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Bilingual Adult Nonword Repetition Performance Patterns in English and Spanish

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BILINGUAL ADULT NONWORD REPETITION PERFORMANCE PATTERNS

IN ENGLISH AND SPANISH

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IN ENGLISH AND SPANISH

by

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ABSTRACT

Nonword repetition (NWR) is known to assess phonological working memory. During NWR, the individual listens to made-up words and repeats them back. This study evaluated NWR performance patterns, and the relationship between NWR and language recall tasks among forty English and Spanish bilingual adults. Bilingual adults' ages ranged from 18-67 years. Four language recall tasks were administered, including NWR tasks (assessed by PPC), language questionnaire to assess participants' language usage in English and Spanish, sentence repetition task (assessed by raw score), and a story retell (assessed by NDW). All recall measures were administered in a counterbalanced manner across English and Spanish. Results indicated a relationship between Spanish and English NWR, but yielded no statistically significant correlation with other language recall measures. This revealed that phonological short-term working memory is not required to support performance on other language tasks. Findings demonstrated that current language usage did not influence bilingual adults' NWR performance. This study may yield information and aid interpretation of NWR performance in bilingual children with varying language experiences.

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CHAPTER 1: INTRODUCTION

There is limited normative information regarding nonword repetition (NWR) performance patterns in English-Spanish bilingual adults within current body of literature in the field of Speech Language Pathology (SLP). Further information on NWR performances in bilingual adults is warranted to aid interpretation of bilingual children's performances on NWR. Literature has provided information regarding performance patterns in NWR in bilingual children; however evidence has not shown how performances are influenced with factors such as age and language experiences. In addition, evidence has demonstrated that French-English bilingual adults NWR performances were influenced by long-term language knowledge (Thorn & Gathercole, 2001). However, it is unknown if NWR performances in English-Spanish bilingual adults will vary as a function of language experiences. The following study focused on further exploring these clinical issues by completing a repeated measures design and a correlational analysis to assess NWR performances in forty English-Spanish bilingual adults.

Recently NWR performance in bilingual children has become an area of interest for SLPs and researchers, after recognizing its potential diagnostic validity for assessing liguisticallly and culturally diverse children (Dollaghan & Campbell, 1998). In particular, bilingual children are often misdiagnosed with language impairment due to bias in standardized assessments used to evaluate children's language skills (Kohnert et *al.*, 2006). Standardized assessments evaluate bilingual children's specific language knowledge which may be limited; due to distinct language experiences (age of first exposure, usage, dominance, etc.) and varying proficiency across languages (Kohnert, 2008). Therefore, bilingual children performance may be lower when compared to their monolingual peers, if not familiar with the language concepts being evaluated (Gutierrez-Clellen & Simon-Cerejido, 2010). Furthermore many standardized assessments are

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normed exclusively on English or Spanish monolingual speaking children, which may not adequately assess bilingual children's language skills that are distributed across two languages (Gutierrez-Clellen & Simon-Cerejido, 2010).

Additionally, there are limited nonbiased assessments available, which may increase potential misdiagnosis of linguistically and culturally diverse children. Therefore there is an increased demand for nonbiased assessments to evaluate bilingual children. Research has demonstrated that NWR is a nonbiased assessment to assess language skills among linguistically and culturally diverse children (Winsor et *al.,* 2010). NWR is not as dependent on child's long-term language knowledge, as repeating nonwords relies more on underlying capacity phonological working memory (Gutierrez-Clellen & Simon-Cerejido, 2010). This is important because NWR may be a potential diagnostic tool to accurately assess English-Spanish bilingual children's language skills.

During NWR, the child listens to made-up words and repeats them back. Children with language impairments have been shown to perform poorly on NWR task compared to typically developing children, which may indicate that NWR assesses underlying deficits (Estes, Evans, & Else-Quest, 2007). NWR may provide information regarding what underlying factors contribute to language deficits exhibited by children with language impairments. In addition NWR has been shown to be related to other language abilities among young children. Research has demonstrated a relationship between NWR and children's vocabulary skills and syntactic skills (Summers et *al.*, 2010). This may indicate that similar underlying capacities that facilitate repeating nonwords may contribute to vocabulary acquisition and development of syntactic elements among young children (Summers et *al.*, 2010).

However, evidence has yielded mixed results for NWR performances among bilingual children. Research has demonstrated variability among nonword repetition performance exhibited among children with language impairment (Estes, Evans, & Else-Quest, 2007). Therefore further research is warranted to increase generalizability of NWR task as an assessment tool for ruling out language impairment among linguistically and culturally diverse children. Also, there is limited research demonstrating how NWR performance patterns among English-Spanish bilingual children change over time. This information would aid interpretation of expected performance of bilingual children on NWR, in particular when comparing performance with monolingual children.

Research of NWR performance patterns among English-Spanish bilingual adults is needed to provide normative information on the expected NWR patterns among bilingual children as they develop. It is expected that bilingual children will perform similarly to bilingual adults over time. Currently it is unknown how English-Spanish bilingual adults would perform on NWR task. Further research would help clarify how bilingual adults' perform on NWR tasks. Information on NWR performance of bilingual adults would contribute to the current body of knowledge of NWR performances of bilingual children. Further research may assist in determining if the relationship between NWR and vocabulary skills and syntactic skills is present among English-Spanish bilingual adults or only exhibited by young children.

1.1 Nonword repetition task and underlying processes

Nonword repetition has provided understanding regarding the underlying deficits of working memory among children with SLI and how that may affect their language development. Working memory has a critical role in early language learning because it permits children to analyze and comprehend language elements. After children become more familiarized with the

language, working memory is utilized to temporarily store and process linguistic information necessary to facilitate language comprehension within long-term memory (Marton & Schwartz, 2003). Therefore in order to clarify how phonological working memory continues to influence language development among bilingual children over time; gaining understanding of NWR performance among bilingual adults would help determine to what extent phonological working memory influences other language processes, and determine how NWR performance changes throughout a bilingual individual's development.

Nonword repetition (NWR) includes nonwords that are neither real words nor meaningful. They are strings of phonemes that resemble sound combinations of the language being tested. Performance on NWR is influenced by articulation and understanding of words and phonological awareness. Nonwords adhere to the phonotactic constraints, the rules that indicate how sounds are combined to form words, of a particular language. NWR requires individuals to discriminate each nonword, temporarily store information in working memory, access phonological knowledge in long-term memory and repeat strings of sounds. Successful completion of a NWR task involves phonological working memory capability, phonological processing ability, correctly discriminating and articulating speech sounds (Baddeley, 2003; Kohnert, Windsor, & Dongsun, 2006; Summers et *al.* , 2010).

Nonword repetition accuracy is primarily influenced by phonological working memory capacity, also referred as phonological loop (Gathercole, Hitch, Service & Martin, 1997). Terms phonological working memory and phonological loop will be used interchangeably within this paper. During nonword repetition, phonological working memory mediates immediate recall of unfamiliar sound combinations not previously stored within the individual's mental lexicon (Gathercole, Hitch, Service & Martin, 1997). According to Baddeley's model of working

memory, there are two components; short-term memory and long-term memory which aid processing and acquisition of language information. Working memory facilitates temporary rehearsal and storage of information. Also, working memory facilitates comprehension of information stored within long-term memory. According to Baddeley's model, the working memory is further divided into slave components; the phonological loop, visual spatial sketch pad and the episodic buffer that are controlled by the executive function (Baddeley, 2003).

The phonological loop component includes temporary storage of phonological information which is held for a short amount of time. The subvocal rehearsal system is utilized to increase storage of information for longer periods of time, and to process visual information. Auditory stimuli perceived, is immediately analyzed and transferred into short-term storage. This information is transmitted to phonological output buffer where it is recalled or rehearsed through the subvocal rehearsal system. This process is similar for written information, which is processed into a phonological code, and transferred into the phonological output buffer and then is articulated into speech (Baddeley, 2003). The phonological loop is vital in forming stable phonological representations of sound and syllables of a language, which are transferred into long-term lexical knowledge to support vocabulary development (Estes, Evans, & Else-Quest, 2007).

1.1.1 Structural differences in English and Spanish. Phonological capacity is relevant in the initial acquisition of language structures in both English and Spanish. Bilingual individuals must develop two distinct phonological systems and/or one complete phonological system to support acquisition of phonological representations and aid understanding of sounds, syllable, and words combinations in more than one language (Estes, Evans, & Else-Quest, 2007). English and Spanish exhibit various structural differences in phonology, morphology and syntax

that bilingual children must acquire and comprehend (Girbau & Schwartz, 2008). In Spanish there are more morphological markers. Also, Spanish has fewer vowels (5 vowels) and consonants (20 consonants) than English (13 vowels and 24 consonants) (Summers et *al.*, 2010). Therefore Spanish monolinguals typically acquire Spanish vowels earlier due to vowel system being less complex than English vowel system (Goldstein & Pollock, 2000). The phonotactic rules in English and Spanish affect the acquisition of phonemes in each language. Speech sounds in Spanish are acquired earlier by children then speech sounds acquired in English; which contain more later-developing sounds. Most monolingual children acquiring Spanish master early developing speech sounds similarly to English monolinguals by age five years (Jimenez, 1987). Also, phonological acquisition among bilingual children with varying exposure to English and Spanish demonstrated similar trends and showed similar speech errors compared to monolingual children (Goldstein et a*l.,* 2005). Furthermore, Spanish words have more syllable combinations than English. English increases phonological complexity by adding consonants in final position of syllables and consonant structures. Spanish increases complexity by increasing syllables and adding consonant vowel structures (Dollaghan & Campbell, 1998; Kohnert et *al.*, 2006; Summers, et *al.*, 2010).

1.2 NWR and bilingual children with language impairment

   1.2.1 Understanding linguistic differences among bilinguals. Research has shown an increase in the Hispanic population, resulting in a growing population of bilingual children and Spanish speaking children learning English as a second language (Gutierrez-Clellen & Simon-Cerejido, 2010). The majority of bilingual individuals exhibit varying language experiences (e.g. dominance, proficiency, history, etc.), which change throughout development and into adulthood, and may influence their language knowledge in both English and Spanish. Bilingual

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individuals may be categorized as sequential or simultaneous bilingual learners. Sequential

bilingual learners learn their native language (L1) from birth and learn a second language (L2)

during their childhood (Goldstein, 2012). Sequential bilinguals typically learn (L1), Spanish, as

their native language and then acquire English (L2) after entering an academic setting (Girbau &

Schwartz, 2008). Simultaneous bilingual learners acquire English and Spanish simultaneously

from birth (Genesee, 1989).

Additionally, language exposure to and use of English and Spanish varies for

simultaneous and sequential bilinguals, based on external factors which includes: age of first

exposure to each language before or upon entering school, type of school program, and amount

of exposure in each language (Genesee, Nicoladis, & Paradis, 1995). Variability among

language experiences (dominance, history, proficiency, etc.) in English and Spanish may result

in bilingual children developing different levels of proficiency, and language domains remaining

underdeveloped (Girbau & Schwartz, 2008). Evidence has demonstrated that sequential

bilinguals who acquired Spanish as their first language and English as their second language at

school; become more proficient in English in both receptive and expressive production, by the

time their adolescents (Girbau & Schwartz, 2008). Reaching a level of equal proficiency in

English and Spanish is dependent on the child's experiences in each language; which include

formal instruction received, communication interactions, and usage of each language that may

change over time (Girbau & Schwartz, 2008).

1.2.2 Bilingual children with language impairment. The term language impairment has

been generally used in research to describe presence of any language deficits among children.

Recently term for language deficits occurring in children in absence of intellectual deficits,

sensory disorders, neurological damage, and emotional deficits is referred to specific language

impairment (SLI) (Dale et *al.*, 2003). However, recent evidence has indicated that it is not adequate to make diagnosis of SLI until the child is at least four years old, as language deficits may improve if related to a mild delay in language development (Rescorla & Lee, 2001; Dale et *al.*, 2003). Therefore both terms language impairments and SLI will be used interchangeably in the present study. As many studies indicating terms SLI and language do not provide clear guidelines for using labels.

Research has shown that there is an increased risk for English language learners (ELLs) and bilingual children to experience academic delays compared to other minority students (Gutierrez-Clellen & Simon-Cerejido, 2010). This may be attributed to the unique development of language skills across two languages which may not be evenly distributed. Also, bilingual children are considered at risk for language impairments. Specific language impairment (SLI) is the highest occurring language impairment in children with 5-7% prevalence (Kohnert, Windsor, & Ebert, 2009). SLI is identified when children demonstrate a decreased language performance and fail to make expected language gains during development (Kohnert, Windsor, & Ebert, 2009). Other problems may arise and co-occur in children with SLI, such as speech and reading comprehension deficits.

Another problem facing bilingual children is risk of being overidentified within special education, resulting from limited use of available assessments that adequately differentiate children's abilities related to their English status and to their disability (Gutierrez-Clellen & Simon-Cerejido, 2010). There are various problems associated with utilizing standardized assessments among the bilingual population. Many standardized assessments utilized within clinical practice are normed exclusively on monolingual English-speaking children, which may not accurately assess bilingual children's unique language skills in English (Gutierrez-Clellen &

Simon-Cerejido, 2010). In addition, conventional language assessments are reliant on bilingual children's language knowledge in English which may be limited, resulting in overidentification of SLI among bilingual or linguistically and culturally diverse children (Kohnert, Windsor, & Ebert, 2008; Summers et *al.*, 2010). Also, it is important to consider that bilingual children's performance on tests based on language knowledge may be affected by age of acquisition in English.

Research has shown that after a second language is introduced, a bilingual individual's cognitive functioning changes and becomes wired distinctly from monolingual speakers (Kohnert, Windsor, & Ebert, 2008). Therefore even if the bilingual individual may achieve proficiency in the second language, their performance may continue to differ on assessments developed for monolingual speakers, and not bilingual speakers (Kohnert, Windsor, & Ebert, 2008). Diagnostic procedures have changed in an attempt to appropriately evaluate bilingual children with varying "balanced" to "dominant" language proficiency. Testing methods should measure understanding of both L1 and L2 by assessing their knowledge of concepts (Kohnert, Windsor, & Ebert, 2008).

1.2.3 Identifying SLI among bilingual children with NWR. Measures of phonological working memory have been shown to accurately identify children with language impairment and reduce bias in standardized assessments (Gutierrez-Clellen & Simon-Cerejido, 2010). Evidence has demonstrated that phonological working memory is impaired among children with learning disabilities, attention deficits, and reading disabilities (Estes, Evans, & Else-Quest, 2007; Marton et *al.*, 2007; Marton & Schwartz, 2003; Weismer et *al.*, 2000). Underlying deficits in phonological working memory are apparent in children with SLI as indicated by decreased performance on various working memory tasks (Estes, Evans, & Else-Quest, 2007; Marton et *al.*,

2007; Marton & Schwartz, 2003; Weismer et *al*., 2000). Decreased performance on phonological working memory tasks was noted in children with SLI, including on nonword repetition and nonwords lists when compared to age-matched, younger, and language age matched children (Estes, Evans, & Else-Quest, 2007) .

A growing body of literature has demonstrated that children with SLI repeat nonwords with less accuracy indicating a phonological processing deficit not a lack of language knowledge. The phonological processing deficit is more apparent as the nonword length increases (Dollaghan & Campbell, 1998). Evidence demonstrated that children with SLI have increased difficulties repeating nonwords at three and four syllable lengths, compared to children with typical language development which demonstrate less accuracy at four syllable lengths. Similar results were found among bilingual and Spanish-speaking children which demonstrated decreased performance on nonword repetition as syllable length increased, in particular at four and five syllable lengths (Girbau & Schwartz, 2007, 2008; Marton et al., 2007; Munson, Kurtz, & Windsor, 2005; Summers et *al*., 2010). Word length effect has been demonstrated in younger children and appears to persist in older school-age children with SLI (Montgomery, 1995). Therefore, reduced performance at three to four syllable nonwords may be a good indicator of children who may have language impairment (Dollaghan & Campbell, 1998). Repetition performance of longer nonwords also decreases among typically developing children, however limited phonological capacity may result in longer nonwords becoming more taxing for children with SLI (Estes, Evans, & Else-Quest, 2007). Breakdown of nonword repetition performance of longer nonwords may be attributed to limited storage of phonological loop which decreases ability to accurately recall nonwords, and not phonological abilities (encoding, rehearsal,

articulatory/output abilities) which have been previously ruled out by prior evidence (Montgomery, 1995).

Therefore, a nonword repetition task may be a useful diagnostic tool for identifying children with LI (Kohnert, Windsor, & Dongsun 2006; Kohnert, Windsor, & Ebert, 2008; Summers et *al.,* 2010). Nonword repetition is a less biased measure because repeating nonwords is not as reliant on language knowledge, compared to conventional language measures (Dollaghan, & Campbell, 1998; Ellis Weismer, et *al*., 2000; Girbau, & Schwartz, 2007). "Language-based" measures such as NWR, can serve as an unbiased assessment within clinical practice for identification of children with SLI and/or linguistically diverse children (Kohnert, Windsor, & Ebert, 2008; Summers et *al*., 2010). Repeating nonwords are more familiar to children and less dependent on specific language knowledge, making it a sensitive measure to rule out SLI among bilingual children; whose language skills are dispersed across two languages (Kohnert, Windsor, & Dongsun 2006; Kohnert, Windsor, & Ebert, 2008; Summers et *al.*, 2010, Gutierrez-Clellen & Simon-Cerejido, 2010).

NWR was found to be sensitive in identifying Spanish-speaking children with SLI from children with typically developing language using NWR; providing evidence that deficits in phonological working memory persist in other languages. Girbau and Schwartz (2007) evaluated nonword repetition performance among older school-age Spanish-speaking children with typically developing language and children with SLI, using Spanish nonwords that they developed. Results demonstrated that Spanish-speaking children with SLI were accurately identified from children with typically developing language using NWR; providing evidence that deficits in phonological working memory persist in other languages (Estes, Evans, & Else-Quest, 2007; Girbau & Schwartz, 2007; Weismer et *al*., 2000). Winsor and colleagues (2010)

demonstrated comparable results to Kohnert et *al*. (2006), indicating that an English and Spanish NWR accurately separated children with language impairments from typical monolingual English speaking children and bilingual children.

1.3 Sources of variations in NWR skills among bilingual children

Evidence has demonstrated that long-term language knowledge is influenced by the bilingual speaker's language experiences. This is unsurprising as balanced bilingual individuals must have comparable lexical, semantic, morphosyntactic, and phonological knowledge in each language to perform adequately on assessments. Achieving equal language knowledge in more than one language may be difficult to achieve because both Spanish and English are structurally different (Girbau & Schwartz, 2008). Children were more accurate at repeating nonwords that resemble the rules for word combinations in the language most familiar to them (Summers et *al.,* 2010). NWR performance is influenced by the phonotactic constraints the child is learning in their native language and /or second language. English and Spanish Bilingual children repeated Spanish nonwords with higher accuracy than English nonwords, indicating a recall advantage for their native language (Summers et *al.*, 2010).

In addition, children that frequently speak and hear a language that contains longer words demonstrate a higher accuracy on nonwords that increase in syllable length. This information has been supported by several studies. In a study by Masoura and Gathercole (1999) Greek children performed better on the two-syllable to five-syllable nonwords, which resembled their native language, Greek, which is more multisyllabic than English, their second language. Children's higher performance on NWR is attributed to the nonwords resembling more closely the language; which they're most proficient in. Summers, Bohman, Peña and Gilliam (2010)

demonstrated that English and Spanish bilingual children were better at repeating multisyllabic nonwords that resembled closely longer words in the Spanish language.

1.3.1 Variations in NWR performance among bilingual children. Many NWR tasks have been administered in only one language making evaluation of bilingual children's language skills difficult (Kohnert et al., 2006; Girbau & Schwartz, 2007). Administering NWR solely in one language may be inadequate to rule out SLI in bilingual children, as language skills are dispersed across both languages. Kohnert and colleagues (2006) found that performance among bilingual children were lower than typical developing English only (EO) children using an English nonword repetition task (ENWR). Bilingual children's decreased performance compared to EO children may have been influenced by their limited proficiency and knowledge in the English language. Bilingual "children with less experience in the test language would be at further disadvantage on these language processing measures" (Kohnert, Windsor, & Dongsun, 2006). Although ENWR accurately distinguished children with SLI from Bilingual children it may not accurately differentiate children who have SLI from typically developing bilingual children (Kohnert, Windsor, & Dongsun, 2006). Nonword repetition performance must be completed in both languages to avoid misdiagnosis of language impairment among bilingual children.

Winsor and colleagues (2010) also demonstrated that NWR in English only is insufficient to accurately separate typical bilingual children from monolingual English-speaking children. Results on English NWR showed that typical bilingual children performed less accurately than monolingual English speaking children, but demonstrated an overlapping performance with English speaking children with language impairment and higher repetition than bilingual children with language impairment. This is relevant as it provided further

evidence of language experiences affecting NWR performance independently of the child's underlying language ability. Bilingual children performed significantly higher on the Spanish NWR than on the English NWR, possibly highlighting factors such as early exposure to Spanish and length of language exposure that were key to accuracy (Winsor et *al.*, 2010; Kohnert et *al.* 2006). Therefore in order to appropriately assess nonword repetition performances exhibited by bilingual children despite variations demonstrated, normative data from bilingual adult performance is needed to disambiguate performances among bilingual children.

1.4 Contributions of long-term knowledge to NWR skills

Nonword repetition recall advantage results from long-term memory influencing phonological working memory among both adults and children (Gathercole & Adams, 1994). Working memory mediates language information with long-term memory, also referred to as crystallized memory. Higher recall has been found in real words and nonwords that resemble phonological structures stored within phonological working memory; indicating that repetition is influenced by long-term knowledge (Thorn & Gathercole, 1999). After an individual hears nonwords, sequences of speech sounds are processed through the phonological loop; which are temporarily stored and rehearsed prior to repetition. Long-term memory is activated if combinations of speech sounds resemble vocabulary found within lexicon of the language (Gatercole & Adams, 1994).

Nonwords that resemble the phonotactic constraints of the language with the most experience may lead to quicker recall of nonwords resembling that language (Munson, Kurtz, & Windsor, 2005; Summers et *al*., 2010). Baddeley (2003) demonstrated that nonwords constructed similarly to the English language were easier to recall then words constructed less similarly to English. NWR may activate long-term experiences based on the nonwords "word

likeness" and resembling the phonotactic constraints of the language being tested. Words that have higher phonotactic resemblances are typically produced more correctly than words with lower phonotactic resemblance. An effect for wordlikeness was found among children with SLI, who repeated high wordlike nonwords more accurately than low wordlike nonwords (Munson, Kurtz, & Windsor, 2005).

Similar results have been extended to adults. A study on English and French bilingual adults demonstrated a higher performance on words and nonwords; which closely resembled the language they were most experienced in (Thorn & Gathercole, 2001). Therefore repetition accuracy of low wordlikeness nonwords appears to be more representative of phonological working memory capacity, as it is less reliant on long-term knowledge. Also low wordlikeness nonword stimuli have been correlated with other phonological working memory measures such as digit span. Repetition accuracy of wordlike nonwords has been strongly correlated with vocabulary knowledge (Gatercole & Adams, 1994). Bilinguals' knowledge of each language may not be equally dispersed, resulting in delayed retrieval of lexical items if equal language proficiency has not been reached (Baddeley, 2003; Summers et *al*., 2010).

Among bilingual individuals, language experience may increase rapid retrieval and repetition of nonwords, if nonwords resemble the vocabulary of a language. Recall accuracy of nonwords are affected by an individual's native language and their experiences in that language. Thorn and Gathercole (1999) evaluated if "short term memory accuracy on English and French NWR was higher in children's native language than in their second language, due to the support of the long-term knowledge at both lexical and sublexical levels for the native language" (Thorn and Gathercole, 1999). Results indicated that high accuracy on English nonwords were

demonstrated by all three groups of Monolingual English speaking children, English-French bilingual children, and children acquiring French as their second language learners.

However on the French NWR, second language learners and bilingual children performed comparably, while monolingual English-speaking children demonstrated low performance. Similar findings in another experiment demonstrated that simultaneous bilingual children performed equally on both English and French nonwords, while sequential bilinguals demonstrated higher accuracy in their native language (Thorn & Gathercole, 1999). Findings confirmed that bilingual children with balanced knowledge in each language maintain comparable phonological representations within phonological working memory, which may be equally facilitated by vocabulary knowledge in English and French. The study also showed that sequential bilingual children with dispersed language knowledge demonstrated increased stable phonological representations in their long-term storage of their dominant language, which facilitated high accuracy of nonwords in the language.

Evidence has demonstrated comparable findings with bilingual adults which exhibited higher recall accuracy in the digit span task, which resembled the more experienced language (Thorn & Gathercole 2001). Bilingual adults may rely on their long-term memory to assist processing words that resemble the language most dominant it. Memory performance of adults has been found to be higher in short words then in longer words. The rehearsal process of longer words may be delayed resulting in loss of information within the phonological storage. Phonological processing and rehearsal of shorter words is faster permitting better recall of the words. In a study of Welsh-English bilingual adults, participants demonstrated a higher digit span in English, even though they reported being higher proficiency in welsh. Prior language

experiences and vocabulary knowledge facilitates quicker retrieval of words (Thorn & Gathercole, 2001; Summers et *al*., 2010).

1.5 Correlation between phonological working memory and other language recall measures

   1.5.1 NWR and vocabulary skills. Evidence has shown an association between phonological short-term memory and children's vocabulary knowledge. Relationships found between NWR and bilingual children's vocabulary skills contradict prior evidence demonstrating a higher performance in the children's more familiar language. Young children depend on phonological short-term memory when acquiring a new language, due to their lack of vocabulary knowledge in that language (Masoura & Gathercole, 1999). A study by Masoura and Gathercole (2005) evaluated Greek children's initial word learning of a second language. Results revealed that phonological working memory supports word acquisition in the second language until sufficient vocabulary knowledge is attained. The study also demonstrated that learning new English words was enhanced by prior vocabulary knowledge. The children in this particular study had some experience learning English and had sufficient vocabulary knowledge to facilitate learning new words that resembled prior stable phonological forms and did not depend on phonological working memory to facilitate word learning (Masoura & Gathercole, 2005). Therefore word learning is facilitated by the children's prior vocabulary knowledge and their phonological short-term abilities (Gathercole, Hitch, Service & Martin, 1997; Masoura & Gathercole, 1999).

   NWR is a useful predictor for determining the children's vocabulary at 5 years of age (Masoura & Gathercole, 1999; Baddeley, 2003). It is suggested that phonological working memory initially assists children in acquiring vocabulary; which enhances accuracy of NWR if the nonwords resemble their dominant language (Baddeley, 2003). Gathercole *et al*. (1992)

provided further evidence by demonstrating a correlation between vocabulary and NWR performance in children ages 4 to 6 years old. It is suggested that the phonological loop is a predictor of vocabulary learning in younger children (Gathercole *et al*. 1992). After children gain sufficient exposure to language and acquire more vocabulary; association between phonological working and vocabulary knowledge decreases (Gathercole *et al*. 1992). This suggests that younger children depend on their phonological working memory as they are developing their language skills in their native and second language (Gathercole *et al*. 1992). However, as the children develop a certain amount of language and their mental lexicon expands, they rely more on their long-term knowledge to process information in the each language (Summers et *al*., 2010).

Another study, Gathercole, Hitch, Service & Martin (1997) demonstrated that NWR was highly correlated to learning paradigms associated with learning new words in children's (ages=5-7 years old). These learning paradigms included a word-nonword task and two story measures (recall of new names, and recall of definitions). A positive relationship was demonstrated between NWR and three vocabulary scores, even when age and nonverbal scores were taken out Findings showed that overall vocabulary scores were related with the four word learning tasks, even when NWR and age were taken out. However, NWR was correlated with performance on the word-nonword task, and was not related with the word-word learning task. Results demonstrated that phonological short-term memory facilitated children's learning of new vocabulary words with sound combinations not previously exposed too in their SL1. Yet, children also depended on other language knowledge, including vocabulary knowledge to aid their learning of new words. Therefore findings indicated that other underlying processes

besides vocabulary knowledge and phonological short-term memory are required in acquisition of new words (Gathercole, Hitch, Service & Martin, 1997).

Reliance on phonological short term memory is apparent among individuals learning a foreign language, which may be facilitated if vocabulary in the foreign language resembles the phonological representations stored within their first language (Thorn & Gathercole, 1999). These findings coincide with Masoura and Gathercole (1999) study of Greek children (mean age=10;3) who had been learning English as a foreign language for three years and nonword repetition performance was evaluated in Greek and English. The results demonstrated that foreign vocabulary knowledge was highly correlated to nonword repetition scores after native vocabulary, age and nonverbal ability was factored out. This may indicate that children acquiring a second language depend more on their phonological short-term memory language, due to lack of vocabulary knowledge in their second language. Yet, when foreign vocabulary was factored out, native vocabulary was no longer significantly correlated with NWR. Vocabulary knowledge in the children's native language was sufficient to facilitate retrieval of words, without requiring support from phonological short-term memory.

Phonological short term memory facilitates learning of new vocabulary words despite unfamiliar sound combinations (Baddeley, 2003; Gatercole & Adams, 1994). Thorn and Gathercole (1999) proposed that long-term knowledge activate stored phonological representations within phonological working memory, which fills the gap of unknown phonological structures within phonological storage. The recall process is facilitated and allows the individual to guess the missing parts of the words. Nonwords may be recreated with greater facility if the individual has increased knowledge about phonological representations resembling new language within long-term knowledge (Thorn & Gathercole, 1999).

1.5.2 NWR, semantic, and syntactic skills. Evidence has indicated that phonological working memory is correlated with other language abilities among typically developing children (Summers et al., French & O' Brien, 2008). However there is limited research examining to what extent phonological working memory influences sentence recalling and other similar language tasks. There appears to be contradictory views for underlying cognitive processes that guide sentence repetition. A further discussion regarding these views is required within the current body of research.

However one standing view regarding sentence repetition was proposed by Potter and Lombardi (1990). Potter and Lombardi (1990) argued that sentence recall is primarily based on meaning representation. They proposed that phonological working memory does not play a major role in recalling sentences (Schweppe et al., 2011). Recalling sentences is dependent on working memory capacity to repeat the sentences exactly as heard. Recalling sentences accurately depends on the number of words included, 12 words or less are ideal for the sentence to be recalled exactly. As a sentence increases in length by adding more words, there is a decrease in recall accuracy. Short-term memory temporarily stores information based on its attributes, including phonology, orthography, and articulation. Long-term memory is involved in maintaining the sentence meaning. Meaning is represented in short-term memory yet centralized in the long-term memory, due to words and sentences representing distinct meanings (Potter & Lombardi, 1990).

During sentence recall, meaning is maintained even though exact syntactic structure is not recalled (Potter & Lombardi, 1990). Repetition of words is activated based on their meaning and the individual's familiarity with the meaning. The long-term memory assists in storing words based on meaning and short-term memory assists in temporarily storing sentences and

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words; and activating quick retrieval of words and sentences based on meaning triggering one or more words with that similar meaning. Characteristics of that word or sentence (orthography, phonological, speech) may assist in triggering the meaning. Recalling of meaning relies on subsystems of the working memory, including the phonological working memory. Phonological working memory may help trigger words through knowledge of sequences of speech sounds. This knowledge of speech sounds and the phonotatic constraints of the language may assist in activating the meaning which helps trigger other words in the sentence if it includes other familiar and similar words in meaning (Potter & Lombardi 1990).

Further analysis of research has demonstrated that although sentence recall relies on other sources of knowledge, including vocabulary knowledge, syntactical knowledge and semantic knowledge; phonological short term memory also influences sentence recall (Alloway, 2007; Willis, & Gathercole, 2001). Influence of phonological working memory on sentence recalling appears to be more evident among younger children than adults. Willis and Gathercole (2001) demonstrated that sentence repetition of various lengths by 4 and 5 year old typically developing children was related to NWR performance. However, it was noted that children were more accurate on recalling shorter sentences than longer sentences. This signifies that phonological short-term memory mediates immediate recall of sentences, indicated by decreased recall accuracy on longer sentences. Working memory capacity in young children may not be as extensive as in adults to support temporary storage of longer morphosyntax units (Gathercole, 1999). Therefore children may be able to recall smaller units of information, but once load surpasses children's phonological working memory capacity, breakdown will occur.

Similar findings were demonstrated among cross-linguistic studies. Phonological working memory facilitated grammatical skills among younger and older typically developing

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children. Girbau and Schwartz (2007) indicated a strong relationship between NWR and monolingual Spanish-speaking children with typical language development grammatical skills. These findings were replicated by Girbau and Schwartz and extended to older school-aged English and Spanish bilingual children with typical language and with SLI. Results demonstrated that NWR was strongly related with children's grammatical skills. Therefore phonological working memory influences children's grammar development in a second language (French & O' Brien, 2008). Even though bilingual children were older, there was still a dependence on phonological working memory to facilitate recall of syntactic elements that were not established within long-term knowledge. Another study demonstrated that phonological working memory predicted typically developing children's grammatical skills in two languages; Italian and English. Nonword repetition performance was found to predict children's grammatical ability in both Italian and English languages among 3-4 year old typically developing children (Dispaldro et *al.,* 2011).

In addition a higher relationship between phonological short-term working memory and grammatical skills has been found among children with language impairment. Individuals with phonological short term memory deficits have shown to demonstrate decreased sentence repetition accuracy (Martin et al., 1994).   Therefore individuals may rely exclusively on repeating only the central points of the sentence rather than repeating it verbatim (Martin, 1993). Phonological short term working memory appears to facilitate underdeveloped morphosyntax skills during a narrative retell in English-Spanish bilingual children with language impairment. In a preliminary study, Summers, Bedore, Peña, and Gilliam (2009) demonstrated that bilingual children with language impairment had a greater relationship between NWR and narrative retell skills than compared to their typically developing peers. Phonological working memory may

help mediate limited language skills among bilingual children with language impairment, until linguistic skills are better developed to support performance on narrative retell tasks.

Overall, evidence has demonstrated that typically developing young children rely on phonological working memory to a greater extent than adults (Willis & Gatercole, 2001). Also, children with language impairments may depend more on their phonological working memory than their typically developing peers to support acquisition of syntactic and semantic features due to present language deficits. During early language development children must learn sequences of information which are rehearsed and practiced until the children can use them fluently. As observed with vocabulary development, children must attain understanding of sounds, syllables and rules for combining words through frequent exposure to speakers who utilize the language and by speaking it; which is mediated by underlying process phonological working memory (Willis & Gathercole, 1999).

A similar learning process is expected during acquisition of grammatical skills and learning longer and grammatically complex utterances used for discourse. Young children must acquire syntactic and semantic elements (e.g. word order, use of clauses, etc.) that are unique to their language and rely on phonological working memory to rehearse these units until they become established within the long-term language knowledge (Ellis & Sinclair, 1996). After sequences of information have been established there is reciprocal relationship between long-term knowledge and phonological working memory. Increased storage of sequences of information increases automatic retrieval of units within long-term knowledge which increases working memory capacity (Ellis & Sinclair, 1996).

There is limited research on relationships between NWR and other language tasks performance among bilingual adults. It is unclear whether an association between phonological

working memory and recall measures will remain or lessen due to the influence of long-term knowledge (syntactic knowledge, vocabulary knowledge, etc.); which may aid in reconstruction of sentences. Some studies have indicated a relationship between adult's sentence repetition and phonological working memory (Ellis & Sinclair, 1996). Ellis and Sinclair (1996) demonstrated that adults' recalling accuracy of sentences in a foreign language (Welsch) increased when they heard the sentence and immediately repeated back. However, role of phonological working memory may have increased to support rehearsal and processing of new sequences of information in an unfamiliar language. Long-term knowledge of syntax and semantics in their native language may have facilitated recall of new sequences of information, if information resembled their familiar language.

However, findings have yielded inconclusive results. Therefore an association between phonological working memory and other language abilities may not be significant in an individual's familiar language. Alloway (2007) demonstrated that lexical knowledge facilitated adults' sentence repetition to a greater extent than phonological working memory; during repetition of sentences with semantic based and phonological based word-intrusions. These findings provide support for the argument suggesting that accurate repetition of sentences requires access to phonological representations that are held within phonological working memory, and to some greater extent access to long-term knowledge (syntactic knowledge, lexical knowledge, etc.) (Wills & Gathercole, 1999).

1.6 Aims of the Study

The current study was designed to evaluate phonological working memory, assessed by performance patterns on NWR tasks among bilingual English and Spanish adults. Prior research on phonological working memory capacity has been conducted among bilingual children, but research of bilingual English and Spanish adults is limited. Research on NWR performances of bilingual adults may aid interpretation on what performance patterns are expected in English-Spanish bilingual children with varying language experiences, as they develop. This will help determine if children's varied NWR performances is attributed to their bilingual status or their distinct language experiences. Also, performance on NWR may indicate if long-term knowledge influences recall accuracy in English and Spanish (Thorn & Gathercole, 2001). The study may determine if phonological working memory influences recall among bilingual adults with dispersed language knowledge in English and Spanish (Thorn & Gathercole, 2001).

Another objective of the study was to determine if relationships between NWR and other language abilities, as observed in young and school-age bilingual children remain or become insignificant over time. If these relationships between NWR and other language tasks remain; will they be more significant in their stronger or in their weaker language that is used less often? Phonological working memory may be required to facilitate other language recall tasks in the weaker language, due to less automatic access to their long-term knowledge. Further information on the role of phonological short-term memory in facilitating language abilities, such as grammatical and semantic skills among bilingual adults may be provided. Bilingual adults within the study may demonstrate varying language experiences and proficiency, which may increase their reliance on phonological working memory to facilitate language recall measures (Schweppe et *al.*, 2011). If relationships between NWR and other language tasks in

bilinguals' stronger or weaker language then it is expected that bilingual children will perform similarly. However there is no current evidence to indicate this information yet.

Therefore, the following questions were posed within the study:

1. What are the Nonword Repetition (NWR) performance patterns among English and Spanish bilingual adults?

2. What is the relationship between NWR and other recall measures among English and Spanish bilingual adults?

CHAPTER 2: METHODS

2.1 Research Design

The aim of the study was to examine phonological working memory performance across English and Spanish in bilingual adults using a NWR. The study implemented a repeated measures design to evaluate bilingual adults' repeated NWR performance across both English and Spanish languages and varying nonwords. There were two independent variables that included; language (English and Spanish) and syllable Length (1-4 syllables in English and 2-5 syllables in Spanish). Also, the dependent variable was bilingual adult performance on NWR assessed by percent of phonemes correct (EPPC and SPPC). Another aim of the study was to evaluate if NWR was highly related to other language recall tasks (sentence repetition and story retells) in English-Spanish bilingual adults as exhibited in bilingual children. Therefore, the study employed a correlational design to examine associations between language recall tasks. Significance between relationships was evaluated between NWR tasks (assessed by PPC), sentence repetition tasks (assessed by raw score), and story retells (assessed by number of different words (NDW) across both English and Spanish.

2.2 Participants

Forty bilingual English-Spanish adults between ages 18 and 67 participated in the following study. Participants were recruited utilizing the following inclusionary criteria:

(1) Participants' ages ranged between 18-77 years old.

(2) Bilingual in English and Spanish, demonstrating sufficient competence in each language to complete recall tasks.

In order to generalize normative information on NWR performances obtained from English-Spanish bilingual adults to typically developing English-Spanish bilingual children NWR performance exclusionary criterion was included. Exclusionary criteria ensured that bilingual participants recruited were competent in English and Spanish and did not have prior language, neurological, and/or cognitive deficits, which may skew the validity of results. Exclusion criteria included the following:

(1) Limited experience and proficiency in English and/or Spanish

(2) Participants did not meet minimum age requirements

(3) Participants unable to attend two required testing sessions

(4) Documented history of psychiatric, emotional, Intellectual-cognitive, learning, and

    developmental disability.

(5) Documented history of hearing loss.

The participants in the study included 24 females and 16 male (m=28). Participants were recruited through purposive (based on selection criteria previously discussed, including inclusionary and exclusionary factors) and snowball sampling (participants referred and/or recruited other potential participants for the study). Participants were recruited utilizing advertisement and in-house resources of the University of Texas at El Paso (UTEP). A research assistant created flyers soliciting English and Spanish bilingual participants. Flyers delineated the purpose of the study and disclosed selection criteria for participants. Flyers were located around El Paso Community College (EPCC) and UTEP campus. Participants already recruited also referred other individuals to participate within the study that met the selection criteria.

Furthermore, bilingual English/Spanish undergraduate and graduate research assistants were granted approval from EPCC and UTEP professors, to visit their classes and invite students to participate.

Prior to scheduling testing sessions, research assistants reminded the participants of the requirements of the study including fulfilling the selection criteria and attending two testing sessions approximately 20-30 minutes each. Participants confirmed that they demonstrated sufficient competence to speak, read, listen, and repeat words and sentences in both English and Spanish. Participants were scheduled for two appointments through email or over the phone at the UTEP Bilingual Language Learning Lab. Individuals did not meet selection criteria were informed they did not qualify for the study and thanked for their interest. Participants were informed that upon completion of the two testing sessions they would receive a $30 gift card from Wal-Mart. Based on the stratified sampling of participants results obtained in the study should be interpreted with caution. Participant sampling was not randomized and may not be indicative of the general population.

2.2.1 Demographic information. During the first testing session demographic background information was collected for each participant (see Table 1.1 and Table 1.2). Participants' self- identified their ethnicity and racial background as follows: (27) Mexican-American, (6) Latino/a, and (7) as Hispanic (Table 1.1). Participants identified their level of education as follows: (5) High School or equivalent, (15) Some College but no degree, (10) Associate degree, (9) Bachelor degree and (1) Graduate degree (Table 1.2). Data obtained reported participants' level of education, gender and age differences and their ethnicity. Majority of participants were recruited at UTEP or EPCC which increased the likelihood that they had obtained a higher level of education. Also an effort was made to recruit a balanced

sample among women and men participants, in order to increase generality of result obtained to the bilingual population. Although overall recruitment of male participants was more difficult, indicated by lower census of male participants reported within the study. Additionally, the participants were not required to indicate their data of birth but instead indicated an age range that approximated their actual age. Data demonstrated that the majority of the participants were within 21 to 29 years of age.

2.3 Measures

Four language recall measures that included a language questionnaire, a NWR task, sentence repetition task, and story retell task were administered to bilingual adults in both English and Spanish to address the aims of the study. Nonstandardized measures were administered to reduce bias in standardized assessments, when evaluating bilingual performance. Also, there is a lack of normative samples available for English-Spanish bilingual adults on the recall measures: language questionnaire, NWR tasks, and story retells. Sentence repetition subtests are normed across English or Spanish monolingual speaking adolescents and adults (14-21 years). However, normed samples were unable to be utilized due to recruited participants' ages ranging between 18-67 years-old. In addition, assessment of bilingual adults' grammatical performance using normed sample on monolingual individuals may not have yielded reliable results. All measures were administered in a counterbalanced manner to bilingual participants (see table 1.3).

2.3.1 Language questionnaire. Participants were asked to complete a language use questionnaire (Peña, Bedore, Gutiérrez-Clellen, Goldstein, & Iglesias, in preparation) to evaluate their current language usage in both English and Spanish. Bilingual adults completed the

language questionnaire in the English language prior to initiating testing sessions. Language questionnaire was transmitted via two methods 1) participants filled out an electronic version of the questionnaire on survey monkey or 2) participants filled out a paper version of the language questionnaire, which was completed on the first testing session. Furthermore, survey monkey is a website that allows questionnaires to be constructed and be accessed directly on the website or through a link sent to an individual's personal email. Electronic version of language questionnaire was created by a graduate student. Participants completed questionnaire via method of transmission most convenient for them.

Language questionnaire assessed participants' overall language profile/routine on a daily basis. Bilingual participants indicated what their language usage was in both English and Spanish for an entire week, including the weekend. Therefore, participants reported their hour-by-hour (7 a.m. to 11 p.m.) total exposure (input) to and use (output) of both English and Spanish. Participants reported the activity (e.g. breakfast, work, etc.) they participated in and the language they spoke (e.g. English, Spanish, or both) during the activity. If communicating with a communication partner (e.g. co-worker, friend, etc.), participants reported what language their communication partner used.

Prior to completing language questionnaire, participants were given instructions to indicate their current language usage that was representative of their daily communication interactions and exclude unanticipated communication situations that occurred during the week, which deviated from their typical language use. Instructions were provided to ensure that participants' reported language input/output was an accurate representation of their overall language usage in both English and Spanish, and not of circumstantial communication situations. Therefore, data obtained from the language questionnaire was analyzed to determine how much

English and Spanish bilingual participants used on a daily basis to communicate with others and within different contexts.

Evaluation of bilingual participants' overall language usage in English and Spanish indicated that participants (n=9) demonstrated less than 20% daily usage of Spanish language; which may not be sufficient current language knowledge to support performance on recall measures. Further evaluation of the participants' language history was conducted to determine if participants remained suitable for the study and/or should be ruled out. Therefore, another portion of language questionnaire was administered to evaluate the participants' overall language ability in both English and Spanish. Bilingual participant's rated what they believed their overall language ability was in both English and Spanish. During this portion of the questionnaire, participants rated their language ability in reading, writing, and speaking and listening for both formal and casual communication situations in both English and Spanish, on a scale ranging from number 1 (non-fluent, only know several words or few simple sentences) ranging to a number 5 (fluent, completely comfortable with skills like a native speaker). Further evaluation (see results) indicated that all participants demonstrated sufficient language knowledge to complete the recall measures.

2.3.2 Nonword repetition tasks (NWR). Phonological working memory was assessed by evaluating English and Spanish nonword repetition performance patterns among bilingual adults. For the present study an English NWR task developed by Dollaghan and Campbell (1998) was administered. The English NWR task was compromised of 96 total speech phonemes contained within 16 nonwords. Nonwords increased in syllable length, to represent words of varying lengths typically found in the English language. The 16 nonwords were divided into four nonwords ranging at each syllable length, from one to four syllables in length

(e.g. /nɑɪb/ or /teɪvak/). The English nonwords were constructed to follow the phonotactical constraints (rules that establish plausible word combinations) of the English language. English nonwords included only tense vowels and later developing consonants were excluded. The consonants and vowels included occurred only once in each nonword. In addition, syllable combinations and consonant clusters that occur frequently in English were excluded and only syllables that occur less than 25% in English were included. Therefore English nonwords were rated as low "wordlikeness" or less likely to resemble real word typically encountered in the English language.

For the Spanish NWR, Spanish nonwords were adapted from a nonword list developed by Calderon (2003). Spanish NWR task was compromised of 133 speech phonemes within 16 nonwords, four at each length from two to five syllables in length (e.g. /gauβer/ or /merfas/). Spanish nonwords were constructed to resemble multisyllabic words typically found in the Spanish language. The Spanish nonwords included syllables that did not occur more than 200 times within two million words as reported in Alameda and Corpus (1995). Spanish nonwords included only earlier developing speech sounds and stressed patterns that occur in the language. Therefore many later developing speech sounds were excluded (e.g. /s/ and /r/). Also, the final syllable in the nonwords was always stressed. Spanish nonwords were constructed to not resemble real words in the Spanish language.

2.3.3 Sentence repetition task (SR). Syntactic performance was evaluated using sentence repetition subtest from the Clinical Evaluation of Language Fundamentals fourth edition English and Spanish (CELF-4), (Semel, Wiig, & Secord, 2003). Each participant was administered the entire SR subtest, despite number of errors recorded. Bilingual research assistants orally recited all 24 sentences in the subtest and participants immediately repeated

each sentence verbatim. Standardized procedures for administering testing items were not followed, yielding normative data invalid. Therefore SR was scored using only the raw scores. Raw scores were obtained following scoring protocol according to the CELF-4 manual guidelines.

2.3.4 Story retell (RT). Each of the bilingual adults participated in English and Spanish story retell tasks. Semantic performance was evaluated using four story retell tasks, which included two English stories and two Spanish stories. The books Frog Goes to Dinner/La Rana Va a Cenar (FGTD), (Mayer, 1974) and Frog on His Own/La Rana Solitaria (FOHO), (Mayer, 1973) were used. Transcriptions of the stories were downloaded from the Systematic Analysis of Language Transcripts (SALT) website (Miller & Iglesias, 2010). Two stories were randomly selected for each participant and presented in a counterbalanced order in English and Spanish (see Table 1.3).

2.4 Procedures

2.4.1 Informed consent form. Prior to initiating testing, participants were given an informed consent form on the first testing session that had been approved by the University of Texas at El Paso institutional research review board. The consent form delineated the participant requirements and any risks posed within the study. The consent form included the following:

(1) Purpose of the study, to assess working memory skills in bilingual English and
    Spanish adults.

 (2) No direct risks were directly involved to the participants.

(3) Participation was voluntarily and participants could withdraw from the study at any
    time.

(4) Research members could stop participants' participation at any time.

(5) Participants would be paid $30 for their participation in the study.

(6) Data records and audio recording collected would remain confidential.

Participants' information was not identified directly by their name, but labeled with a number and only the researcher and research assistants would have access to this information. Each participant printed and signed their name on the consent form before continuing the testing.

Administration of the tasks took place at the UTEP Bilingual Language Learning Lab. The room was quiet and the tasks were administered by an undergraduate or graduate research assistant. Before participants came to the scheduled testing session, research assistants prepared the materials and the equipment utilized. Folders (labeled with a number from one through forty) that contained the informed consent form, testing protocol, and recall measures were utilized for each participant. Folders included track order 1 or track order 2 protocols that were referred to for testing order (See Table 1.3). Each track protocol outlined the order each task would be executed and the language used for two testing sessions.

Track 1 included (1) read English story (2) listen and repeat English NWR (3) English sentence repetition task (4) English Narrative retell, during the first testing session. On the second testing session, the research assistant administered the same tasks and a distinct Spanish story was selected. Track 2 included (1) read Spanish story (2) listen and repeat Spanish NWR (3) Spanish sentence repetition task (4) Spanish narrative retell, during the first testing session. On the second testing session, the research assistant administered the same tasks and a different English story was selected.

Table 1.1 Order of recall measures presented

Testing order	Session 1	Session 2
Tracking Order 1	Language Use Questionnaire Read English Story English NWR English Sentence Repetition English Narrative Retell	Read Spanish Story Spanish NWR Spanish Sentence Repetition Spanish Narrative Retell
Tracking Order 2	Language Use Questionnaire Read Spanish Story Spanish NWR Spanish Sentence Repetition Spanish Narrative Retell	Read English Story English NWR English Sentence Repetition English Narrative Retell

Research assistants checked that the audio recorder Sony IC-Recorder ICD-MCX was operating with fully charged batteries, and was connected to a microphone. Participant's responses for the NWR, SR, and RT were audio-recorded in English and Spanish, for further analysis. A microphone (Sony ICD-IX) was clipped onto the participant's shirt to amplify their verbal output and diminish any excess noise in the room. The English and Spanish NWR were previously recorded by a male individual and uploaded on a desk computer or a laptop (Dell Latitude E-124 or E6410). English and Spanish NWR were presented to participants via headphones. Research assistants used the computer mouse to select each nonword (16 nonwords) in order to avoid nonwords being presented twice to participants. Each nonword was presented only once and afterwards the participant repeated it verbatim.

For the story retell task, the research assistants verbally recited the instructions with the participant. Instructions were provided in the language that was tested on the session. Research assistant handed a copy of the story script to the participant as indicated in the testing protocol.

The following statement was recited:

> Please read this story out loud. You will need to tell me this story again later. Please begin now. Tell me when you have finished reading the story.

> Entrega el guión al participante. Por favor, lee este cuento en voz alta. Recuerda que me lo vas a contar orta vez despues. Puedes empiezar. Porfavor, dime cuando termines de leer el cuento.

Research assistants pushed record on the audio recorder when the participant began reading and stopped recording after the story was completed. An English or Spanish NWR task followed, order of NWR was indicated on the testing protocol. Research assistants provided verbal instructions in the language that was tested on the session. The research assistant followed written instruction with the following statement:

> Now I'm going to ask you to listen carefully to each word, they are not real words, just made up words. I will only play it for you once. Try you best to repeat what you hear. Do you have any questions? Please begin now.

> Ahora te voy a pedir que escuches cuidadosamente cada palabra, repite lo que escuches, recuerda no son palabras reales, son compuestas. Recuerda que tocare cadsa palabra solo una vez. Tíenes alguna pregunta? Vamos a comenzar.

Research assistants pushed record when the participant began repeating the words and stopped recording after participant completed the words. A sentence repetition task followed, order was indicated on the testing protocol. Research assistants provided verbal instructions in the

language that was tested on the session. The research assistant followed written instructions with the following statement:

> I am going to say a sentence. I want you to listen carefully and repeat exactly what I say. (Example; Let's try my sister is in the sixth grade, participant repeats the sentence VERBATIM). Now let's continue. Remember to listen carefully and say exactly what I say. Let's begin.

> Voy a decir una frase. Quiero que escuches atentamente y repite lo que digo. (Ejemplo; Vamos a participar, intent Mi Hermana esta en el sexton grado, El participante repite la frase palabra por palabra). Recuerde que debes esuchar atentamente y decir lo que digo. Vamos a empezar.

Research assistants pushed record when the participant began repeating the sentences and stopped recording after the participant completed last sentence. The research assistant verbally repeated 24 sentences and the participants' repeated them back verbatim.

2.4.2 Reliability

Participants' audio recordings of NWR, SR, and RT were uploaded onto the computers (Dell Latitude E-124) in the Bilingual Language Learning Lab, using the Digital Voice Editor 2 program. Audio recording files were created for each participant labeled with their assigned identification number (1-40). One bilingual research assistant listened to each audio recording of English and Spanish story retells via headphones. Story retells were transcribed using the Systematic Analysis of Language Transcripts (SALT). In order to reduce subjective bias among one transcriber, a second bilingual research assistant independently listened to 20% of the audio recordings and transcribed them. Inter-rater reliability was established by comparing the

transcriptions from both research assistants, to assess the degree to which different observers similarly rate or describe events (Hedge, 2003). Inter-rater reliability for transcriptions for 20% for English = 97% and Spanish = 96%. The remaining participants' story retells were individually transcribed by either research assistant. Research assistants assessed participant's semantic skills by conducting a rectangular data file and analyzing story retell using Number of different words (NDW).

For NWR tasks, a bilingual research assistant listened to audio recordings of English and Spanish nonwords via headphones using Digital Voice Editor 2. The audio recordings were transcribed using the International Phonetic Alphabet (IPA). Procedures for scoring each phoneme followed Dollaghan and Campbell (1998). Phonemes were scored as incorrect or correct. A correct phoneme was defined as a phoneme produced exactly as target phoneme. Additions and distortions of phonemes were not considered as incorrect as additional information did affect phoneme accuracy. Allophonic variations of consonants and vowels (/b/-/v/, /ae/-/a/, /o/-ou/, /e/-/ei/-/ɛ/, /d/-/ɾ/) produced were considered correct if they were determined to be a dialectal difference.

An incorrect phoneme was constituted as substitution, and omission of phonemes. If the participant produced syllable deletion, the remaining syllables were compared to target syllables and scored. For scoring syllables, the total number of correct phonemes were divided by the total number of phonemes produced representing the percent of phonemes correct (PCC). A second bilingual research assistant independently listened to 20% of the audio recordings for nonwords and scored each phoneme. Inter-reliability was established by comparing the scores for each phoneme from both research assistants. Inter-rater reliability for 20% of NWR words

was English = 92% and Spanish = 91%. The remaining audio recordings were individually transcribed by either an undergraduate or graduate research assistant.

Participants' responses from the sentence repetition task were recorded and scored during the administration, following the manual guidelines. Research assistants marked each error and calculated the total amount of points collected for each sentence. Later, research assistants listened to the audio recording via headphones to ensure all errors were accounted for and that each sentence was scored accurately. Incorrect errors included transpositions, substitutions, omissions, repetitions and additions at word level. The total number of points collected were added and reported as the total raw score.

CHAPTER 3: RESULTS

3.1 Analyses

An analysis was conducted to assess the participant's current usage in English and Spanish, by calculating percent of total input and output. This information provided a measure of bilingual adults' current language experiences across English and Spanish, and determined how varying exposure in each language may affect performance patterns on ENWR and SNWR. A repeated measures ANOVA evaluated bilingual adult performance on English and Spanish NWR tasks, with separate Post hoc Bonferroni tests to determine language by syllable length interactions. Bilingual performance across varying syllable lengths (assessed by percent of phonemes correct PPC) in English and Spanish was described using descriptive statistics. Descriptive statistics demonstrated bilingual performance on story retell (NDW), sentence repetition (raw score) and indicated current input/output in English and Spanish. Relationships between varying syllable lengths across English and Spanish were evaluated using Pearson correlation method. Pearson correlation method also evaluated the relationship between ENWR and SNWR performance and language recall measures across both English and Spanish.

3.2 Current Language Usage

Analysis of bilingual adults' current language use indicated that bilingual individuals within the study used English at a higher rate than Spanish. The average current usage was English= 62% and Spanish= 38%. The language questionnaire demonstrated that nine participants' (22.5% of sample) daily usage in Spanish was less than 20% and were classified as English dominant bilinguals. Analysis was conducted to ensure that the nine participant's language competence was sufficient to adequately complete the recall tasks for the study. Prior

information indicated that participants rated their own language ability on the language questionnaire through a series of questions. Participants rated themselves proficient in speaking, listening and reading and writing in both English and Spanish. Participants' average rating ability in Spanish=3.7 (1-Nonfluent speaker, 5-fluent speaker) and in English = 4.6. The nine participants demonstrated a higher rated language ability in English than in Spanish. Despite the language rated ability being lower in Spanish the analysis revealed that the participants' language skills in Spanish were sufficiently competent to complete the recall measures used within the study.

3.3 Descriptive Results

Table 2.1 displays the mean PPC scores in the tested languages. As syllable length complexity increased from one syllables to four syllables on ENWR, repetition accuracy decreased in English nonwords. Bilingual adults maintained a more consistent performance on SNWR, by maintaining high accuracy on two to four syllable lengths before accuracy decreasing at five syllable lengths. The means for English nonwords lengths were as followed: one syllable= 67.7, two-syllables= 77.9, three-syllables= 72.3 and four syllables= 66.0. The means for Spanish nonwords lengths were two-syllables= 82.6, three-syllables= 80.1, four syllables=78.9, and five syllables= 49.2.

Overall, bilingual adults demonstrated slightly higher accuracy in the SNWR with EPPC total (mean= 71.0), and SPPC total (mean = 72.7). Descriptive results for other measures are found in Table 2.3. Adults scored slightly higher in Spanish for NDW than in English (SNDW mean = 87.90; ENDW mean = 85.28). The sentence repetition scores in Spanish were slightly

higher (SSR mean = 70.80; ESR mean = 69.65). English input/output was higher (mean = .62) than Spanish input/output (mean = .38).

3.4 First Research Question: NWR Performance

3.4.1 Repeated Measures Analysis. The first research question assessed bilingual adult performance patterns on English and Spanish NWR tasks. Repeated-measures ANOVA revealed a statistically significant effect for language ($F = 47.347$, $p = <.01$, S>E); indicating that bilingual adult's nonword repetition accuracy was influenced by the language tested Bilingual adults demonstrated significantly higher accuracy on Spanish nonwords compared to English nonwords. There was also a significant effect for Syllable Length ($F = 16.637$, $p = <.01$), demonstrated by decreased nonword repetition accuracy as syllable length increased. Results demonstrated a significant interaction effect of Language by Syllable Length ($F = 5.901$, $p=.004$), indicating that bilingual adult nonword repetition performance varied as syllable lengths increased in complexity across English and Spanish. Post hoc Bonferroni method analysis was completed to determine where ENWR and SNWR performance differed across varying syllable lengths (two, three, and four syllables). Results revealed a significant difference between three-syllable and four-syllable lengths across both English (p = .01) and Spanish (p =.01). However, there were no significant differences between two and three syllables and two and four syllables (see Figure 1.1).

3.4.2 NWR length correlations. A Pearson correlation analysis was conducted to determine the relationships between syllable lengths in English and Spanish NWR tasks as indicated by (PPC). English NWR results demonstrated that EPPC 1 was strongly correlated to EPPC 3 ($r=.664$, $p = .019$), and EPPC 4 ($r = .769$, $p = <.01$). EPPC 1 was also related to EPPC 2

(r=.370, $p = 0.019$) but relationship was less significant. EPPC1 was strongly correlated with SPPC 3 (r=.433, $p = .005$), SPPC 4 ($r = .450$, $p = .004$), SPPC 5 ($r = .498$, $p = <.01$), and SPPC total (r=.495, $p = <.01$).

Results revealed that EPPC 2 less significantly related to EPPC 3 ($r = .375$, $p = 0.017$) and SPPC total (r= .337, p= 0.033), but highly related to EPPC total ($r = .582$, $p = .0$). There was a strong correlation between EPPC 3 and EPPC 4 (r = .728, $p = .0$) and EPPC total ($r = .869$, $p < .01$) that was significant. EPPC 3 was also highly related to SPPC 3 ($r = .456$, $p = 0.003$), SPPC 4 ($r = .497$, $p = 0.001$), and SPPC total ($r = .634$, $p < 0.1$). EPPC 3 was correlated to SPPC 5 ($r = .382$, $p = .015$) but the relationship was statistically less significant. A strong relationship was demonstrated between EPPC 4 and EPPC total ($r = .859$, $p < 0.1$), SPPC 3 ($r = .507$, $p = 0.001$), SPPC 4 ($r = .562$, $p < 0.1$), SPPC 5 ($r = .546$, $p < 0.1$), and SPPC total ($r = .634$, $p < 0.1$) that was statistically significant.

Results on Spanish NWR revealed a high correlation between SPPC 3 and SPPC 4 (r=.525, $p = .001$) and SPPC total ($r = .803$, $p < 0.1$) that was significant. SPPC 3 was also related to SPPC 5 ($r = .399$, $p = 0.011$) but this relationship was statistically less significant. There was a relationship found between SPPC 4 and SPPC 5 ($r = .433$, $p = 0.05$) and SPPC total ($r = .823$, $p < 0.1$). Results also demonstrated a high correlation between SPPC 5 and SPPC total that was significant ($r = .671$, $p < 0.1$). Overall results indicated that if bilingual adults were accurate at repeating nonwords in one language then they were likely to accurately repeat nonwords in the other language.

3.5 Second research question: NWR and recall tasks correlations.

The second research question assessed the relationship between NWR tasks and language recall measures across English and Spanish. Table 2.3 demonstrates that bilingual adults' overall performance was higher on Spanish NWR compared to English NWR (SPPC total mean = 72.7, EPPC total mean = 70.9). Results revealed a higher semantic performance on Spanish RT than English RT (SNDW mean= 87.90, ENDW mean = 85.28) among bilingual adults. Comparable results were demonstrated on sentence repetition tasks across both languages. Bilingual adults demonstrated slightly higher repetition in Spanish than in English (SSR mean = 70.80; ESR mean = 69.65), yet scores did not reach level of significance. Results demonstrated that English input/output was higher (mean = .62) than Spanish input/output (mean = .38) among bilingual adults.

Pearson correlation analysis was conducted to determine the relationship between phonological working memory assessed by NWR and language recall measures sentence repetition and story retell (assessed by raw score and NDW) within and across English and Spanish. Correlation results were demonstrated on Table 3.1. Results demonstrated a high correlation between ENWR and SNWR that was statistically significant (r =.628, $p < .01$); indicating that bilingual adults accurately repeated nonwords in both languages. English NDW and Spanish NDW were also strongly correlated ($r = - .661$, $p < .01$); indicating that lexical diversity was equally preserved across both languages. Results revealed that Spanish sentence repetition was highly correlated with Spanish input/output ($r = -.581$, $p< .01$). Data demonstrated a significant negative correlation between English input/output and Spanish input/output ($r= 1.000$, $p < .01$); indicating that if bilingual adult's English usage increased than their Spanish usage would inadvertently decrease.

Table 1.2 Summary of bilingual participant's demographic history

Characteristics	Number	Percentage of sample
Gender		
Female	25	62.50%
Male	15	37.50%
Ethnicity		
Mexican	27	67.50%
Mexican-American	6	15%
Latino/a	7	17.50%
Hispanic	0	0%
Spanish	0	0%
Chicano	0	0%
Current Education Level		
High School or equivalent	5	12.50%
Some College but no degree	15	37.50%
Associate degree	10	25%
Bachelor degree	9	22.50%
Graduate	1	2.50%
Total	40	100%

Table 1.3 Summary of gender and age differences among bilingual participants

Age Range	Women (n=25)		Men (n=15)	
18-20	12%	(n=3)	13.3%	(n=2)
21-29	44%	(n=11)	46.6%	(n=7)
30-39	20%	(n=5)	20%	(n=3)
40-49	16%	(n=4)	13.3%	(n=2)
50-59	8%	(n=2)	6.6%	(n=1)
60 or older	0%	(n=0)	0%	(n=0)
Total	100%		100%	

Table 2.1 Mean percent of phonemes correct (PPC) and standard deviations by syllables length across English and Spanish for bilingual adults.

	English		Spanish	
	Mean	SD	Mean	SD
NWR Syllable Length				
one syllable	67.7	12.5		
two syllables	77.9	9.5	82.6	9.6
three syllables	72.3	11.5	80.1	10.9
four syllables	66	10.5	78.9	12.6
five syllables			49.2	11
Total	71	8.9	72.7	8.1

Note: SD, Standard deviation.

Table 2.2 Pearson correlations among nonword repetition (NWR) syllable lengths across languages English and Spanish for bilingual adults.

	EPPC1	EPPC 2	EPPC 3	EPPC 4	EPPC total	SPPC 2	SPPC 3	SPPC 4	SPPC 5	SPPC total
EPPC 1	1.0	.370*	.664**	.769**	.890**	.019	.433**	.450**	.498**	.495**
EPPC 2		1.0	.375*	.226	.582**	.155	.297	.308	.212	.337**
EPPC 3			1.0	.728**	.869**	.260	.456**	.497**	.382*	.553**
EPPC 4				1.0	.859**	.203	.507**	.562**	.546**	.634**
EPPC total					1.0	.191	.572**	.565**	.515**	.628**
SPPC 2						1.0	.430**	.373*	0.1	.618**
SPPC 3							1.0	.525**	.399*	.803**
SPPC 4								1.0	.433**	.823**
SPPC 5									1.0	.671**
SPPC total										1.0

*Significant at p<.05. **Significant at p<.01

Table 2.3 Bilingual participants' means and standard deviations for NWR and language recall measures in English and Spanish. Current usage for English and Spanish among bilingual participants is indicated.

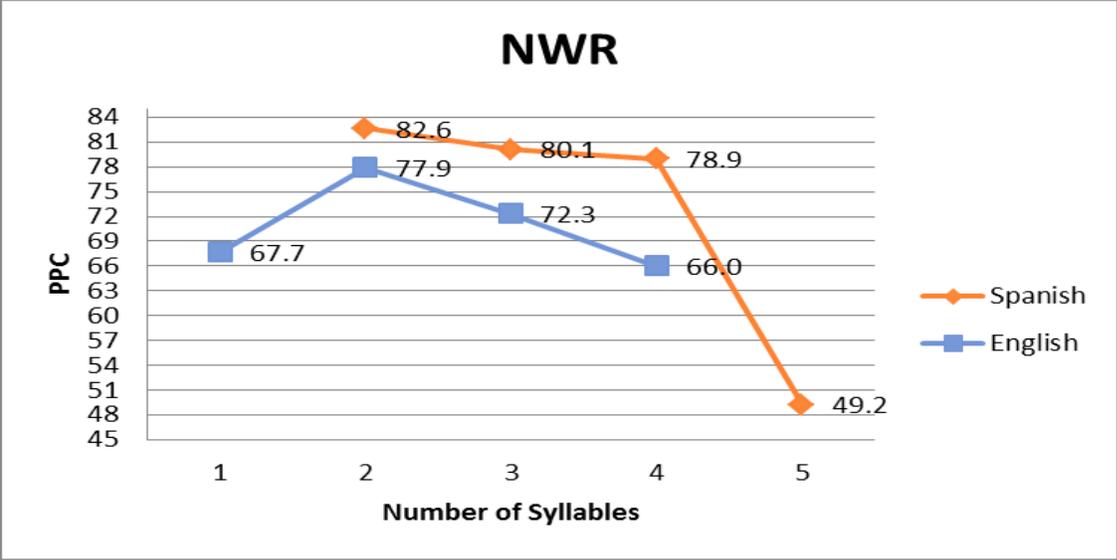|	English		Spanish	
	Mean	SD	Mean	SD
Current usage	61.9%	0.2	38.0%	0.2
PPC total	70.9%	8.9	72.7%	8.1
SR raw score	69.6	14.1	70.8	20.5
NDW	85.2	30.2	87.9	29.6

Note: NDW, number of different words; SR, sentence recall.

Table 3.1 Pearson correlations among NWR performance and language recall measures in English and Spanish for bilingual participants.

	EPPC Total	SPPC Total	ENDW	SNDW	ESR	SSR	SP usage
EPPC Total	1.0	0.628**	0.058	-0.126	0.276	-0.138	-0.155
SPPC Total		1.0	0.258	0.164	0.02	0.131	-0.044
ENDW			1.0	.661**	0.142	-0.166	-0.071
SNDW				1.0	-0.13	0.249	0.152
ESR					1.0	-0.308	-0.282
SSR						1.0	0.581**
SP usage							-1.0**

**Significant at $p<.01$

Figure 1.1 English and Spanish NWR performance (PPC scores) across varying syllable lengths for bilingual adults.

CHAPTER 4: DISCUSSION

The present study evaluated the performance patterns on Spanish and English NWR tasks among bilingual adults with varying languages experiences. Findings from the study will further aid the interpretation of NWR performance patterns demonstrated by bilingual children. This study did not aim to determine the underlying cause of NWR performance patterns demonstrated by English and Spanish bilingual adults, but described the performance patterns exhibited. Information found within the study will contribute to limited body of knowledge, indicating how NWR performance may change over time among bilingual children. The study aims to discuss how factors such as current language experience and long-term knowledge may contribute to bilingual adult's accurate nonword repetition across two languages.

4.1 Evaluating cross-linguistic NWR performance patterns

First, the study evaluated bilingual adult's performance across an English and Spanish NWR task. Results demonstrated that bilingual adult's overall performance on English and Spanish NWR was comparable and performance decreased as syllable lengths increased in both languages. Strong correlations between NWR tasks demonstrated that bilingual adults were able to accurately repeat nonwords in either language, despite structural differences found between English and Spanish. This supports that bilingual's adult's long-term knowledge and experiences in both English and Spanish may facilitate recall performance. These particular bilingual adults were experienced in both English and Spanish and may not have depended on phonological working memory to activate phonological representations within phonological storage; to facilitate recall of nonwords in English and Spanish, as exhibited among children and adults learning a second or foreign language (Cheung, 1996; Masoura & Gathercole, 2005).

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4.1.1 Analyzing cross-linguistic syllable length effects. Findings revealed a significant

effect for language; revealing higher accuracy on Spanish NWR at three to four syllable lengths

but not for two syllable nonwords, suggesting that bilingual adults' accuracy varied across

English and Spanish syllable length. As complexity of syllables increased from two syllables to

four syllables, repetition accuracy decreased in English; which is similar to performance patterns

found in bilingual English and Spanish children (Dollaghan & Campbell, 1998; Girbau

&Schwartz, 2007; Summers et *al.*, 2010). Word length effects on nonword repetition

performance indicated that bilingual adults maintained high accurate repetition of two, three, and

four syllables on Spanish NWR, until reaching five syllables and decreased from 78.9% at four

syllables to 49.2% at five syllables. Results support prior evidence suggesting that with age

accuracy of nonword repetition increases in monolingual Spanish-speaking and bilingual

typically developing children and this trend appears to continue in adulthood (Ebert et *al.*, 2008;

Girbau & Schwartz, 2007).   Also, bilingual adults demonstrated a more stable performance

across Spanish nonwords; indicating that accurate recall was facilitated by long-term knowledge

to a greater extent in their familiar language (Thorn & Gathercole, 2001). However, decreased

accuracy at five syllable length may indicate the influence of prior languages experience which

was not evaluated within the study.

4.2 Sources of NWR performance patterns

4.2.1 Influence of long-term knowledge on NWR performance. The study revealed an

important finding that NWR performance was not correlated to bilingual adults' current language

use in English or Spanish. Results indicated a negative perfect correlation between English

input/output and Spanish input/output; which may indicate that as bilingual adult's usage

increases in English than their Spanish usage will decrease. Although English and Spanish

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bilingual adults within this study demonstrated higher usage in English than in Spanish, it did not affect their performance on both NWR tasks. Results indicated that English and Spanish bilingual adults do not depend on current usage of English or Spanish to facilitate accurate repetition of nonwords of varying syllable lengths; but may rely on prior long-term knowledge to facilitate accurate repetition. Study results support findings by Thorn & Gathercole (2001) which suggest that English and Spanish bilingual adults' higher recall performance in SNWR may be supported by long-term language memory; which assisted nonwords recall performance in their more familiar language.

Furthermore, the effects of long-term knowledge and length of experiences in languages demonstrated among bilingual adults within this study replicate prior findings from Summers, Bohman, Gilliam, & Bedore (2010). This study demonstrated similar NWR performance among children ranging ages of 4;6-6;5, who performed higher in Spanish nonwords than in English nonwords. Although, at the time of the study these children demonstrated higher usage in Spanish than in English; which indicated that early language experiences in Spanish are necessary in order to accurately repeat nonwords that are comprised of multisyllabic CV combinations. Prior language experiences may be necessary to develop knowledge of sound combinations and facilitate recall of Spanish nonwords, in particular five syllables length. Although, this study did not complete an analysis on the influence of prior language experiences on English and Spanish NWR, for the majority of bilingual adults, Spanish was their native language and English was acquired as their second language. Further analysis is required to determine if age of first exposure to English and prior language experiences in English and Spanish are related to bilingual adults' nonword repetition performance.

4.2.2 NWR performance across English and Spanish. Correlational analysis revealed that overall English nonwords were statistically significantly related to Spanish nonwords by syllable length. It was interesting to note that English three syllables were strongly related to English four-syllable nonword. Also, English three-syllable to four syllable nonwords were highly related to Spanish nonwords at three to five- syllable lengths. This may indicate that English three and four syllables are a good indicator of bilingual adult's performance in Spanish. These findings correspond to previous studies (Dollaghan and Campbell; 1999; Kohnert, K., Windsor, & Dongsun, 2006) which demonstrated that nonwords longer in syllable length, such as four syllables provided a better depiction of performance cross-linguistically in English and Spanish, and between bilinguals and children with SLI.

Therefore, based on this study and prior findings, it is expected that sequential English-Spanish bilingual children could demonstrate similar results on English and Spanish NWR tasks as they develop. The majority of bilingual adults within the study acquired Spanish as their native language and English as their second language. Even though bilingual participants demonstrated language competence in both English and Spanish, increased exposure in their native language may have anchored phonological representations further into their long-term storage; which facilitated higher accuracy of Spanish nonwords. Present findings support evidence demonstrated by Thorn and Gathercole (1999) which showed that sequential bilingual children with dispersed language knowledge demonstrate increased stable phonological representations in their long-term storage of their dominant language that facilitates high accuracy of nonwords in their dominant language.

4.3 Evaluating phonological working memory influence on other language abilities

Secondly, the study aimed to evaluate the relationship between phonological short-term memory and other language recall measures. Results indicated that English and Spanish NWR were not statistically significantly related with other language recall measures; which may indicate that children may be more dependent on phonological working memory to facilitate early acquisition of vocabulary and morphosyntax skill, but after sufficient lexical and syntactic long-term knowledge is attained; retrieval of items is no longer facilitated by working memory. Present findings demonstrated that English and Spanish bilingual adults syntactic and semantic performance is not facilitated by phonological working memory as demonstrated by younger and school-age children (Girbau & Schwartz 2007, 2008; French & O' Brien, 2008; Winsor et *al.*, 2010). These findings may indicate that accurately recalling semantic and syntactic structures in English and Spanish may not be dependent on phonological short-term working memory, but on bilingual adults' long-term knowledge.

Bilingual adult's performance on sentence repetition and story retell is supported by their lexical, semantic, and syntactic long term knowledge to accurately recall items in each language. Another possibility is that successful performance on a sentence repetition task and story retell are more dependent on bilinguals' prior language knowledge to support accurate recall. Bilingual adults' lexical knowledge may facilitate retrieval of words that resemble familiar words even if the participants are not proficient in that language. Phonological short-term memory may be required for other tasks that require learning and recalling of new and/or unfamiliar words or sound combinations; but not on words or sentences that resemble familiar vocabulary or syntactic forms.

Findings revealed a statistically significant relationship across languages among the other language recall tasks but not across tasks. Spanish SR and Spanish input-output were strongly correlated as shown in the results; indicating that sequential English and Spanish bilingual adults require current usage in Spanish to facilitate recall of syntactic structures stored within long-term knowledge. This is expected as Spanish and English have distinct grammatical and morphosyntax structures; which may require current usage of the language to facilitate retrieval of syntactic knowledge in crystallized memory. This would explain why English was not correlated with any of the SR tasks. Bilingual adults within this study used English more on a daily basis compared to Spanish, which supported recall of syntactic structures anchored within in long-term memory. Another hypothesis is that bilingual adults with limited syntactical knowledge in Spanish require current usage in the language, to establish syntactical representations of grammatical forms not previously exposed and facilitate recall of sentences. This is supported by English SR and English language usage not being statistically significant related. Bilingual adults demonstrated a higher input-output in English, which may facilitate retrieval of syntactic form in syntactical knowledge, due to having more experience with syntactic forms.

The statistically significant strong correlation found between EPPC and SPPC suggests that despite phonotactic constraints and structural difference between both languages, the more accurate a bilingual adult is at repeating nonwords in one language, than the more accurate they'll repeat nonwords in their other language. NWR uses similar underlying mechanisms across languages in a way that other language tasks do not. While variations in language proficiency can account for performances on language tasks such as sentence repetition and number of different words, it has less of an influence on NWR performance in adults.

Furthermore, findings revealed a high correlation between English NDW and Spanish NDW, indicating that more lexically diverse their retell was in one language, than the more lexical diverse bilingual adults were in the other retell in the second language. This may indicate that bilingual adults with varying language experiences can accurately recall similar number of different words in both English and Spanish, as they get older or attain sufficient semantic knowledge in each language. This may signify that bilingual adults must attain a certain level of proficiency in each language to develop their lexical knowledge and semantic knowledge and facilitate accurate recall of different words. It may be supposed that as bilingual children get older their performance on a story retell in one language, may be a good indicator of their semantic skills in their other language. Although further analysis is necessary to further explore these suppositions and determine what language factors if any may influence performance on a story retell in bilingual adults.

Results did not yield a significant relationship across language recall measures. Therefore it appears that language dependent tasks (sentence repetition and story retell) may first activate other cognitive resources, including semantic and lexical information before phonological working memory (Alloway, 2007). Other sources of language knowledge (semantic, syntactic, lexical) may be more significant for facilitating recall across tasks; and role of phonological working memory may be restricted solely to articulatory loop component among adults (Alloway, 2007). Phonological working memory may also be automatically activated during these tasks, but to a lesser extent as revealed by an insignificant relationship among tasks. Instead different language skills (semantic, lexical, and syntactic) within long-term memory are automatically activated to a greater extent to support performance on task-dependent demands. These particular tasks did not appear to significantly rely on interdependent language knowledge

to support its performance, but other tasks constructed distinctly may further do so. Bilingual adults within the current study were competent in both languages, which further decreased reliance of phonological working memory to support accurate recall across language tasks (Thorn & Gathercole, 2001).

4.4 Future research

The present study assessed bilingual adults NWR performance patterns and relationships between NWR and other language recall measures. Participants recruited for this study were English and Spanish bilingual adults with varying language experiences. Future studies should focus on recruiting monolingual Spanish-speaking and monolingual English-speaking adult participants to strengthen results found within this study, and determine if monolingual speaking adults in English or Spanish performance varies, compared to bilingual adults with languages knowledge dispersed across two languages. Also, this study evaluated the effects of current language experience on NWR and other language recall tasks. Future studies should focus on evaluating prior language experiences and their effects on bilingual adults NWR performance patterns and other language recall measures. This would yield information regarding what types of language experience among children affect NWR performance or other tasks that assess phonological working memory.

4.5 Limitations

The present study demonstrated limitations that may be addressed in future studies. One of the limitations of the study was failing to randomly recruit participants, which limits the generalization of the results demonstrated within this study. The aim of the study was to evaluate the NWR performance patterns and relationships between NWR and other language

recall measures among English and Spanish bilingual adults, which would have been impossible if recruitment was randomized. In order to achieve the overall goal of the study, participants with specific characteristics (bilingual, adults, etc.) need to be recruited. Another limitation of the study was that NWR performance was evaluated exclusively among English and Spanish bilingual adults, and not among monolingual Spanish-speaking and/or English-speaking adult participants; which would have strengthened the results of this study and provided further information as to what types of language experiences effect NWR performance.

Furthermore, it should be noted that bilingual adults provided qualitative information regarding their current language usage and rated language ability in both English and Spanish. Information provided may have not been an accurate representation of their language history due to participants' subjective bias. The study provided important normative data on English-Spanish bilingual adults, which could indicate how NWR performance patterns change over time in English-Spanish bilingual children. However, major implications may not be concluded due to the sample size of English-Spanish bilingual adults collected for the study.

4.6 Clinical relevance

This study indicated that NWR is a good indicator of phonological working memory skills among English and Spanish bilingual adults. Bilingual adults in this study demonstrated similar performance patterns observed among bilingual children, as shown in prior studies. Therefore, it can be assumed that as bilingual children with varying language experiences develop NWR performance across English and Spanish will remain comparable, with individual differences of accuracy at longer nonwords. This study demonstrated word length effect on NWR tasks, bilingual adults were more accurate at repeating longer syllable lengths. Therefore,

it can be assumed that as typical developing children gain language experiences and knowledge of English and Spanish their accuracy of longer nonwords will also increase.

This study adds important information concerning NWR performance patterns and current language experiences. The study demonstrated that current language use in bilingual adults does not affect NWR performance patterns and long-term knowledge may be a better indicator of bilingual children's performance on NWR or similar tasks that assess phonological working memory. This should be taken into account when evaluating bilingual children's language skills. It is recommended that both languages should be evaluated to account for varying languages experiences and language dominance shift observed among bilingual children, which may affect performance on NWR tasks.

Furthermore, the study added information regarding relationships between NWR and language recall tasks. The study demonstrated that strong correlation between NWR and lexical and morphosyntactic skills among children are not observed among bilingual adults. Therefore, phonological working memory may mediate early acquisition and recalling of language structures due to limited long-term knowledge. After sufficient long-term knowledge is acquired in both languages then performance is mediated by long-term storage and not working memory.

CONCLUSION

This study of Nonword repetition task performance among bilingual English and Spanish sequential adults provides important information to current research concerning the role of phonological short-term working memory in relationship to language recall measures and expected performance patterns in English and Spanish NWR. Based on this study current usage of English and Spanish does not influence bilingual adults' phonological short-term working memory as observed in their NWR performance patterns in each language. English and Spanish NWR performance patterns may be influenced by their knowledge and proficiency in each language. Based on the study, phonological working memory does not play a significant role in facilitating recall of syntactic and semantic structures during story retells and sentence repetition tasks. Bilingual adult performance on story retells and sentence repetition tasks may be facilitated by long-term knowledge of each language. Current usage of each language may be required to facilitate recall of stored syntactic structures during sentence recalling. Future studies should focus on analyzing prior language experiences and how that may influence nonword repetition performance and other language measures in English and Spanish. This may clarify assumptions regarding specific language experiences that may affect bilingual children's and children with SLI performance on NWR and language recall tasks. This assists us in providing information as what is expected as a bilingual child develop.

REFERENCES

Alloway, T.P.(2007). Investigating the roles of phonological and semantic memory in sentence recall. Memory, 15(6), 605-615.

Archibald, L. M. D., & Gathercole, S. E. (2007). Nonword repetition in specific language impairment: more than a phonological short-term memory deficit. *Psychonomic Bulletin & Review*, *14*(5), 919-924.

Baddeley, A. (2003). Working memory and language: An overview. *Journal of Communication Disorders*, *36*, 189-208. Retrieved from www.sciencedirect.com

Calderon, J. (2003). *Working memory in Spanish-English bilinguals with language impairment*. Unpublished doctoral dissertation, University of California, San Diego and San Diego State University.

Cheung, H. (1996). Nonword span as a unique predictor of second-language vocabulary learning. *Developmental Psychology, 32*(5), 867-873. Retrieved from www.Ebsco.com

Dale, P., Price, T., Bishop, D., & Plomin, R. (2003). Outcomes of early language delay: I. Predicting persistent and transcient language difficulties at 3 and 4 years. *Journal of Speech, Language, and Hearing Research, 46*, 544-560.

Deevy, P., Weil, L.W., Leonard, L.B., & Goffman, L. (2010). Extending use of NRT to preschool-age children with and without specific language impairment. *Language, Speech and Hearing Services in Schools*, *41*, 277-288.

Dispaldo, M., Deevy, P., Gianmarco, A., & Leonard, L.B. (2011). A cross-linguistic study of real Word and non-word repetition as predictors of gramatical competence in children with typical language development. *International Journal of Language and Communication Disorders, 46(5)*, 564-578.

Dollaghan, C., & Campell, T. F. (1998). Nonword repetition and child language impairment. *Journal of Speech, Language, and Hearing Research*, *41*, 1136-1146. Retrieved from http://jslhr.asha.org/cgi/content/abstract/41/5/1136

Ebert, K.D., Kalanek, J., Cordero, K.N., & Kohnert, K. (2008). Spanish Nonword repetition stimuli development and preliminary results. *Communication Disorders Quarterly, 29*(2), 67-74.

Ellis, N.C., & Sinclair, S.G. (1996). Working memory in the acquisition of vocabulary and syntax: Putting language in good order. *The Quarterly Journal of Experiemental Psychology, 49A(1)*, 234-250.

Ellis, N.C, Weismer, S., Tomblin, J. Zhang, X., Buckwalter, P., Chynoweth, J., & Jones, M. (2000). Nonword repetition performance in school-age children with and without language impairments. *Journal of Speech Language, and Hearing Research*, *43*, 865-878.

Estes, K. G., Evans, J.L., & Else-Quest, N.M. (2007). Differences in the nonwords repetition performance of children with and without specific language impairment: A meta-analysis. *Journal of Speech Language, and Hearing Research, 50*, 177-195.

French, L.M., & O'Brien, I. (2008). Phonological memory deficits in language disordered children: Is there a causal connection? *Journal of Memory and Language, 29*, 336-360.

Gathercole, S.E. (1999). Cognitive approaches to the development of short-term memory. *Trends in Cognitive Science*, *3*, 410–418.

Gathercole, S.E., & Adams, A.M. (1994) Children's phonological working memory: Contributions of long-term knowledge and rehearsal. *Journal of Memory and Language, 33*, 672-688.

Gathercole, S. E., Hitch, G. J., Service, E., & Martin, A. J. (1997). Phonological short-tem memory and new word learning in children. *Developmental Psychology*, *33*(6), 966-979. Retrieved from http://www.Ebsco.com

Gathercole, S. E., Willis, C. S & Emslie, H. (1992). Phonological memory and vocabulary development during the early: A longitudinal study. *Developmental Psychology*, *28*, 887-898.

Genesee, F. (1989). Bilingual Language Development of ELLs. Goldstein, B.A. (2nd Ed.), *Bilingual language development & disorders in Spanish-English speakers* (3-30). Baltimore, MD: Brookes.

Genesee, F, Nicoladis, E., & Paradis, J. (1995). *Bilingual Language Development of ELLs.* Goldstein, B.A. (2nd Ed.)*, Bilingual language development & disorders in Spanish-English speakers (3-30). Baltimore, MD: Brookes.*

Girbau, D., & Schwartz, R. G. (2008). Phonological working memory in Spanish-English bilingual children with and without specific language impairment. *Journal of Communication Disorders*, *41*, 124-145.

Goldstein, B.A. (2012). *Bilingual language development & disorders in Spanish-English speakers* (2nd ed.). Baltimore, MD: Brookes.

Goldstein, B., Fabiano, L. & Washington, P. (2005). Phonological skills in predominantly English, predominantly Spanish, and Spanish-English bilingual children. *Language, Speech, Hearing Services in Schools, 36,* 201-218.

Goldstein, B., & Polluck, K. (2000). Vowel errors in Spanish-speaking children with phonological disorders: A retrospective, comparative study. *Clinical Linguistics and Phonetics, 14,* 217-234.

Gorman, B.K. Relationships between vocabulary size, working memory, and phonological awareness in Spanish-speaking English language learners. *American Journal of Speech-Language Pathology, 21*, 109-123.

Gutierrez-Clellen, V. F., & Simon-Cerejido, G. (2010). Using nonword repetition tasks for the identification of language impairment in Spanish-English speaking children: Does the language of assessment matter?. *Learning Disabilities Research & Practice*, *25*(1), 48-58.

Hedge, M. N. (3rd edition). (2003). *Clinical Research in Communicative Disorders: Principles and Strategies*. Austin, TX: PRO-ED.

Jimenez, B.C. (1987). Acquisition of Spanish consonants in children aged 3-5 years, 7 months. *Language, Speech and Hearing Services in Schools, 18*, 357-363.

Kohnert, K., Windsor, J., & Dongsun, Y. (2006). Do language-based processing tasks separate children with language impairment from typical bilinguals. *Learning Disabilities Research & Practice*, *21*(1), 19-29.

Kohnert, K., Windsor, J., & Ebert, K. D. (2008). Primary or "specific" language impairment and children learning a second language. *Brain & Language*, *109*, 101-111. Retrieved from www.sciencedirect.com

Martin, R.C. (1993).Short-term memory and sentence processing: Evidence from neuropsychology. *Memory and Cognition*, *21*, 76–183.

Martin, R.C., Shelton, J.R., & Yaffee, L.S. (1994).Language processing and working memory: Neuropsychological evidence for separate phonological and semantic capacities. *Journal of Memory and Language*, *33*, 83–111.

Marton, K., & Schwartz, R. G. (2003). Working memory capacity and language processes in children with specific language impairment. *Journal of Speech, Language, and Hearing Research*, *46*, 1138-1153.

Marton, K.,Schwartz, R.G., Farkas, L., & Katsnelson, V. (2007). Effect of sentence length and complexity on working memory performance in Hungarian children with specific language impairment (SLI): A cross-linguistic comparison. *International Journal of Language & Communication Disorders*, *41 (6),* 653-673.

Masoura, E. V., & Gathercole, S. E. (1999), Phonological short-term memory and foreign language learning. *International Journal of Psychology*, *34*, 383-388.

Masoura, E. V., & Gathercole, S. E. (2005), Contrasting contributions of phonological short-term memory and long-term knowledge to vocabulary learning in a foreign language. *Journal of Memory, Knowledge, and Foreign Vocabulary, 13 (3/4),* 422-429.

Metsala, J.L. (1999). Young children's phonological awareness and nonwords repetition as a function of vocabulary development. *Journal of Educational Psychology, 91*(1), 3-19. Retrieved from www.Ebsco.com

Miller, J. & Iglesias. (2010). Systematic Analysis of Language Transcripts (SALT) Research Version 2010 [Computer Software], SALT Software, LLC.

Montgomery, J.W. (1995) Sentence comprehension in children with specific language impairment: The role of phonological working memory. *Journal of Speech and Hearing Research*, *38*, 187-199. Retrieved from www.Ebso.com

Munson, B., Kurtz, B. A., & Windsor, J. (2005). The influence of vocabulary size, phonotactic probability, and wordlikeness on nonword repetitions of children with and without specific langauge impairment. *Journal of Speech, Language, and Hearing Research*, *48*, 1033-1047.

Potter, M. C., & Lombardi, L. (1990). Regeneration in the short-term recall of sentences. *Journal of Memory and Language*, *29*, 633-654. Retrieved from www.sciencedirect.com

Rescorla, L., & Lee, E. (2001). Language impairment in young children. In T. Layton, E. Crais, and L. Watson (Eds.). *Handbook of early language impairment in children: Nature* (1-55). Albany, New York: Delmar Publishers.

Schweppe, J., Rummer, R., Bormann, T., & Martin, R.C. (2011). Semantic and phonological information in sentence recall: Converging psycholinguistic and neuropsychological evidence. *Cognitive Neurolpsychology, 28*(8), 521-545.

Summers, C., Bedore, L., Peña, E., & Gilliam, R. (2009). *Memory skills in bilingual children: Nonwords and narratives*. Paper presented at the Symposium on Research in Child Language Disorders, Madison, WI.

Summers, C., Bohman, T. M., Gilliam, R. B., Peña, E. D., & Bedore, L. M. (2010). Bilingual performance on nonword repetition in Spanish and English. *International Journal of Language & Communication Disorders*, 1-14. Retrieved from www.informahealthcare.com

Thorn, A. S. C., & Gathercole, S. E. (1999). Language-specific knowledge and short-term memory in bilingual and non-bilingual children. *The Quarterly Journal of Experimental Psychology*, *52 A*(2), 303-324.

Thorn, A. S. C., & Gathercole, S. E. (2001). Language differences in verbal short-term memory do not exclusively originate in the process of subvocal rehearsal. *Psychonomic Bulletin & Review, 8*(2), 357-364.

Vitevitch, M. S., & Stamer, M. K. (2006). The curious case of competition in Spanish speech production. *Language and Cognitive Processes, 21,* 760-77.

Weismer, S.E., Tomblin, J.B., Zhang, X., Buckwalter, P., Chynoweth, J. G., & Jones, M. (2000). Nonword repetition performance in school-age children with and without language impairment. *Journal of Speech, Language, and Hearing Research, 43*, 865-878.

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During her time in the Speech Language Pathology program she worked at the bilingual language lab and assisted in data collection and analysis. Through her experience with research, she presented a poster *Bilingual Nonword Repetition performance in English and Spanish* at the American Speech Language Hearing Association (November 2012) and was a co-author on the poster *Relationships in Recall Measures in English and Spanish Bilingual Adults.* Also, she was an author for *The Effect of Language Experiences on Nonword Repetition Tasks in English and Spanish,* which was presented at the Texas Speech Language Hearing Association (March 2013).

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