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Effects of Bilingualism in Short-Term Memory in Individuals with Down Syndrome

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EFFECTS OF BILINGUALISM IN SHORT-TERM MEMORY IN INDIVIDUALS WITH DOWN SYNDROME

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by

Evelyn I. Pinto-Cardona

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To: Dean Ora Strickland
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This thesis, written by Evelyn I. Pinto-Cardona, and entitled Effects of Bilingualism in Short-Term Memory in Individuals with Down Syndrome, having been approved in respect to style and intellectual content, is referred to you for judgment.

We have read this thesis and recommend that it be approved.

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Florida International University, 2017

DEDICATION

This thesis is dedicated to my family for their countless support and encouragement. To my parents, Olga and Sergio, thank you for your selfless decisions to provide a better future for me and for your immense support in everything I have embarked on in life. To my precious husband, Juan, thank you for your words of wisdom, for believing in my capabilities, for pushing me at times when I have felt like giving up, for lifting me up when I fall, and for your pure unconditional love.

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ABSTRACT OF THE THESIS

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by

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Florida International University, 2017

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The purpose of this study is to examine the effects of bilingualism in short-term memory (STM) compared to monolingualism with individuals who have Down syndrome. Five tasks were used for STM skills comparison between monolingual and bilingual participants. Sixteen participants between the ages of 13 to 37 were included in this study. Participants were divided based on their language groups. The experimental tasks consisted of non-verbal activities to examine visual (RVDLT) and spatial (Corsi) STM; as well as three verbal STM tasks (RAVLT, WMS, and Digits). The results showed that bilinguals acquired higher overall correct responses, with a significant difference found in visual STM performance and a trend towards significance in verbal logical STM. Thus, the findings of this study support the bilingual advantage theory. This study will enhance understanding in memory capacity of bilingual individuals with Down syndrome for potential implications to put into practice in clinical intervention strategies.

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CHAPTER I

Review of Literature

Introduction

Recently, there have been an increasing number of studies examining the influence of bilingualism on typically developing individuals. Some of these studies include neuroanatomical evidence in support of the bilingual advantage theory by Olulade et. al. (2015), the bilingual advantage in novel word learning by Kaushanskaya and Marian (2009), and a bilingual advantage in task switching by Prior and MacWhinney (2010). However, to date, there have been few studies that examine the effects of bilingualism on memory with individuals who have specific disabilities, such as the language abilities of bilingual children with Down syndrome (Kay-Raining Bird, Cleave, Trudeau, Thordardottir, Sutton, & Thorpe, 2005).

This study examines difference in short-term memory between bilingual and monolingual individuals with Down syndrome. Due do the lack of existing research, the purpose of this study is to increase knowledge on the effects of bilingualism on individuals who have Down syndrome. Further research in this area is essential to better understand the difference in brain capacity related to memory between a bilingual and a monolingual speaker with the same specific disability. Furthermore, this study will help improve our understanding of individuals with Down syndrome with potential implications to put into practice in clinical intervention strategies.

The following literature review will address short-term memory as well as the nature of Down syndrome. The relationships between short-term memory in bilinguals and monolinguals, bilingualism and Down syndrome, and short-term memory and Down

syndrome also will be discussed. More specifically, the influence of language dominance on short-term memory abilities in Spanish-English bilinguals and English monolinguals with Down syndrome will be examined in this study.

Short-Term Memory

According to Feldman (2009), memory is a system that is composed of three sequential components. These three components are known as sensory memory, short-term memory, and long-term memory. The first part involved in memory is sensory memory, which is the immediate storage of information that is later recorded by the sensory system as a stimulus with no meaningful meaning. The second part involved in memory is short-term memory, which is known to store information for a few seconds. The last part involved in memory is long-term memory, which is where the information is stored. In long-term memory, the information can be stored quite permanently if the information is rehearsed (Feldman, 2009).

One particular type of short-term memory is working memory. This type of memory has two important components, capacity and duration (Cowan, 2008). Short-term memory has a small capacity; the number of seconds capable for us to remember something within our short-term memory depends on the amount or duration of concentration that we put into remembering it. According to Atkinson and Shiffrin (1971), the duration of short-term memory is of about 15 to 30 seconds. The duration is accounted to as the unattended information that is stored in short-term memory. The capacity of short-term memory is assessed using the memory span task. In this memory task, a participant is given a series of items one at a time and then must recall the items in the order in which they were presented (Griggs, 2006). A study conducted by Miller in

1956 used the memory span task and derived with the Magic number 7, plus or minus two as the capacity for short-term memory. Miller's findings asserted that most individuals are capable of storing between 5 to 9 items in their short-term memory.

Short-term memory can be tested formally and informally. Informal tests include online interactive tasks such as visual picture recalling activities that examine visual short-term memory. Formal tests include subtests from the Wechsler Memory Scale-III (WMS-III) (Wechslet, 1997) and Benton Visual Retention Test (Sivan, A. B. (1992). Additional short-term memory tests are the Corsi block-tapping test (Strauss, Sherman, & Spreen, 2006), Rey's Auditory Verbal Learning Test (RAVLT) and Rey's Visual Design Learning Test (RVDLT) (Rey, 1964).

Short-Term Memory in Bilinguals and Monolinguals

In a country like the United States, most people consider themselves to be monolingual, speakers of one language; however, most people in the world are bilingual, speakers of two languages (Mihalicek & Wilson, 2011). In history bilinguals have come a long way in the way that they are perceived as they are no longer necessarily seen or depicted as disadvantaged and inferior to monolinguals (Paradis, Genesee, & Crago, 2011). The belief use to be that the complexity of learning two vocabularies would cause children's language development to be delayed (Paradis et al., 2011). However, research studies such as the one conducted by Bialystok (2008), have proven that individuals who are fluent in two languages have better performance, when compared to monolinguals, on tasks that involve execute control –attention, short-term memory, and inhibition. Although, there are studies that confirm that bilinguals have a better short-term memory than their monolingual counterparts (Morales, Calvo, & Bialystok, 2013), there are also

studies that do not think that there is enough evidence to deem it true (Bonifacci, Giombini, Bellocchi, & Contento, 2011).

Short-term memory can be studied through various tasks that can either be verbal or non-verbal. A study by Fernandes et. al. (2007) considered the effects of language between bilingual and monolinguals related to verbal short-term memory word recall. Their findings showed that the bilingual group had a disadvantage in word recall compared to the monolingual participants. According to Schroeder and Marian (2014), the findings from such studies can prove a disadvantage in bilinguals due to negative effects in some aspects of linguistic processing at the word level. However, an advantage was noted in short-term memory non-verbal tasks with bilingual participants since these tests do not require or minimize the use of linguistic processing. A study by Schroeder and Marian (2012) studied short-term memory performance between bilingual and monolingual participants at recalling pictures. In their study, they found that bilinguals showed an advantage recalling the pictures due to their advantage in executive control. As concluded by Calvo, Ibáñez, and García's (2016) study, some of the aspects of short-term memory may be enhanced by bilingualism but the discrepancies in the results reflect methodological differences in their failure to observe significant differences between bilinguals and monolinguals in most studies.

Contemporary neuroimaging research studies have found that in bilinguals there are brain activation patterns in working memory that show to be more complex when using a second language, making those tasks to be more demanding. During short-term memory tasks, different brain areas are activated; while we are trying to retain information, there is temporal activation and when we are trying to manipulate the

information retained there are prefrontal dorsolateral activation patterns (Ardila, 2003). Due to the reported inconsistencies in research related to bilingualism and short-term memory, a different approach was taken to find out if bilinguals had an advantage over monolinguals and studied whether bilinguals had a greater amount of gray matter volume than monolinguals. In their findings, the researchers found that Spanish-English speakers had a greater amount of bilateral frontal gray matter volume than English speaking monolinguals; thus, their results proved that neuroanatomical evidence supports the bilingual advantage theory without the conflicting confusion that arrives from studies that use various tasks measures (Olulade et al., 2015).

Down Syndrome

Down syndrome is a disorder that results from a chromosomal abnormality named after John Langdon Down, an English physician who in the nineteenth century was the first person to publish a study depicting the accurate descriptions of a person with it as a distinctive and individual entity as stated by The National Down Syndrome Society (NDSS, 2016). Down Syndrome is also referred to as trisomy 21 because individuals with this syndrome have a triplicate of chromosomal 21, rather than the normal duplicate, which results in a total of 47 instead of the usual 46 chromosomes (Shipley & McAfee, 2015).

Although trisomy 21 accounts for 95% of Down syndrome cases, making it the most common one, according to The National Down Syndrome Society (NDSS, 2016), there are three types of Down syndrome. The second most common type of Down syndrome is translocation and it accounts for about 4% of Down syndrome cases. In translocation, the total chromosomes in the cells are the usual 46 but an additional partial

or full copy of the chromosome 21 attaches to another chromosome causing Down syndrome. The least common type of Down syndrome is mosaicism, which accounts for only about 1% of Down syndrome cases. In mosaicism, there is a mixture of two types of cells, some of them contain the usual 46 chromosomes and others contain 47, the cells that have 47 contain an extra chromosome 21. Research has found that those individuals with mosaic Down syndrome tend to have fewer characteristics of Down syndrome than the other two types (NDSS, 2016).

Individuals with Down syndrome have distinctive characteristics. Paul and Norbury (2012), mention that Down syndrome is characterized by mild to moderate levels of intellectual disability, hypotonia which is low muscle tone, distinctive facial features such as microgenia (an abnormally small chin), round face, macroglossia which is a protruding or oversized tongue, ephical folds (folds of the skin on the eyelids), short stature and shorter limbs, and hyperflexobolity of the joints. Down syndrome is also associated with certain health concerns that include higher risks of congenital heart defects, recurrent ear infections, obstructive sleep apnea, thyroid dysfunction, and troesophageal reflux disease (Paul & Norbury, 2012)

Down syndrome can be detected prenatally or at birth and the only link that has been found to be a factor that affects the chances of having a child with Down syndrome is maternal age for trisomy 21 and mosaic Down syndrome, the older the mother is the higher the chances of having a child with Down syndrome. The only type of Down syndrome that has been slightly linked to heredity is translocation (NDSS, 2016). The Centers for Disease Control (CDC) in 2011 estimated that the frequency of Down syndrome diagnosis in the United States is 1 out of 691 live births, which makes it the

most common genetic condition with a population of about 400,000 in the United States. This means that there are about 6,000 diagnoses of Down syndrome in the United States per year (Parker et al., 2010). These numbers are expected to increase since people nowadays are postponing parenting until later in their life and technology has allowed for people with Down syndrome to have longer lives.

Intellectual Profile of Down Syndrome Related to Cognition

Down syndrome is an intellectual disability that ranges from mild to severe. Recent research supports the predominate theory of neural deficits in Down syndrome which suggests that the syndrome itself affects late-developing neural systems, including functions in prefrontal cortex and hippocampus. (Edgin, 2013). A study by Jarrold, Nadel, and Vicari (2008) outlined weaknesses and strengths found in persons with Downs syndrome related to their short-term and long-term memory. This study found evidence associating Down syndrome with poor verbal short-term and long-term memory which can be linked to negatively affect some areas of language acquisition. It was also found that implicit memory of individuals with Down syndrome is not as affected which can provide options for intervention purposes.

Abbeduto et. al. (2001), researched the linguistic and cognitive profile of Down syndrome compared to that of someone with fragile X syndrome. The findings of their study showed that individuals with Down syndrome have higher receptive language problems than problems in non-verbal cognition. It was also found that those with Down syndrome have more severe expressive language problems than problems in non-verbal and receptive language skills. Theory of mind problems were also found to be more severe in individuals with Down syndrome than their difficulties with non-verbal

cognition. Further research is necessary to be able to accurately depict an intellectual cognitive profile of individuals with Down syndrome.

Bilingualism and Down Syndrome

As mentioned before a bilingual is an individual that can speak two languages and Down syndrome is a chromosomal abnormality that affects about 400,000 people in the United States as reported by CDC in 2011. Most research found about the effects or differences that exist between bilinguals and monolinguals are with normally developing participants; however, in recent years there has been a growth of interest in disorders that affect cognition and/or language related to dual language speakers. Specifically, the two main disorders that have been looked at relative to their abilities to learn more than one language and the effects that may come from it are individuals with Down syndrome (Kay-Raining Bird et al., 2005) and Specifically Language Impaired, also known as SLI (Paradis, 2007).

To better understand the relationship between bilingualism and Down syndrome there are certain things to consider; for example, at what age was their second language acquired. The time of acquisition of a second language is classified into two groups, simultaneous and sequential. Simultaneous bilinguals learn their two languages at the same time, usually since birth, and sequential bilinguals acquire their second language after their first language has been established. When dealing with bilinguals one must also take into consideration where it is that they use each language (e.g., school, home, community) and who is the person that speaks to the child in each language (e.g., parent, grandparent, siblings). It is also important to take notice of the role that each language plays in the society that it is being used; for example, in Miami Spanish is very common

but since we are in the United States English is the dominant language and Spanish is a minority language. Another important aspect to take into consideration when looking at research that analyzes bilinguals is how similar the two languages are; for example, Spanish and Italian are very similar as opposed to Spanish and Japanese (Paradis et al., 2011). Lastly, studies have found that input is very important for language acquisition, regardless of how many languages the individual has acquired, since people tend to comprehend and speak a language that they utilize and hear frequently then a language that they hear and utilize less frequently (Pearson, Fernandez, Lewedag, & Oller, 1997).

In the past and even to this day there are inconsistencies in the recommendations on whether someone with Down syndrome and other disabilities should be exposed to learning two languages, since many argue that one language is hard enough for them to comprehend due to their limited language and cognitive abilities (Paradis, 2007). However, most of those recommendations are made due to lack of adequate research on the subject and without taking into consideration that restricting bilingual parents to speak a non-native second language or to change their way of interacting would probably affect their child even more, in a negative way, then exposing them to more than one language (Kay-Raining Bird et al., 2005).

Children with Down syndrome are known to have cognitive impairments that range from mild to severe. The cognitive impairments lead them to have difficulties to learn language and in general, affect their overall language and cause a delay in relation to their age. However, research conducted by Chapman and Hesketh in 2000 (as cited in Kay-Raining Bird et al., 2005), found that monolingual children with Down syndrome have distinctive strengths and weakness in their language profile. For example, they have

a better understanding of comprehensive language than spoken language, which means that it can be difficult to measure just how much someone with Down syndrome knows about language in relation to what they say. Additionally, it was found that individuals with Down syndrome are better at learning vocabulary than grammar (Chapman & Hesketh, as cited in Kay-Raining Bird et al., 2005).

In hopes to give more clarity to the subject of bilingualism and Down syndrome there needs to be a comparison between Down syndrome participants who are bilinguals to their monolingual counterparts. Kay-Raining Bird et al. in 2005, conducted a study in hopes to find the effects of bilingualism with Down syndrome by comparing three groups, simultaneous bilinguals with Down syndrome, monolinguals with Down syndrome, and monolingual typically developing individuals. Their findings showed that dominant language skills of simultaneous bilinguals with Down syndrome are parallel to that of the single language skills that monolingual individuals with Down syndrome of the same mental age have (Kay-Raining Bird et al., 2005), which proves that being a bilingual is not a disadvantage even if the individual has a disability such as Down syndrome.

Short-Term Memory in Down Syndrome

As previously stated, short-term memory is the part in the memory system that holds information for a short period (Roediger III, & Craik, 2014). To understand short-term memory in individuals with Down syndrome we must first understand their learning process. For example, research shows that individuals with Down syndrome tend to have poor verbal short-term memory (Jarrold, Baddeley, & Phillips, 2002) as opposed to their ability to process and maintain visual stimuli.

According to Down Syndrome Education International (DSEI, 2016) research suggests that the learning of individuals with Down syndrome is enhanced with illustrations. Being able to visually see things allows people with Down syndrome to have higher acquisition of motor skills, language, and literacy. Children and adults with Down syndrome demonstrate more difficulty with basic number skills than with reading skills (Lemons, Powell, King, & Davidson, 2015). Many people with Down syndrome tend to have hearing problems, which can potentially affect their verbal comprehension skills (Jarrold & Baddeley, 2001). Moreover, research has found that an individual with Down syndromes' visuo-spatial short-term memory is relatively unaffected when comparing it to their verbal short-term memory performance (Jarrold & Baddeley, 2001).

A longitudinal study conducted by Hick, Botting and Conti-Ramsden in 2005, investigated short-term memory development in children with Down syndrome compared to a group of children with specific language impairment and typically developing children. Their study compared the development of verbal short-term memory and visuo-spatial short-term memory and their vocabulary. Their participants were matched according to their mental age and the results showed that the children with SLI had slightly more difficulties with visuo-spatial short-term memory than typically developing children and children with Down syndrome. Additionally, their findings demonstrated that vocabulary or verbal short-term memory was about the same between children with specific language impairment and Down syndrome with the typically developing children showing overall higher vocabulary capabilities (Hick, Botting & Conti-Ramsden, 2005).

Summary and Rationale

Interest to conduct studies comparing bilinguals and monolinguals has recently increased; however, not many studies consider the similarities and differences that bilingualism has in individuals with disabilities, such as Down syndrome. Thus, further research on the subject is essential for clinical purposes. In the field of communication sciences and disorders, knowing the effects that a language or that many languages have on bilinguals and monolinguals with Down syndrome will allow for more accuracy in an individualized plan of care for their population.

Current studies on either short-term memory with Down syndrome or bilingualism and Down syndrome also take in consideration other languages, such as French and English, rather than English and Spanish. Thus, further research on English-Spanish bilinguals is essential, especially in the population of Down syndrome, due to the growing number of English-Spanish bilinguals in the United States. Research in Spanish-English bilinguals with Down syndrome can add to advancements in academics, clinical settings, and an increased quality of life for individuals who have Down syndrome.

Research supports that individuals with Down syndrome have greater understanding and higher retention of information with visual stimulus and that their visuo-spatial short-term memory is superior than their verbal short-term memory; however, there is no research that separates and compares the three types of short-term memory – spatial, verbal, and visual. There is a study that considers visuo-spatial and verbal short-term memory between individuals who have Down syndrome, amongst those with SLI and typically developing children but none that only compares short-term memory between two groups of individuals with Down syndrome. To enrich the learning

of people with Down syndrome by enhancing the understanding of their thought process, a study on the effects of different factors in short-term memory is fundamental. This study will help increase advancements in academic and clinical settings for individuals in their population since it will compare findings to the capacities of their peer population and not typically developing individuals.

Research Questions and Hypothesis

This study will examine the effects of bilingualism on short-term memory in individuals who have Down syndrome as compared to their monolingual counterparts. The following research questions will be addressed:

1. Do bilinguals with Down syndrome have a better short-term memory performance than monolinguals with Down syndrome?
    - H1.1: Bilinguals will demonstrate higher performance on English verbal memory tasks than monolinguals.
    - H1.2: No differences in non-verbal tasks will be found when comparing monolinguals and bilinguals.
2. Do bilinguals with Down syndrome have a better short-term memory performance in English than in Spanish?
    - H2.1: Bilinguals will have a higher performance in English than in Spanish in verbal tasks.

CHAPTER II

Method

This study has one independent variable, a classification group with 2 levels. The first group consists of 8 bilingual participants with Down syndrome and the second group consists of 8 monolinguals with Down syndrome. The dependent variable in this study is the score gathered based on number of correct responses from five short-term memory tasks.

Participants

Participants were selected through convenience random sampling from local private schools and community habilitation centers who service individuals with intellectual disabilities. The participants were composed of 8 bilingual individuals with Down syndrome who met the following criteria: Hispanic descent, reside in Miami, Spanish-English bilingual, 13 years of age or older, have a Down syndrome diagnosis, and have no secondary diagnosis. The participants also consisted of 8 monolingual individuals with Down syndrome who met the following criteria: reside in Miami, English monolingual, 13 years of age or older, have a Down syndrome diagnosis, and have no secondary diagnosis. Across groups, the participants were between the ages of 13 and 37 years old. There were 4 females and 12 males who participated in this study. The participants and their parents or guardians were fully aware of this study and asked to sign a consent form before participating in any activity related to it. A consent form copy can be found on Appendix A.

Table 1. Participants Demographic Information

Participant	Demographics			
#	Language Group	Age	Age Group	Gender
1	Monolingual	15	Teenager	Male
2	Monolingual	30	Adult	Male
3	Bilingual	14	Teenager	Female
4	Monolingual	13	Teenager	Male
5	Bilingual	19	Teenager	Male
6	Monolingual	13	Teenager	Male
7	Monolingual	19	Teenager	Male
8	Monolingual	30	Adult	Female
9	Monolingual	26	Adult	Male
10	Monolingual	24	Adult	Male
11	Bilingual	36	Adult	Male
12	Bilingual	37	Adult	Male
13	Bilingual	37	Adult	Female
14	Bilingual	35	Adult	Male
15	Bilingual	19	Teenager	Male
16	Bilingual	19	Teenager	Female

Testing Materials

The materials used for this study were nine 1-inch cubes made from wood attached to a 9 x 11-inch board to create a Corsi apparatus for the spatial task and a set of 15 visual stimuli cards for the visual task. A copy of the 15 stimulus cards can be found on Appendix B. The rest of the tasks required an experimental form per participant; these forms can be found on Appendix C. There was one equipment necessary for this study, a pure tone audiometer. The following visual, spatial and verbal memory tests were used:

Task 1 was the visual short-term memory task. In this task, the participants were given the Rey Visual Design Learning Test (RVDLT) (Rey, 1964). For this task, each participant was shown a series of 15 cards, each with a different design, to analyze for 2 seconds each. Once the series of designs were shown the participants were given a paper with 15 boxes and instructed to draw as many of the designs as they recalled. This task consisted of 5 trials, each time the same procedure was followed. The participants were shown the stimulus cards one by one and then instructed to draw as many of the figures as they remembered. For the first trial the participants were given 60 seconds and then instructed to put their pencil down and for the rest of the trials, 2-5, the participants were given 90 seconds and then instructed to stop and put their pencil down. This task was based on number of correct responses from a possible maximum score of 75.

Task 2 was the spatial short-term memory task. In this task, the participants were presented with a Corsi apparatus to conduct the Corsi block-tapping test (Strauss, Sherman, & Spreen, 2006). In this test, the participants were presented with an arrangement of 9 blocks and instructed to pay close attention to the examiner. The examiner then touched a block sequence and asked the participant to mimic the same block-tapping pattern that the examiner made. At first the sequence started out very simple, using just one block and then it went on to a two-block sequence, three block sequence, and so on. The participants had two attempts per trial, if they did not get the sequence correct the first time. Once they got the answer incorrect for the same number sequence twice then the task was discontinued and the participant acquired the score of the last number of correct block sequence produced. For example, if they got the sequence of 3 blocks incorrect twice then they acquired a 2 as their score.

Task 3 through 5 were all part of the verbal short-term memory tasks. In the third task, the participants were administered the Rey Auditory Verbal Learning Test (RAVLT) (Rey, 1964). This test consisted of a list of 15 words that the participants were instructed to listen carefully to and then required to recall. The task consisted of five trials and for each trial the same procedure was followed. The participants had an unlimited number of time to recall the list of words per trial and instructed to say, "that is it" once they reached their maximum number of recalled words. This task was recorder based on number of correct responses, each participant had the opportunity to score a maximum of 75 points.

In task 4, all the participants were given the logical memory portion of the Wechsler Memory Scale-III (WMS-III) (Wechsler, 1997). In this subtest, narrative verbal short-term memory was assessed through two short stories presented to them orally. It was explained to the participants that they needed to hear the two stories and pay close attention because each story was going to be read to them only once. After each story was told, they were prompted to recall and mention everything they could remember from the story read to them. The scores were based on the number of correct ideas they recalled from the stories, the maximum score they could receive was a 50.

Task 5 consisted of a forward digits test (Wechsler Memory Scales-III; Wechsler, 1997). The participants were instructed to listen carefully as the examiner said some numbers. When the examiner finished saying the series of numbers, the participants were instructed to say the same numbers in the same order that the examiner said them. At first the digit span started out very simple, using just one number and then it went on to a 2-digit sequence, 3-digit sequence, and so on. The participants had two attempts per trial, if

they did not get the digit sequence correct the first time; but, once they got the answer incorrect for the same number sequence twice then the task was discontinued and the participant acquired the score of the last number of correct digit span sequence produced. For example, if they got the 4-digit span sequence incorrect twice then they acquired a score of a 3.

Procedures

Initially the eight bilingual and eight monolingual participants with Down syndrome were chosen from local institutions that were contacted in the Miami-Dade County area. Some of the participants were from a private school, The Learning Experience School, whose population consists of children and adults with developmental disabilities. The rest of the participants were seen at an adult day training center, The Wow Center, that serves adults with developmental disabilities. The study was assessed in a friendly quiet room in each of the participant's respective institutions. All the information and results from this study were analyzed at Florida International University's Modesto Maidique Campus in the Communication Science and Disorders Department. The Institutional Review Board (IRB) at Florida International University approved this study.

Prior to commencing the experimental testing phase, the participants were assigned a number to keep their identity anonymous and spent an amount of 10-15 minutes interacting with the examiner. A pre-experimental form, found on appendix D, was used to collect each participant's demographic information, such as, age and gender. Participants were asked if they spoke Spanish and if they indicated that they did then they were verbally asked in a Spanish a series of questions to identify their language

proficiency and classify them as Spanish-English bilinguals or monolinguals. The questions were tailored to find out about their current language use across different settings and language partners. The questionnaire also had the participant analyze and classify how they felt about their understanding, speech, reading, and writing abilities in both Spanish and English from a scale of 1 to 4. A copy of the adapted bilingual language proficiency questionnaire from Gathercole et al. (2013), can be found on Appendix E. The interaction before conducting short-term memory tasks was also used to allow the participants to become more comfortable with the examiner.

Each participant was placed into a language group relative to language proficiency; however, before initiating testing they were all administered a hearing screening test to ensure that their hearing was within normal/functional limits. The participants were tested according to the guidelines for audiological screenings of the American Speech-Language-Hearing Association (ASHA, 1997). As per ASHA guidelines, audiological screenings should be tested on both ears at 25 dB HL across the speech frequencies of 500 Hz, 1000 Hz, 2000 Hz, and 4000 Hz. However, for this study a modified hearing screening was conducted since individuals with Down syndrome are associated with hearing difficulties (Jarrold & Baddeley, 2001). Participants had to be able to accurately identify hearing at 40 dB HL or less through the speech frequencies. The pass conditions for the participants are based on their responses to a pure tone audiometer screening in both ears at 40 dB HL across the speech frequencies of 500 Hz, 1000 Hz, 2000 Hz, and 4000 Hz. As per the modified criteria of the hearing screening for this study, participants were considered to have a hearing within functional limits to partake in this study. The participants were informed of the total time of the study and

that once it was completed they would receive a $10 gift card for participating. If they were bilingual, their total study time was of about 60 minutes and if they were monolingual, their study took approximately 45 minutes. The experimental parts of the study were the five tasks that measured three types of short-term memory abilities – spatial, verbal, and visual short-term memory. Each task was thoroughly explained to the participants before conducting each, and were reassured that questions were welcomed to clear any confusions prior to initiating each task.

All the participant responses were recorded as either correct or incorrect for data analysis purposes for all the tasks. The monolingual participants conducted the entire study in English and then were debriefed and dismissed. The bilingual participants were randomly assigned to conduct the verbal tasks first in one language, either English or Spanish, and then in the other language to later be debriefed and dismissed.

Statistical Analysis

Initially descriptive statistics were obtained, the mean scores and standard deviations, for each one of the groups. A multivariate test was run to see the effects between language group on tasks performance. A one-way MANOVA was run to see between subject effect per task related to language groups and task performance. Paired sample t-test were run to see within bilingual subject effects of performance per task in English and Spanish.

CHAPTER III

Results

Analysis of both within groups and between groups were measured in this study using a one-way MANOVA and paired samples t-tests. Data were analyzed to determine if there were significant differences between and within groups.

Non-verbal and English Verbal Task Performances Between Language Groups

Question 1. Do bilinguals with Down syndrome have a better short-term memory performance than monolinguals with Down syndrome?

Table 2. Mean result of correct responses in English verbal and non-verbal tasks for bilingual and monolingual participants

Task	Language Group	Mean # Correct	F-value	Sig.
RVDLT	Bilingual	20.63	17.867	p = .001
	Monolingual	10.25		
Corsi	Bilingual	3.87	0.529	p = .479
	Monolingual	3.50		
RAVLT English	Bilingual	26.75	1.461	p = .247
	Monolingual	21.13		
WMS English	Bilingual	6.50	3.419	p = .086
	Monolingual	3.88		
Digits English	Bilingual	3.38	2.032	p = .176
	Monolingual	3.00		

A one-way MANOVA was used to analyze performance between language groups, bilinguals vs. monolinguals, in each of the five short-term memory tasks. Bilingual participants demonstrated to have higher mean number of correct responses in every task; however, significant differences across tasks were not consistent. The MANOVA analysis showed that for the visual short-term memory task (RVDLT) there was a statistical significant difference ($p = 0.001$). The bilingual group participants were significantly superior in numbers of correct number of responses acquired than monolinguals in the visual short-term memory task. A trend towards significance was found in the English logical memory (WMS) task ($p = 0.086$). The bilingual participants attained significantly higher number of correct responses in story short-tern memory retention. There were no statistically significant differences found in spatial (Corsi), English word verbal (RAVLT), or English digit tasks between monolingual and bilingual performance, $p > 0.05$ (See Table 2). For a visual representation of the mean number of correct responses in each task between language groups see Figure 1.

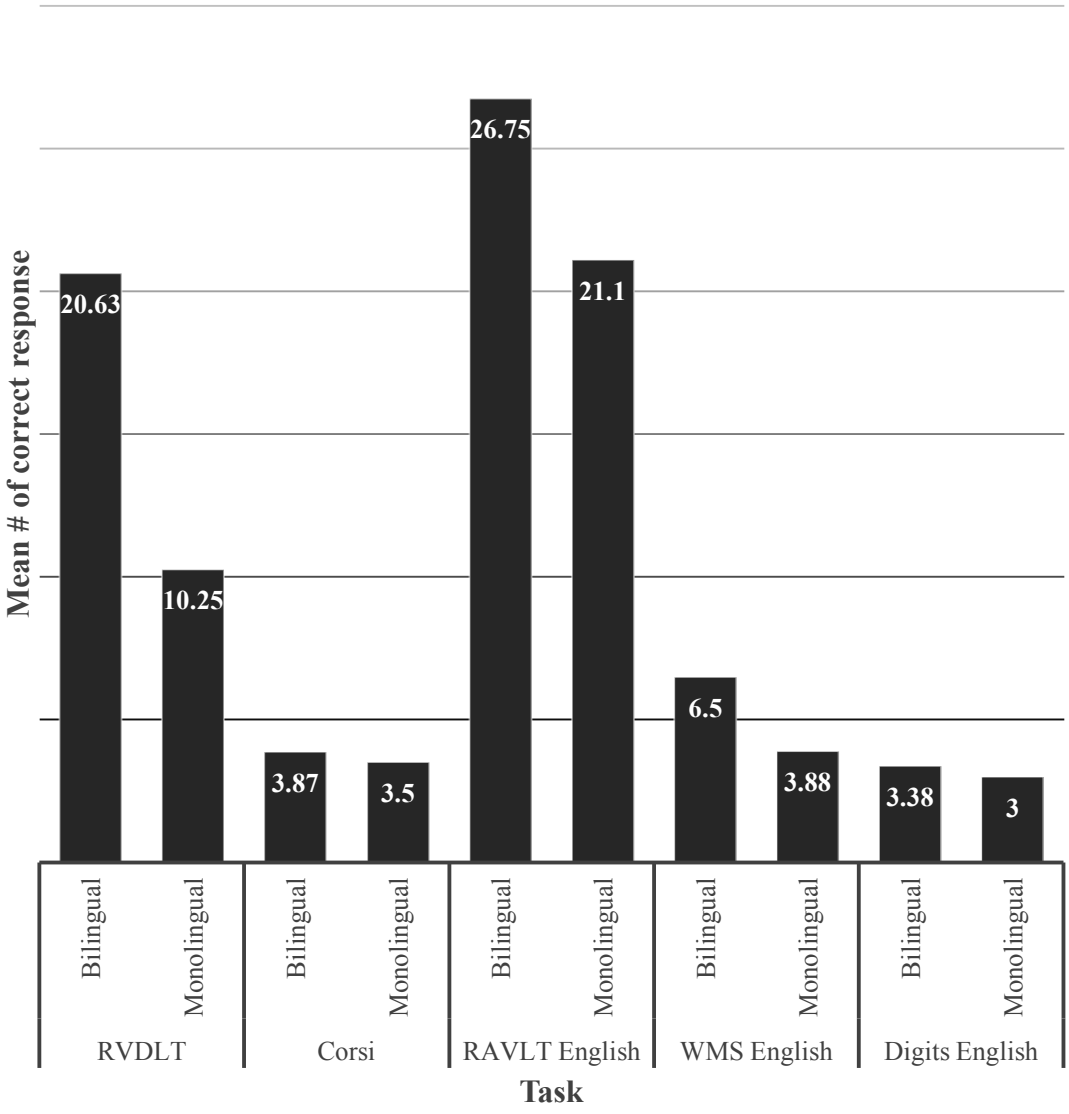

Figure 1. Mean correct responses per English verbal and non-verbal tasks for bilingual and monolingual participants

Bilinguals Performance on Verbal Tasks in English and Spanish

Question 2. Do bilinguals with Down syndrome have a better short-term memory performance in English than in Spanish?

Table 3. Mean result of correct responses in verbal tasks for bilingual participants

Verbal Task	Language	Mean # Correct	T - Value	Paired-Samples T Tests
RAVLT	English	26.75	2.595	p = 0.036
	Spanish	22.13		
WMS	English	6.5	1.297	p = .236
	Spanish	4.88		
Digits	English	3.38	-0.552	p = .598
	Spanish	3.5		

Paired-samples t-tests were used to determine if there were statistically significant mean differences between bilingual participants' performance in English and Spanish verbal tasks (See Table 5). In the verbal word recall task (RAVLT), participants attained higher number of correct responses in English (M = 26.75, SD = 8.172) than they did in Spanish (M = 22.13, SD = 8.774), resulting in a statistically significant difference (p = 0.036). There were no statistically significant differences between bilingual participant's performance in the logical memory (p > 0.05) and digits (p > 0.05) task. For a visual representation of the mean number of correct responses in each task see Figure 3.

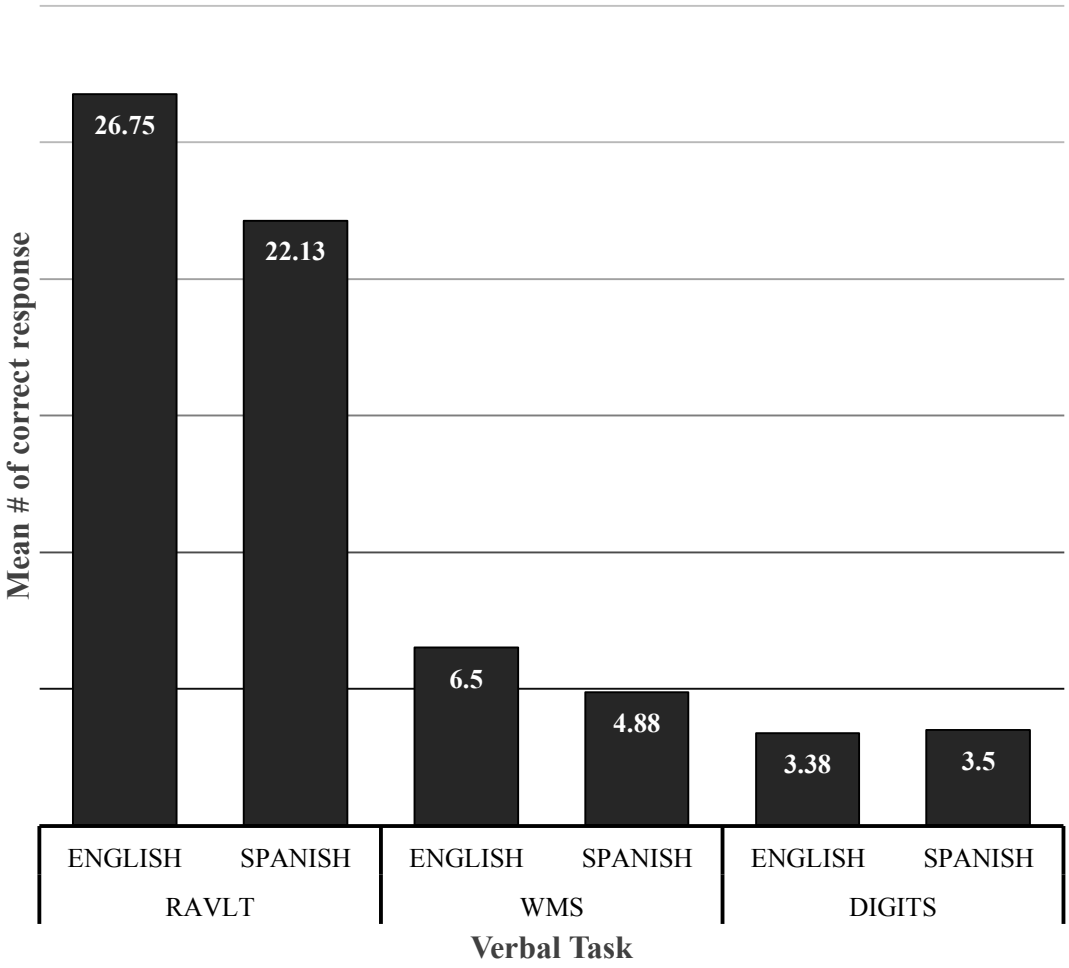

Figure 2. Mean correct responses per verbal tasks for bilinguals in English and Spanish

CHAPTER IV

Discussion

This study examined visual, spatial and verbal short-term memory performance on five different tasks between bilingual and monolingual individuals with Down syndrome. The overall results showed a higher mean number of correct responses per task in bilinguals than monolinguals (refer to figure 1 and figure 2); however, there was a statistical significant difference found only on the performance of the visual short-term memory task with bilingual participants performing better than monolingual participants. A trend towards significance was also found in logical short-term memory with bilingual participants performing significantly higher than monolingual participants. It was also found that within the bilingual group, there was a statistically significant difference found in word recall task (RAVLT) with higher overall mean number of correct responses in English than in Spanish. The study did not have any confounding variables.

Short-Term Memory Performance Between Language Groups

The first question of this study asked if bilinguals with Down syndrome have a better short-term memory performance than monolinguals with Down syndrome. It was hypothesized that bilinguals would demonstrate higher performance on English verbal memory tasks than monolinguals and that there would be no differences found in non-verbal tasks performance between the two groups.

A statistical significant difference was found in the visual short-term memory task and a trend towards significance found in story recall short-term memory. The bilingual participants could recall and draw a total mean number of 20.63 designs vs. 10.25 of the monolinguals in a set of five trials for the visual short-term memory task. In

the verbal story recall task the total mean number of correct responses for the bilinguals was a 6.5 with the monolinguals acquiring a mean number of 3.88 words story ideas recalled. Tables of raw data can be found on Appendix F. These findings do not support the study hypothesis of no differences found in non-verbal performance. However, these findings do support the literature pertaining to the bilingual advantage theory (Olulade et al., 2015).

The results showed no significant difference in spatial or English verbal word and digits short-term memory between bilingual and monolingual participants (refer to table 2). These findings can be related to the findings of a study by Jarrold, Nadel, and Vicari (2008), that found an association between Down syndrome and poor verbal short-term memory, leading to no significant difference between the two language groups since weak verbal abilities are expected to affect them equally.

Short-Term Memory Performance Within Bilinguals

The third question of this study asked if bilinguals with Down syndrome have a better short-term memory performance in English than in Spanish. It was hypothesized that bilinguals would show higher performance in English verbal tasks than in Spanish verbal tasks. Findings showed a statistically significant difference in performance in word recall short-term memory tasks with a higher performance in English than in Spanish. It can be concluded that the participants in this study performed better in English due to English being the dominant language in the United States and Spanish the minority language. This study demonstrated that the bilingual participants were overall English dominant supporting the literature pertaining to the importance of input. Research shows that people tend to understand and use a language that they utilize and listen to more

frequently than a language that they use or hear with less frequency (Pearson, Fernandez, Lewedag, & Oller, 1997).

Limitations of the Study

A larger sample size would allow a stronger comparison between bilinguals and monolinguals with Down syndrome related to short-term memory. Some of the tasks were deemed too difficult for the participants; therefore, other short-term memory tests would possibly show better results for this study. For example, for the visual retention task, it was difficult for some of the participants to have to remember the visual stimuli and then draw the images recalled. The logical memory verbal task was also too complex for most of the participants since it required a lot of attention and short-term memory recall to measure story retention. Having a control group of typically developing bilingual and monolingual individuals and matching the participants to their cognitive age would improve data comparisons and outcomes of this study. Stronger results would also be attainable with a more versatile population since the participants from this study were all from the Miami demographic area, resulting in most being exposed to more than one language at some point in their life even if they were considered monolinguals.

Implications for Further Research

The results of this study suggest implications for individuals with Down syndrome and their families. Families of people with intellectual disabilities, such as Down syndrome, will be more likely to encourage their children's upbringing to include more than one language and welcome the idea of their children being bilingual. Implications for education or clinical settings can include the use of more images with individuals with Down syndrome and encouragement of the use of another language

other than their primary language. It is important in clinical settings to take into consideration the full potential of each individual, which includes their language use, and adapt their plan of care to include each individual's needs and abilities. There are few studies that have examined the effects of bilingualism in short-term memory with individuals who have Down syndrome; therefore, this study may be an important step towards improvements in this area of research.

Conclusion

The overall findings of this study showed that bilingual individuals with Down syndrome do have an advantage in short-term memory when compared to those who are monolingual; thus, this study supports the literature related to the bilingual advantage theory (Olulade et al., 2015). Ultimately, this research supports that being a bilingual is not a disadvantage even if the individual has a disability such as Down syndrome (Kay-Raining Bird et al., 2005).

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Appendix A

Parental Consent Form

FIU IRB Approval:	03/31/2017
FIU IRB Expiration:	03/31/2018
FIU IRB Number:	IRB-17-0120

FIU | FLORIDA INTERNATIONAL UNIVERSITY

PARENTAL CONSENT TO PARTICIPATE IN A RESEARCH STUDY
Effects of Bilingualism in Short-Term Memory in Individuals with Down Syndrome

PURPOSE OF THE STUDY
You are being asked to give your permission for your son/daughter to be in a research study. The purpose of the study is to increased knowledge and awareness of Down Syndrome. This study will investigate the difference, if any, that bilingualism has on the retention of information in short-term memory of individuals with Down Syndrome when compared to monolinguals with Down Syndrome.

NUMBER OF STUDY PARTICIPANTS
If you agree to allow your son/daughter to participate in this study, he/she will be one of twenty people in this research study.

DURATION OF THE STUDY
Your son/daughter's participation will require one meeting of approximately 60 minutes.

PROCEDURES
If your son/daughter participates in this study, we will ask your son/daughter to do the following things:

1. Be part of pre-experimental testing to acquire their case history, determine if they are Anglo monolinguals or at least 25% bilinguals through their interactions with the examiner, and undergo a hearing screening to ensure that their hearing is within functional limits using a pure tone audiometer.
2. Be part of experimental testing to determine their memory retention in spatial, verbal, and visual short-term memory. Their responses will be recorded based on correct vs. incorrect.
    a. During the spatial short-term memory task, participants will be presented with a Corsi apparatus to conduct the corsi block-tapping test. The apparatus is used to test memory on sequences remembered related to location.
    b. During the verbal short-term memory task, participants will be given the logical memory portion of the Wechsler Memory Scale (WMS) and a digit memory test. The WMS will consist of two short stories that will be narrated to the participants to then answer yes/no questions related to both stories. In the digit memory test participants will listen to different sets of numbers at a time and then repeat them. The digit span will be tested forward and backward.

c. During the visual short-term memory task, participants will be given part of the Benton Visual Retention Test (BVRT). Designs/pictures will be shown for 10 seconds and then chosen from a multiple choice of four designs.

RISKS AND/OR DISCOMFORTS
There are no identified risks associated with your son/daughter's participation in this study.

BENEFITS
The following benefits may be associated with your son/daughter's participation in this study:

- Enriching knowledge and awareness on Down Syndrome.
- Contributing to advancements in science.

ALTERNATIVES
There are no known alternatives available to your son/daughter other than not taking part in this study. However, any significant new findings developed during the course of the research which may relate to your son/daughter's willingness to continue participation will be provided to you.

CONFIDENTIALITY
The records of this study will be kept private and will be protected to the fullest extent provided by law. In any sort of report we might publish, we will not include any information that will make it possible to identify your son/daughter as a subject. Research records will be stored securely and only the researcher team will have access to the records. However, your son/daughter's records may be reviewed for audit purposes by authorized University or other agents who will be bound by the same provisions of confidentiality.

COMPENSATION & COSTS
Your son/daughter will receive a $10 gift card for participating in the study. The disbursement of the gift card will occur at the end of the study, after completing the pre-experimental and experimental testing. Your son/daughter will not be responsible for any costs to participate in this study.

RIGHT TO DECLINE OR WITHDRAW
Your son/daughter's participation in this study is voluntary. Your son/daughter is free to participate in the study or withdraw his/her consent at any time during the study. Your son/daughter's withdrawal or lack of participation will not affect any benefits to which he/she is otherwise entitled. The investigator reserves the right to remove your son/daughter from the study without your consent at such time that they feel it is in the best interest.

FIU IRB Approval:	03/31/2017
FIU IRB Expiration:	03/31/2018
FIU IRB Number:	IRB-17-0120

RESEARCHER CONTACT INFORMATION
If you have any questions about the purpose, procedures, or any other issues relating to this research study you may contact Evelyn Pinto-Cardona at (786) 326-5480 or epint005@fiu.edu.

IRB CONTACT INFORMATION
If you would like to talk with someone about your son/daughter's rights of being a subject in this research study or about ethical issues with this research study, you may contact the FIU Office of Research Integrity by phone at 305-348-2494 or by email at ori@fiu.edu.

PARTICIPANT AGREEMENT
I have read the information in this consent form and agree to allow my son/daughter to participate in this study. I have had a chance to ask any questions I have about this study, and they have been answered for me. I understand that I will be given a copy of this form for my records.

_____ _____
Signature of Parent/Guardian Date

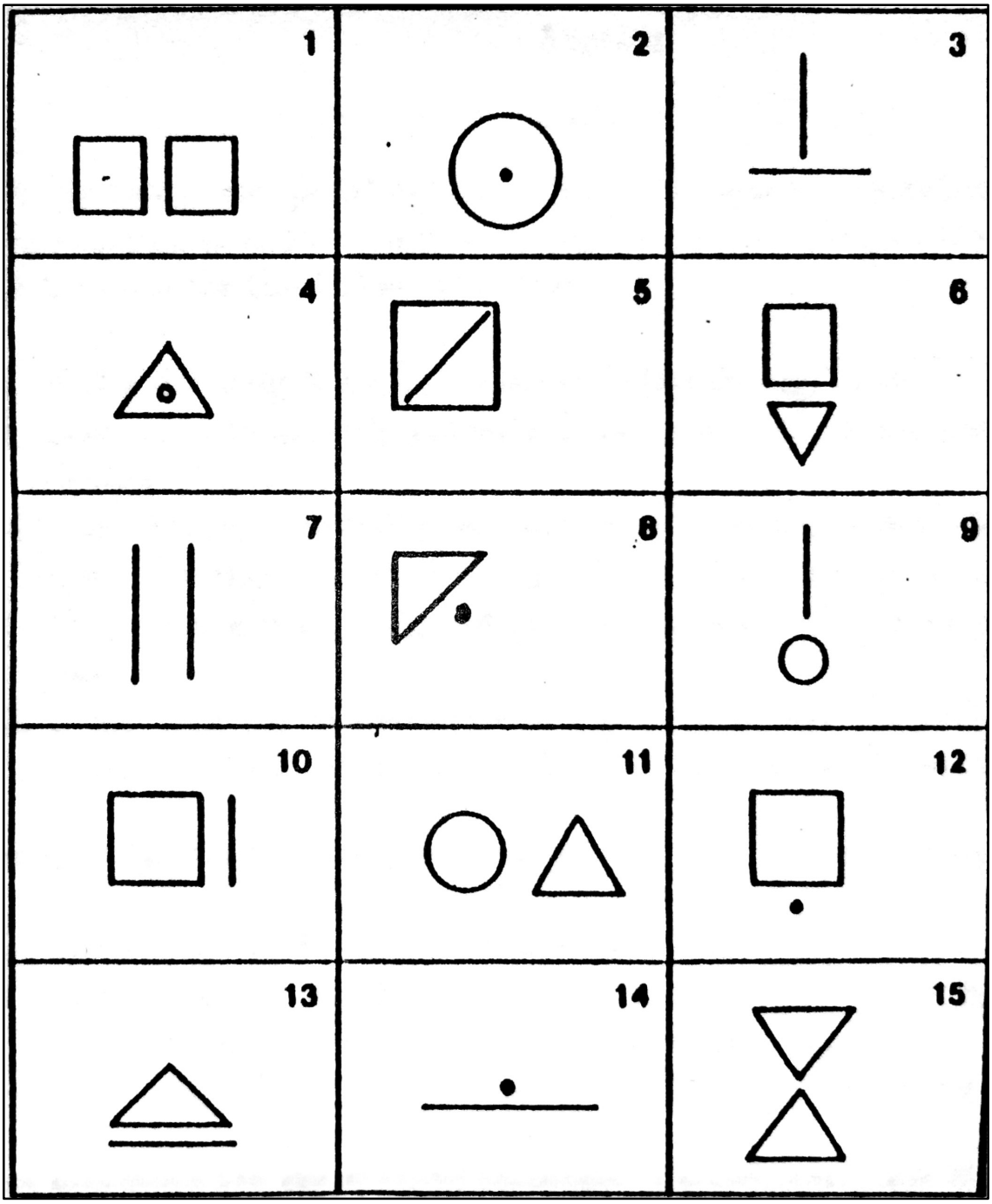
_____
Printed Name of Parent/ Guardian

_____
Printed Name of Participant

_____ _____
Signature of Person Obtaining Consent Date

Appendix B

RVDLT Stimulus Designs



Appendix C

Experimental Task Forms

Visual Short-Term Memory Task

- **Rey Visual Design Learning Test (RVDLT)**

Image #	Trial 1 60’	Trial 2 90’	Trial 3 90’	Trial 4 90’	Trial 5 90’	5 Trials Total
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						

Total Score: _____/75

Spatial Short-Term Memory Task

- **Corsi Tapping Test**

Assessment 1 (Forward Series)				
Length	Trial 1	✓ or ×	Trial 2	✓ or ×
2	5-8		4-9	
3	6-9-2		5-8-3	
4	3-8-1-4		6-1-8-5	
5	4-1-6-9-2		9-4-1-8-3	

Assessment 2 (Forward Series)				
Length	Trial 1	✓ or ×	Trial 2	✓ or ×
2	6-1		2-5	
3	2-7-4		4-3-9	
4	4-3-9-6		1-7-6-8	
5	5-2-1-7-4		8-5-9-3-2	

Highest Pattern Span Recall #_____/5

Verbal Short-Term Memory Tasks

- **English Rey Auditory Verbal Learning Test (RAVLT) – Phase I**

List A	A1	A2	A3	A4	A5	5 Trials Total
Drum						
Curtain						
Bell						
Coffee						
School						
Parent						
Moon						
Garden						
Hat						
Farmer						
Nose						
Turkey						
Color						
House						
River						

Total Score: _____/75

- **Spanish Rey Auditory Verbal Learning Test (RAVLT) – Phase I**

List A	A1	A2	A3	A4	A5	5 Trials Total
Tambor						
Cortina						
Campana						
Café						
Escuela						
Padre						
Luna						
Jardín						
Sombrero						
Granjero						
Nariz						
Pavo						
Color						
Casa						
Rio						

Total Score: _____/75

- **English Logical Memory – Wechsler Memory Scale**

Administer both stories. Score 1 point for each correct item.	Score
Story A	
Anna/ Thompson/ of South/ Boston/, employed/ as a cook/	
in a school/ cafeteria/, reported/ at the City Hall/ Station/	
that she had been held up/ on State Street/ the night before/	
and robbed/ of fifty-six dollars/. She had four/	
small children/, the rent was due/, and they had not eaten/	
for two days/. The police/, touched by the woman's story/,	
took up a collection/ for her/.	
Max = 25 Total Story A	
Story B	
Robert/ Miller/ was driving/ a ten-ton/ truck/	
down a highway/ at night/ in the Mississippi/ Delta/,	
carrying eggs/ to Nashville/, when his axle/ broke/.	
His truck skidded/ off the road/, into a ditch/.	
He was thrown/ against the dashboard/ and was badly shaken/.	
There was no traffic/ and he doubted that help would come/.	
Just then his two-way radio/ buzzed/. He quickly answered/,	
"This is Grasshopper/."	
Max = 25 Total Story B	
Max = 50 **Total Sum of Stories A + B**	

- **Spanish Logical Memory – Wechsler Memory Scale**

Presente ambas historias. 1 punto por cada idea correcta.	Score
Historia A Ana/ Moreno/ del Sur/ de Boston, / empleada/ como cocinera/	
en la cafetería/ de una escuela/, reporto/ a la comisaria/ municipal/	
que había sido atracada/ en la calle Libertador/ la noche anterior/	
y le habían robado/ cincuenta y seis dólares/. Tenía cuatro/	
hijos pequeños/, debía el alquiler/, y no había comido nada/	
durante los últimos dos días/. La policía/ se conmovió con su historia/,	
e hizo una colecta/ para ayudarla/.	
Max. 25 Total Historia A	
Historia B Juan/ Martínez/ estaba conduciendo/ un camión/ de diez toneladas/	
por una carretera/ durante la noche/ cercal del área/ de los Everglades/.	
Llevaba huevos/ a Orlando/, cuando se le rompió/ un eje/.	
Su camión se salió/ de la carretera/, y cayó en una zanja/.	
Fue lanzado/ contra el tablero de instrumentos/ y se golpeó fuertemente/.	
No habían más carros/ y dudo que vinieran a ayudarlo/.	
Entonces su radiotransmisor/ sonó/. Rápidamente contesto/,	
"Este es el Saltamontes/."	
Max = 25 Total Story B	
Max = 50 **Total Sum of Stories A + B**	

- **English Digit Memory Span (forwards)**

DIGITS FORWARDS					
Item	Trial 1	✓ or ×	Trial 2	✓ or ×	Total
A	4-3		1-6		
B	7-9-2		8-4-7		
C	5-9-4-1		7-2-5-3		
D	9-3-8-7-2		7-5-3-9-6		

DIGITS FORWARDS					
Item	Trial 1	✓ or ×	Trial 2	✓ or ×	Total
A	8-3		2-9		
B	4-7-5		6-1-5		
C	2-6-1-9		3-8-5-2		
D	2-8-7-3-6		5-9-4-1-3		

Highest Pattern Digit Recall #_____/5

- **Spanish Digit Memory Span (forwards)**

DIGITOS HACIA ADELANTE					
Articulo	Prueba 1	✓ o ×	Prueba 2	✓ o ×	Total
A	4-3		1-6		
B	7-9-2		8-4-7		
C	5-9-4-1		7-2-5-3		
D	9-3-8-7-2		7-5-3-9-6		

DIGITOS HACIA ADELANTE					
Articulo	Prueba 1	✓ o ×	Prueba 2	✓ or ×	Total
A	8-3		2-9		
B	4-7-5		6-1-5		
C	2-6-1-9		3-8-5-2		
D	2-8-7-3-6		5-9-4-1-3		

Highest Pattern Digit Recall #_____/5

Appendix D

Pre-Experimental Data Collection Form

Subject # _____ **Date: _____**

PRE-EXPERIMENTAL TESTING INFORMATION:

- Age: _____
- Sex: Male or Female
- Language proficiency: Bilingual or Monolingual
- Passed hearing screening? Yes or No
    - Right Ear: 500 Hz ___dB, 1000 Hz ___ dB, 2000 Hz ___dB, 4000 ___dB
    - Left Ear: 500 Hz ___dB, 1000 Hz ___ dB, 2000 Hz ___dB, 4000 ___dB
- Additional notes:

_____

_____

_____

_____

_____

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_____

Appendix E

Bilingual Language Proficiency Questionnaire

Subject #: _____ **Date:** _____

- Are you: Male or Female
- Where you born in the USA? Yes ____ No ____
- If you were not born in the USA:
  - At what age did you move to the USA? _____
  - How long have you lived in the USAA? _____ years.
- If you are of Hispanic descent, what is your heritage background?
  - Cuban ___ Puerto Rican ___ Mexican ___ Nicaraguan ___ Argentinean ___ Venezuelan ___ Colombian ___ Other Hispanic ___ Other non-Hispanic ___

Current Language Use

At present, **at home**, I speak

A	B	C	D	E	F
Only Spanish	More S than E	S and E equally	More E than S	Only E	Other/N.A.

At present, **at work/school**, I speak:

A	B	C	D	E	F
Only Spanish	More S than E	S and E equally	More E than S	Only E	Other/N.A.

At present, **to my friends**, I speak

A	B	C	D	E	F
Only Spanish	More S than E	S and E equally	More E than S	Only E	Other/N.A.

At present, my **mother** speaks **to me** in:

A	B	C	D	E	F
Only Spanish	More S than E	S and E equally	More E than S	Only E	Other/N.A.

At present, my **father** speaks **to me** in:

A	B	C	D	E	F
Only Spanish	More S than E	S and E equally	More E than S	Only E	Other/N.A.

At present, my **siblings and I** speak to each other in:

A	B	C	D	E	F
Only Spanish	More S than E	S and E equally	More E than S	Only E	Other/N.A.

At present, my **friends** speak to **me** in:

A	B	C	D	E	F
Only Spanish	More S than E	S and E equally	More E than S	Only E	Other/N.A.

On a Scale of 1 to 4, how well do you feel **you** can…?
Understand Spanish now:

1	2	3	4
I can understand basic words and expressions	I can understand simple conversation	I can understand extended conversations	I can understand virtually any kind of conversation

Speak Spanish now:

1	2	3	4
I only know basic words and expressions	I can carry simple conversations	I can carry out extended conversations	I can carry out virtually any kind of conversation

Read Spanish now:

1	2	3	4
I can read basic words and expressions	I can read simple texts	I can read extended texts	I can read virtually any kind of text

Write Spanish now:

1	2	3	4
I can write basic words and expressions	I can write simple texts	I can write extended texts	I can write virtually any kind of text

On a Scale of 1 to 4, how well do you feel **you** can…?
Understand English now:

1	2	3	4
I can understand basic words and expressions	I can understand simple conversation	I can understand extended conversations	I can understand virtually any kind of conversation

Speak English now:

1	2	3	4
I only know basic words and expressions	I can carry simple conversations	I can carry out extended conversations	I can carry out virtually any kind of conversation

Read English now:

1	2	3	4
I can read basic words and expressions	I can read simple texts	I can read extended texts	I can read virtually any kind of text

Write English now:

1	2	3	4
I can write basic words and expressions	I can write simple texts	I can write extended texts	I can write virtually any kind of text

Appendix F

Raw Data Tables

Participant	Visual STM Task - RVDLT	Spatial STM Task - Corsi
#	Total Recall No. Correct	Pattern Span Recall
1	15	4
2	12	4
3	18	4
4	6	3
5	21	5
6	8	3
7	6	2
8	4	2
9	9	5
10	22	5
11	24	4
12	22	4
13	27	5
14	19	3
15	18	3
16	16	3

Participant	Word Verbal STM - RAVLT	Story Retention STM - WMS	Numerical Verbal STM - Digits
#	Total Recall No. Correct	Total Sum Correct A+B	Pattern Span Recall
1	24	4	3
2	44	8	4
4	21	0	3
6	12	7	3
7	13	4	2
8	14	0	3
9	18	2	3
10	23	6	3

Participant	Word Verbal STM - RAVLT		Story Retention STM - WMS		Numerical Verbal STM - Digits	
	Total Recall No. Correct		Total Sum Correct A+B		Pattern Span Recall	
#	English	Spanish	English	Spanish	English	Spanish
3	15	8	6	0	4	3
5	25	20	8	2	3	3
11	26	20	2	3	3	3
12	39	31	8	9	3	4
13	32	37	9	9	4	4
14	26	19	8	3	4	4
15	17	18	3	2	3	3
16	34	24	8	11	3	4