[2]

- Yes
- No
- Other[3]

12. If so, which year did you start learning Spanish?[3a]

13. Please indicate any Spanish courses you took during college (Class code/Name; example: Spanish 101/Intro Spanish 1)[3a]

---

14. How motivated did you feel to learn Spanish?[4]

15. How much did you enjoy learning Spanish as a language?[4]

16. How would you rate the quality of the instruction in Spanish that you received?[4]

17. When was your last significant interaction with the Spanish language? (Examples: writing/speaking/reading/intentionally listening)[3b]

Experience in the Spanish-speaking world

18. Have you lived in a Spanish-speaking country?[1c]

19. In which Spanish-speaking country(s) did you live and for how long?[3]

20. Which situation best describes your living arrangements in the country?[2]

- I lived in the home of a Spanish-speaking family.
- I lived in group (student) housing.
- I lived alone in a room or in an apartment.
- I lived in a room or an apartment with native or fluent Spanish speaker(s).
- I lived in a room or an apartment with others who are NOT native or fluent Spanish speakers.
- I lived with family members.
- Other (please specify)[3]

21. Please list the members of the family you stayed with (e.g., mother, father, one 4-year-old daughter, one 13-year-old son)[3a]

22. Did they speak English?[2]

- Yes

- ◦ No
- ◦ Yes, but not fluently/not often

23. Were there other nonnative speakers of Spanish living with your host family?[1]

---

24. Select all that apply to your living situation[2]

- ◦ I had a private room.
- ◦ I had a roommate who was a native or fluent Spanish speaker.
- ◦ I lived with others who are NOT native or fluent Spanish speakers.

For the following items, please specify:

(i) How many days per week you typically used Spanish in the situation indicated, and (ii) on average how many hours per day you did so.

---

27. On average, how many days per week did you spend speaking, in Spanish, outside of formal environments (e.g., classroom, foreign language internship) with native or fluent Spanish speakers during this time?[5]

28. On average, how many hours per day did you spend speaking, in Spanish, outside of formal environments (e.g., classroom, foreign language internship) with native or fluent Spanish speakers during this time?[6]

---

29. On average, how many days did you speak in Spanish, outside of formal environments (e.g., classroom, foreign language internship), with the following native or fluent Spanish speakers during this time?

- A formal instructor[5]
- Classmates[5]
- strangers who I thought could speak Spanish[5]
- a host family, Spanish roommate, or other Spanish speakers in a dormitory setting[5]
- My own family members[5]
- service personnel[5]
- Not listed (Other)[5]

30. On those days, how many hours did you spend speaking, in Spanish, outside of formal environments (e.g., classroom, foreign language internship) with the following native or fluent Spanish speakers during this time?

- A formal instructor[6]
- Classmates[6]
- strangers who I thought could speak Spanish[6]
- a host family, Spanish roommate, or other Spanish speakers in a dormitory setting[6]
- My own family members[6]
- service personnel[6]
- Not Listed (Other)[6]

---

31. How many days per week did you use Spanish outside of a formal (professional) context for each of the following purposes?

- to clarify classroom-related work[5]
- to obtain directions or information (e.g., “Where is the post office?”, “What time is the train to ... ?)[5]

- for superficial or brief exchanges (e.g., greetings, “Please pass the salt,” “I’m leaving,” ordering in a restaurant)[5]
- with a host family, Spanish roommate, or acquaintances in a Spanish-speaking dormitory[5]
- extended conversations with my (host) family, Spanish roommate, friends, or acquaintances in a Spanish-speaking dormitory, native speakers of English with whom I speak Spanish[5]

32. One those days, how many hours did you use Spanish outside of a formal (professional) context for each of the following purposes?

- to clarify classroom-related work[6]
- to obtain directions or information (e.g., “Where is the post office?”, “What time is the train to ... ?)[6]
- for superficial or brief exchanges (e.g., greetings, “Please pass the salt,” “I’m leaving,” ordering in a restaurant)[6]
- with a host family, Spanish roommate, or acquaintances in a Spanish-speaking dormitory[6]
- extended conversations with my (host) family, Spanish roommate, friends, or acquaintances in a Spanish-speaking dormitory, native speakers of English with whom I speak Spanish[6]

---

33. During your time studying Spanish, typically how many days per week...

- ...did you try deliberately to use things you were taught in the classroom?[5]
- ...did you take things you learned outside of the classroom (grammar, vocabulary, expressions) back to class for question or discussion?[5]

34. During your time studying Spanish, on those days typically how many hours per day...

- ...did you try deliberately to use things you were taught in the classroom?[6]
- ...did you take things you learned outside of the classroom (grammar, vocabulary, expressions) back to class for question or discussion?[6]

---

35. How many days per week did you spend doing the following?

- speaking a language other than English or Spanish to speakers of that language (e.g., Chinese with a Chinese-speaking friend)[5]
- speaking Spanish to native or fluent speakers of Spanish[5]
- speaking English to native or fluent speakers of Spanish[5]
- speaking Spanish to nonnative speakers of Spanish (i.e., classmates)[5]
- speaking English to nonnative speakers of Spanish (i.e., classmates)[5]

36. On those days, how many hours did you spend doing the following?

- speaking a language other than English or Spanish to speakers of that language (e.g., Chinese with a Chinese-speaking friend)[6]
- speaking Spanish to native or fluent speakers of Spanish[6]
- speaking English to native or fluent speakers of Spanish[6]
- speaking Spanish to nonnative speakers of Spanish (i.e., classmates)[6]
- speaking English to nonnative speakers of Spanish (i.e., classmates)[6]

---

37. During your time studying Spanish, typically how many days each week did you spend doing each of the following activities outside of a formal (professional) context?

- overall, in reading in Spanish outside of a formal (professional) context[5]
- reading Spanish newspapers outside of a formal (professional) context[5]

- reading novels in Spanish outside of a formal (professional) context[5]
- reading Spanish language magazines outside of a formal (professional) context[5]
- reading schedules, announcements, menus, and the like in Spanish outside of a formal (professional) context[5]
- reading e-mail or Internet web pages in Spanish outside of a formal (professional) context[5]
- overall, in listening to Spanish outside of a formal (professional) context[5]
- listening to Spanish television and radio outside of a formal (professional) context[5]
- listening to Spanish movies or videos outside of a formal (professional) context[5]
- listening to Spanish songs outside of a formal (professional) context[5]
- trying to catch other people's conversations in Spanish outside of a formal (professional) context[5]
- overall, in writing in Spanish outside of a formal (professional) context[5]
- writing homework assignments in Spanish outside of a formal (professional) context[5]
- writing personal notes or letters in Spanish outside of a formal (professional) context[5]
- filling in forms or questionnaires in Spanish outside of a formal (professional) context[5]
- filling in forms or questionnaires in Spanish outside of a formal (professional) context[5]

38. On those days, how many hours did you spend doing each of the following activities outside of a formal (professional) context?

- overall, in reading in Spanish outside of a formal (professional) context[6]
- reading Spanish newspapers outside of a formal (professional) context[6]
- reading novels in Spanish outside of a formal (professional) context[6]
- reading Spanish language magazines outside of a formal (professional) context[6]
- reading schedules, announcements, menus, and the like in Spanish outside of a formal (professional) context[6]
- reading e-mail or Internet web pages in Spanish outside of a formal (professional) context[6]
- overall, in listening to Spanish outside of a formal (professional) context[6]
- listening to Spanish television and radio outside of a formal (professional) context[6]
- listening to Spanish movies or videos outside of a formal (professional) context[6]
- listening to Spanish songs outside of a formal (professional) context[6]
- trying to catch other people's conversations in Spanish outside of a formal (professional) context[6]
- overall, in writing in Spanish outside of a formal (professional) context[6]
- writing homework assignments in Spanish outside of a formal (professional) context[6]

- writing personal notes or letters in Spanish outside of a formal (professional) context[6]
- filling in forms or questionnaires in Spanish outside of a formal (professional) context[6]
- filling in forms or questionnaires in Spanish outside of a formal (professional) context[6]

---

39. Currently, how many days each week do you spend doing each of the following activities outside of a formal (professional) context?

- overall, in reading in Spanish outside of a formal (professional) context[5]
- reading Spanish newspapers outside of a formal (professional) context[5]
- reading novels in Spanish outside of a formal (professional) context[5]
- reading Spanish language magazines outside of a formal (professional) context[5]
- reading schedules, announcements, menus, and the like in Spanish outside of a formal (professional) context[5]
- reading e-mail or Internet web pages in Spanish outside of a formal (professional) context[5]
- overall, in listening to Spanish outside of a formal (professional) context[5]
- listening to Spanish television and radio outside of a formal (professional) context[5]
- listening to Spanish movies or videos outside of a formal (professional) context[5]
- listening to Spanish songs outside of a formal (professional) context[5]

- trying to catch other people's conversations in Spanish outside of a formal (professional) context[5]
- overall, in writing in Spanish outside of a formal (professional) context[5]
- writing homework assignments in Spanish outside of a formal (professional) context[5]
- writing personal notes or letters in Spanish outside of a formal (professional) context[5]
- filling in forms or questionnaires in Spanish outside of a formal (professional) context[5]
- filling in forms or questionnaires in Spanish outside of a formal (professional) context[5]

40. On those days, how many hours do you spend doing each of the following activities outside of a formal (professional) context?

- overall, in reading in Spanish outside of a formal (professional) context[6]
- reading Spanish newspapers outside of a formal (professional) context[6]
- reading novels in Spanish outside of a formal (professional) context[6]
- reading Spanish language magazines outside of a formal (professional) context[6]
- reading schedules, announcements, menus, and the like in Spanish outside of a formal (professional) context[6]
- reading e-mail or Internet web pages in Spanish outside of a formal (professional) context[6]
- overall, in listening to Spanish outside of a formal (professional) context[6]

- listening to Spanish television and radio outside of a formal (professional) context[6]
- listening to Spanish movies or videos outside of a formal (professional) context[6]
- listening to Spanish songs outside of a formal (professional) context[6]
- trying to catch other people's conversations in Spanish outside of a formal (professional) context[6]
- overall, in writing in Spanish outside of a formal (professional) context[6]
- writing homework assignments in Spanish outside of a formal (professional) context[6]
- writing personal notes or letters in Spanish outside of a formal (professional) context[6]
- filling in forms or questionnaires in Spanish outside of a formal (professional) context[6]
- filling in forms or questionnaires in Spanish outside of a formal (professional) context[6]

Demographic Information

41. Do you have any experience in linguistics?[1]

    42. Please indicate what linguistics experience you have[3a]

43. Do you have any experience in psychology?[1]

    44. Please indicate what psychology experience you have[3a]

45. Are you familiar with any other languages (not English or Spanish)?[1]

46. What other languages (not English or Spanish) have you been exposed to, and in what context (when, where, and for how long)?[3a]

---

47. What is your gender?[3]

48. What is your age?[3]

---

49. What was your state(s) of permanent residence during childhood?[3]

50. Which US counties have you lived in?[3]

---

51. What is your race/ethnicity?[2]

- Hispanic/Latino
- Black/African-American
- Native American/American Indian
- Asian/Pacific Islander
- White/Caucasian
- Not Listed (please specify)[3]

---

52. What is your socioeconomic status?[4]

53. What was the socioeconomic status of your parents during your childhood?[4]

RCLP Key

a. Shown based on responses to previous question(s) (unless preceding question is marked with a “c”)
b. Shown only to attrition group
c. If this question was answered “no”, participants were directed to block 3 (Demographic questions)

1. Binary yes/no
2. Multiple choice
3. Text entry box
4. Sliding bar (from 1 to 10)
5. Likert scale (with a low of 0 and a high of 7)
6. Likert scale (with a low of 0 and a high of 24)