Phonological Memory Associations Of Language Impairment In Bilingual Children

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PHONOLOGICAL MEMORY ASSOCIATIONS OF LANGUAGE IMPAIRMENT IN BILINGUAL CHILDREN

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A mi mamá por siempre creer en mi y darme su apoyo. A mi esposo por su amor y comprensión en las largas horas de trabajo. Los amo mucho.
Abstract

Knowledge-based assessments of language impairments have been found to contain bias for assessing performance in bilingual children from diverse cultural backgrounds. As an alternative, measures related to performance of phonological working memory are becoming more popular for bilingual children. The purpose of the current study was to investigate how bilingual children with language impairment (BILI) would perform on nonword repetition and sentence repetition when compared to typically developing peers (BITD). Also, the current study investigated the extent to which the nonword repetition task and sentence repetition task were associated with each other in bilingual (English-Spanish) children. Results demonstrated that typically developing children performed better than children with language impairment in all tasks in both languages. Also, significant correlations within Spanish language were found for all participants, but not for the groups separately. There was an indication that experience with the language influenced the performance on the tasks. There were no significant correlations within English which was not as established in the participants as Spanish.
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Introduction

Language assessment can be difficult in the bilingual population as two languages are involved. One reason is that many standardized measures are biased and produce a misrepresentation of children’s true language abilities (Silverman & Restrepo, 2001; Dollaghan & Campbell, 1998; Campbell, Dollaghan, Needleman and Janoski, 1997; Van der Linden, 2002). Language measures that rely on knowledge-based concepts, such as standardized tests in English or Spanish, assess children’s experience with these concepts (e.g. exposure to English or Spanish) yet fail to represent their true language ability (Gutierrez-Clellen & Simon-Cereijido, 2010). In order to accurately determine the language abilities of bilingual children, who are often culturally diverse, clinicians and researchers need to identify the possible sources of measurement bias. Peña, Summers, and Resendiz (2007), suggested that the best diagnostic alternative, to biased measures, is a comprehensive language assessment that includes parent interviews, formal and informal tests of language, and tests of nonlinguistic performance. They concluded that the everyday language needs of children as well as their ability to learn linguistic rules should guide diagnostic and intervention decisions (Laing & Kahmi, 2003; Restrepo, 1998).

Recently researchers have investigated language processing measures as an alternative form of assessment for culturally and linguistically diverse populations (CLD) (Campbell et al., 1997; Dollaghan & Campbell, 2008; Ebert et al., 2008; Gutierrez-Clellen et al. 2004; Gutierrez-Clellen & Simon-Cereijido, 2010; Graf Estes Evans & Else-Quest, 2007; Kohnert, Windsor & Yim, 2006; Stokes, Wong, Fletcher and Leonard, 2006). For instance, one language processing measure, nonword repetition, has emerged as a measure related to phonological skills and vocabulary acquisition (Baddeley, Gathercole & Papagano, 1998). Another measure, sentence repetition is also a measure related to phonological skills, vocabulary development and receptive
grammar skills (Eadie, Fey, Douglas and Parsons, 2002; Stokes et al. 2006). These measures have been presented as alternatives to assessing children’s ability to process language, rather than knowledge-based concepts that can be biased against bilingual children with limited exposure to a specific language (e.g. English or Spanish).

The purpose of the current study was to investigate how nonword repetition and sentence repetition are associated with each other and how the performance of bilingual Hispanic children with language impairment compares to the performance of typically developing bilinguals. The current study contributes to clinicians’ and researchers’ ability to understand the cognitive mechanisms underlying language impairment, with minimal bias, in bilingual children. It is important to understand how these measures can provide a more specific account of the cause of language impairment and reduce the cultural bias. This study is unique in that it specifically investigates the performance of matched pairs of bilinguals with different language abilities for school aged children. Also it provides an account of how the two measures used could be related to each other to explain the underlying mechanisms of language impairment in bilinguals.
The Role of Working Memory in Language Processing

Baddeley and Hitch (1974) developed a model of a particular system within short term memory (STM) responsible for the completion of cognitive tasks that they termed working memory (WM). The components of this model are the central executive, the phonological loop, and the visuospatial sketchpad. The phonological loop is of particular interest for this paper because it is specialized for the processing of verbal information. As described by the model, the phonological loop is made up of a phonological store and a rehearsal process. In a review of studies about the relationship between word learning and the phonological loop, Baddeley et al., (1998) found evidence that the phonological loop mediates the acquisition of new words for normal adults, children, neuropsychological patients and special developmental populations. They suggested that there is evidence the phonological loop “mediates the long-term phonological learning involved in acquiring new vocabulary items” (p.158). Also, its significance is evident when the language units to be acquired contain highly unfamiliar sounds and structures. Using this account, Calderon (2003) asserted that language acquisition and processing relies on WM, as defined by Baddeley et al., (1998), ability to process units of language such as phonemes, syllables, words, and other related information. The performance of WM has also been related to foreign language learning ability (Service, 1992; Masoura & Gathercole, 2005)

In the case of bilinguals, the relationship between WM and language processing has been extensively investigated. For instance, Gutierrez-Clellen, Calderon and Ellis-Weismer (2004) compared the performance of proficient bilinguals and non-proficient bilinguals on language processing tasks requiring little vocabulary knowledge, the Competing Language Processing task (CLPT) and the Dual Processing Comprehension Task (DPCT). The CLPT was a task where a
group of sentences in English and Spanish were presented to the participants and at the end of the presentation they were asked to recall the last word of each sentence and to demonstrate comprehension by answering “true” or “false” to each of the sentences. In the DCPT two sentences (the competing condition) or one sentence (non-competing condition) were presented to the participants to carry out tasks manipulating tokens or toys. They found that in bilinguals, the performance of verbal working memory was not language specific but reflected a more general ability to process language. If this is the case, then the performance of bilingual children in language processing measures should not be influenced by the amount of knowledge specific to the language (e.g. English or Spanish). The performance in language processing measures should rather reflect a general ability to process, store and manipulate language related units. However, in studies of language processing tasks such as nonword repetition, other authors have found that the performance of the speaker is not completely independent of the knowledge of the sounds and structure of the language (Baddeley et al., 1998; Gutierrez-Clellen & Simon-Cereijido, 2010; Kohnert et al., 2006; Summers et al., 2010; Thorn & Gathercole, 1999;).

Given that in the construct of phonological memory, vocabulary knowledge is highly correlated with nonword repetition, (Baddeley et al., 1998), bilingual children provide a unique case for examining the performance of WM and how it influences the processing of both languages. If only knowledge-based tests (i.e. standardized tests) are used to evaluate bilingual children, it is inevitable that the exposure or lack of exposure to the specific language (e.g. English or Spanish) will bias the results. To address the need of unbiased measures to diagnose language impairment in bilingual children, the use of nonword repetition tasks has emerged. This language-based processing measure assesses the underlying cognitive mechanisms involved in language use, such as working memory, attention and perception (Kohnert, 2008), while
reducing cultural bias. The focus of this research is on nonword repetition tasks and their relationship to other language tasks such as sentence repetition that use a similar paradigm, of repeating language units, to potentially provide insights into the underlying mechanisms that affect language learning in bilinguals.

**Nonword Repetition (NWR)**

Campbell, Dollaghan, Needleman, and Janosky (1997), addressed the issue of reducing bias using diagnostic instruments that were processing dependent (i.e. nonword repetition) instead of using knowledge based measures (i.e. standardized language tests). Campbell et al. (1997) argued that using a knowledge dependent measure introduces bias against those individuals that have not been exposed to the amount or type of language that is being tested. In this sense, processing dependent measures have the potential to offer a measure that is less dependent on individual experience or familiarity with a language. Instead, these tasks offer a way to distinguish individuals with language impairment (LI) based on the cognitive mechanisms involved in language use. In another study, Dollaghan and Campbell (1998) used NWR to compare the performance of culturally and linguistically diverse children (CLD) with language impairment to that of typically developing children. They found that, in contrast to traditional language tests, nonword repetition tasks accurately distinguished between children with language impairment and children developing language normally in CLD populations. They concluded that nonword repetition tasks may have considerable clinical utility as a measure for language impairment.

In the latest meta-analysis on studies assessing the utility of nonword repetition tasks, Graf-Estes, Evans, and Else-Quest (2007) found that children with language impairment perform an average of 1.27 standard deviations below children without language impairment on nonword
repetition tasks. Further, they found that children with language impairments consistently repeat both short and long nonwords with less accuracy when compared to children without language impairment.

When assessing bilingual learners, the use of process-based measures versus knowledge-based measures provides an effective means for differentiating language differences from language disorders. Kohnert, Windsor, and Yim (2006) investigated the performance of linguistically diverse school-aged children on nonword repetition tasks using the nonword task developed by Dollaghan and Campbell (1998), which includes sounds and sound combinations common in English. Using this measure, the researchers compared the performance of monolingual-English speakers with language impairment, typically developing monolingual English speakers and typically developing bilingual English-Spanish speakers. They found that typically developing monolingual children outperformed bilingual children who in turn outperformed monolingual children with language impairment. In terms of nonword repetition, they found it can be used to properly rule-out language impairment in bilingual children. However, they noted that it does not have enough sensitivity to positively identify children with language impairment.

Summers et al. (2010) compared the performance of bilingual (Spanish-English) children on nonword repetition, tests of semantics, and tests of morphosyntax. They found that performance on nonword repetition was significantly correlated with cumulative language experience in both English and Spanish. The authors concluded that language exposure tends to increase abilities to repeat nonwords. Finally, the relationship between the performance of morphosyntax and nonword repetition tasks indicated that children rely on similar language-learning mechanisms to mediate these tasks. These results were similar to those of Stokes (2006)
who found that even though sentence repetition and nonword repetition tasks were both associated with vocabulary skills, only sentence repetition was associated with grammar skills. Ebert, Kalanek, Cordero, and Kohnert (2008) used 20 Spanish-like nonwords to test Spanish speaking typically developing children to see how well they recall the nonwords. They concluded that age and word length affected repetition accuracy in Spanish nonword repetition.

Thorn and Gathercole (1999) investigated the differences in performance for bilingual (English-French) and monolingual children in process-based dependent measures (i.e. nonword repetition and Digit Span). They found that for nonword repetition the performance of the individuals mirrored their familiarity with English and/or French. In this account they found that greater vocabulary knowledge was associated with higher levels of recall of words and nonwords in that language.

There have been different studies of nonword repetition in bilingual speakers with language impairment. For instance, Gutierrez-Clellen and Simon-Cereijido (2010) used English and Spanish nonwords with bilingual children with and without language impairment. The typically developing children had higher performance in the tasks for both languages. The specificity of the measures was better when both languages were considered together. An important finding of this study is that they determined that the performance of the children was mediated by the individual differences in language exposure and use.

Another important study, Windsor et al. (2010), compared the performance of bilingual and monolingual children using nonword repetition tasks in English from Dollaghan and Campbell (1998) and Spanish from Ebert et al. (2008). They included four groups of children in their study: typically developing bilinguals, language impaired bilinguals, typically developing English speaking monolinguals and English speaking monolinguals with language impairment.
Overall they found that when longer syllable lengths were introduced, the two typically
developing groups outperformed the children with language impairment for English nonword repetition. In addition, for Spanish nonword repetition, monolingual children with language impairment performed lower than bilingual children with language impairment and typically developing monolingual children. Significant correlations were found for the bilingual typically developing children between nonword repetitions across languages. However, no significant correlations were found for bilingual children with language impairment across languages. These differences in correlations suggested that typically developing bilinguals make more efficient use of their phonological working memory to advance their language skills when compared to bilingual children with language impairment.

Across the studies it has been seen that bilingual children with language impairment perform lower than their age matched typically developing peers in nonword repetition tasks (Girbau & Schwartz, 2003; Windsor et al. 2010) especially when longer syllable lengths are introduced.

**Sentence Repetition (SR)**

Sentence repetition has also been used to investigate the performance of children with language impairment. Sentence repetition tasks use a similar recall paradigm as nonword repetition tasks. In a study with children, Willis and Gathercole, (2001) found that sentence repetition was linked to phonological memory tasks such as nonword repetition. Accurate repetition was influenced by the length and number of words in the sentences and individual differences in memory skills, such that children with superior phonological short-term memory performed higher than those participants with lower phonological short-term memory (see also Bishop et al., 1996; Blake, Austin, Cannon, Lisus, & Vaughan, 1994; Conti-Ramsden et al., 2001; Kamhi & Catts, 1986). However, these tasks are more dependent on language knowledge...
and n has been associated with vocabulary and grammar skills. For instance Stokes et al. (2006) compared the measures of nonword repetition and sentence repetition among Cantonese children. The groups compared included children with specific language impairment, their age matched typically developing peers and younger peers matched on language ability with children with language impairment. They found that the sentence repetition task significantly discriminated children with language impairment from their age-matched typically developing peers but not from the younger language ability matched peers. Further they found that sentence repetition was related to receptive grammar scores (see also Eadie, Douglas and Parsons, 2002).

Sentence repetition has also been investigated as a marker of language impairment. Archibald & Joanise (2009) investigated the sensitivity and specificity of nonword repetition and sentence repetition to language and memory impairments in children 5-9 years old. The nonword repetition measures showed sensitivity for language impairment and working memory of 84% or greater, but specificity only around 50%. Sentence repetition on the contrary showed high sensitivity and specificity values around 80%. The researchers concluded that sentence repetition was a useful clinical marker of language impairment.
Assessment of Language Impairment in Bilingual Children

The current literature suggests that processing-based measures open the possibility to obtain an evaluation that is less biased against those that lack language specific knowledge (i.e. experience). Process-based measures offer the alternative to instead investigate the underlying cognitive mechanisms of language. These underlying cognitive linguistic mechanisms can be assessed in bilinguals using process-based measures such as nonword repetition and the sentence repetition tasks. These measures have been found to be less biased with children from diverse backgrounds in determining language impairment.

Understanding how these cognitive linguistic mechanisms interact in the bilingual children with language impairment can be a powerful piece of information for clinicians and researchers. Important gains could be made in the assessment and treatment of these children if more targeted interventions are implemented. Over identification of children with language differences is a topic that is not discussed here in detail, but it is certainly a topic of concern among practicing clinicians and researchers.

This study compared two groups, typically developing bilinguals (BITD) and bilinguals with language impairment (BILI). The purpose is to determine if the language processing measures used nonword repetition and sentence repetition, discriminate between the performance of bilingual children with language impairment and bilingual children that are typically developing. In addition, the relationship of these two measures with each other was investigated. There were several predictions for the current study. First, according the research of Windsor et al. (2010), a significant correlation between scores on nonword repetition and sentence repetition for BITD students would be expected within both languages due to the reliance of both tasks on phonological working memory. Also, in accordance with the findings of the same authors a
significant correlation across languages would be expected for all groups. Finally, typically
developing children will outperform children with language impairment.

This investigation aimed to answer the following questions:

1. Do bilingual Hispanic children with language impairment perform below
typically developing bilingual children on NWR and SR?

2. How are the two language-processing measures NWR and SR associated with
each other in Hispanic bilinguals?
Method

A total of 10 participants were recruited for the study, five bilingual typically developing (BITD) children and five bilingual children with language impairment (BILI). They were recruited from two school districts in the El Paso region and a local University clinic. The study received approval from the Internal Review Board (IRB) at the University of Texas at El Paso. All rights were protected and no participant was subject to coercion or undue influence. The project was carried out from the month of October 2011 until February 2012. All participants were tested during this time period.

Participants selected for the study were bilingual children (Spanish-English) from elementary school. They were included in the BILI group if they met two of the four following criteria.

- They fell one standard deviation or lower below the mean on the Receptive One Word Picture Vocabulary Test, bilingual edition (ROWPVT; Brownell, 2001).
- They produced a spontaneous narrative sample that contained 85% or less grammatical utterances (Gutierrez-Clellen et al. 2007; Restrepo, 1998).
- There was an expressed parent/teacher concern about language skills (Restrepo, 1998).
- The participant was placed in Speech Language services at their school at the time of the study.

Participants were excluded from this study on the basis of hearing problems, a diagnosis of a mental disorder, a significant articulation problem, cognitive impairment (i.e. mental retardation), and social and emotional behavioral problems per parental or teacher report.
Participants’ ages for both the BILI and the BITD group were within a range of six to nine years. The study included five BILI participants that were matched on age (i.e. range of 0 to 7 months difference), gender, and academic grade with a corresponding participant from the BITD group. A total of 10 children were tested for this study. Written consent forms in English and Spanish were provided to the parents of children. Assent forms were provided in English and Spanish for the participants of the study at the beginning of testing. Both forms were signed by the corresponding parties.

All participants in the BILI group met the inclusionary criteria. All of them were receiving services from the speech language pathologist at their school for language issues. In addition, in the measures of grammaticality 4 out of 5 scored below 85% grammaticality for story tells in both English and Spanish. One student was the exception by scoring 87% on the measures of grammaticality in Spanish. However, his score for English grammaticality was 76% (see table 1). As seen in Table 1, only one participant with language impairment scored below one standard deviation from the mean in the ROWPVT. However, given the results for all BILI participants the ROWPVT was not sensitive for determining group membership.

For all 10 participants there were no concerns about their cognitive status since most participants had a typical performance on the Universal Nonverbal Intelligence Test (UNIT; Bracken & McCallum, 1998). There was one participant that obtained a score that was one standard deviation below the mean (i.e. 78). This low overall UNIT score was affected by poor performance in one of the two subtests administered (i.e. Symbolic Memory). However, the participant did score within the typical range for the second subtest (i.e. Cube Design). This participant did not have any history of cognitive impairment and there was neither teacher nor
parental concern about the participants’ cognitive abilities. For this reason, the student was included in the study (see Table 2).

Table 1. *Group assignment criteria*

<table>
<thead>
<tr>
<th>BILI participant</th>
<th>Speech services</th>
<th>ROWPVT</th>
<th>Egramm</th>
<th>Spgramm</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Yes</td>
<td>72</td>
<td>76%</td>
<td>87%</td>
</tr>
<tr>
<td>2</td>
<td>Yes</td>
<td>100</td>
<td>75%</td>
<td>52%</td>
</tr>
<tr>
<td>3</td>
<td>Yes</td>
<td>86</td>
<td>47%</td>
<td>77%</td>
</tr>
<tr>
<td>4</td>
<td>Yes</td>
<td>103</td>
<td>82%</td>
<td>64%</td>
</tr>
<tr>
<td>5</td>
<td>Yes</td>
<td>132</td>
<td>19%</td>
<td>71%</td>
</tr>
</tbody>
</table>

*Note:* BILI = bilingual language impaired; ROWPVT = Receptive one word picture vocabulary test; Egramm = English grammaticality; Spgramm = Spanish grammaticality.

Table 2. *Performance of BILI and BITD Children on Group Discrimination Measures*

<table>
<thead>
<tr>
<th>Measure</th>
<th>Language Impaired Mean</th>
<th>SD</th>
<th>Typically developing Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>UNIT</td>
<td>96.2</td>
<td>14.132</td>
<td>100.8</td>
<td>16.784</td>
</tr>
<tr>
<td>ROWPVT</td>
<td>96.6</td>
<td>25.57</td>
<td>111.2</td>
<td>13.936</td>
</tr>
<tr>
<td>Egramm</td>
<td>0.6</td>
<td>0.266</td>
<td>0.732</td>
<td>0.164</td>
</tr>
<tr>
<td>Spgramm</td>
<td>0.704</td>
<td>0.131</td>
<td>0.811</td>
<td>0.086</td>
</tr>
<tr>
<td>Eng in/out</td>
<td>0.5287</td>
<td>0.297</td>
<td>0.467</td>
<td>0.203</td>
</tr>
<tr>
<td>Spa in/out</td>
<td>0.471</td>
<td>0.297</td>
<td>0.532</td>
<td>0.203</td>
</tr>
</tbody>
</table>

*Note.* BILI = Bilingual language impaired; BITD = Bilingual typically developing; UNIT = Universal Nonverbal Intelligence Test; ROWPVT = Receptive One Word Picture Vocabulary Test; Egramm = grammaticality in English; Spgramm = grammaticality in Spanish.
**Design**

A standard group comparison was used to measure the degree of association between scores on nonword repetition and sentence repetition tasks. The design involved bilingual (English-Spanish) participants who had been measured to have either typically developing language skills (BITD) or language impairment (BILI). The tasks described in the previous section (i.e. speech services, ROWPVT, teacher/parental concern, and grammaticality) were used to assign the participants to the BILI or the BITD group. Participants performing below the cutoff in two of the four measures were assigned to the BILI group.

**Measures**

All participants were administered a hearing screening at 25dB to rule out hearing impairment. The hearing screening administration time was around five minutes. The frequencies tested were 1000 Hz, 2000 Hz, and 4000 Hz. All participants from both groups passed the hearing screening.

The Universal Nonverbal Intelligence Test (UNIT) was intended to provide the researchers with information about the cognitive abilities of the participant in order to rule out a possible impairment in this area. The UNIT was chosen because it eliminates language dependent measures which make it especially suited for populations with culturally, linguistically and ethnically diverse backgrounds. The UNIT provides entirely nonverbal stimulus and response administration format incorporating eight hand and body gestures. It uses multiple response modes including: manipulation of three-dimensional geometric objects, paper and pencil, and pointing.

The ROWPVT was intended to provide the researchers with information about the receptive single word language abilities of the participant. In the ROWVPT a child has to
identify one of four illustrations that depict the meaning of a stimulus word presented by the examiner.

A parent questionnaire to determine language use and experience was administered for all participants (Peña, Gutierrez-Clellen, Iglesias, Goldstein and Bedore, in preparation). The questionnaire was administered to the parent/caregiver of each participant (see table 2). The questionnaire included questions about the participant’s exposure to English and Spanish and patterns of daily use of both languages.

The English nonwords used were those developed by Dollaghan and Campbell (1998). These nonwords are composed of a total of 96 phonemes in 16 nonwords from one to four syllables. The nonwords were developed following English phonotactics and a CVC sequence. Late developing, consonant clusters, and lax vowels were excluded. The stress patterns do not follow the English patterns and do not have a resemblance with real English words. The Spanish nonwords used were those developed by Calderón (2003). They are composed of a total of 133 phonemes and were developed to not resemble English or Spanish. Only a few later developing sounds in Spanish were included, such as /ɾ/ and /s/. The stress patterns used resemble the stress patterns of Spanish. The sentence repetition tasks used in English and Spanish were those from the Clinical Evaluation of Language Fundamentals, 4th Ed., CELF-4 (Semel et al., 2003).

**Procedures**

All children that met the described criteria were allowed to participate. After the appropriate approval was obtained from the IRB office from the school district, the principals of the schools were contacted. Then the project was presented to them, to the teachers and to the speech language pathologist(s) of the school. After the introduction of the project, the teachers
were asked to send consents to the homes of potential participants. All the signed and non-signed consents were picked up from the teachers within a three day period.

The participants were tested on site at their school in a quiet room or at one of the therapy rooms at the UTEP Speech Language Clinic. The tests were administered by either a licensed and certified speech language pathologist, graduate student clinicians, or trained research assistants from the Bilingual Language Lab. All speech output from the participants was recorded using a Sony ICD-MX20 voice recorder with a built-in triple microphone. On average it took a total of two sessions of 60 minutes each to complete the test battery for each participant. The test battery included: Receptive One Word Picture Vocabulary Test (ROWPVT), bilingual edition (Brownell, 2001), the Universal Nonverbal Intelligence test (UNIT) (Bracken et al., 1998), one spontaneous narrative sample using the book “Frog where are you?” (Mayer, 1969) in Spanish, one spontaneous narrative sample using the book “Frog goes to dinner” (Mayer, 1974) in English, the nonword repetition task in English and Spanish (Campbell, 1998; Calderon, 2003) and sentence repetition tasks in English and Spanish from the Clinical Evaluation of Language Fundamentals, 4th Ed., CELF-4 (Semel et al., 2003).

The ROWVPT administration time ranged between 15 to 20 minutes. The UNIT administration time ranged between 30 and 45 minutes. The test administration was completely non-verbal and following the instructions of the test manual. The parent questionnaire was administrated by a trained research assistant over the phone using the contact information provided in the consent forms. The administration time ranged from 10-15 minutes.

The collection of spontaneous narrative samples in English and Spanish on average took 10 minutes each for English and Spanish. During these tasks the participant was shown a
wordless illustrated book (i.e. *Frog Where are you?* in Spanish and *Frog goes to dinner* in English) and was asked to develop a verbal narrative according to the illustrations presented.

The nonword repetition tasks were administered in approximately 10 minutes. For this task the participants were presented with auditory stimuli containing the nonwords and they were asked to repeat them back to the examiner. The Sentence Repetition task was administered in approximately 15 minutes. Both measures were intended to provide the researchers with information about the language processing abilities of the participants.

All the data collected was scored at the Bilingual Language Lab by trained research assistants and graduate students. The parents of the children that brought back the consents with authorization to enroll their children in the study were contacted over the phone to fill out a parent questionnaire about language use and history. The questionnaire was used to determine the percentage of input and output for English and Spanish for the participants. The parent of one of the BITD children could not be contacted and therefore this information was not included in the average for the group. The average scores for each group are shown in Table 2. Assent was obtained from the participants at the beginning of the first data collection session.

Each nonword was scored by listening to the recordings through headphones. Each phoneme was scored as correct or incorrect. The procedures used for scoring followed those outlined by Campbell and Dollaghan (1998). Sounds scored as incorrect included substitution or omission for the target phoneme. Distortions were counted as correct, due to the background of the participants (i.e. bilinguals). Additions were not counted as errors. When there were syllable omissions, the remaining syllables were matched to target syllables and scored for phonemes on the target syllables. For each syllable level the number of correct phonemes was divided by the total number of phonemes and reported as Percent of Phonemes Correct (PPC). Since PPC
produced an average at the syllable level, performance could be compared at the syllable level despite the number of items for each level. A sample of scores was compared with the scores of a second graduate student to establish inter-rater reliability. Reliability was established with 20% of the transcript samples at 86% in English and 88% in Spanish.

In the case of Sentence Repetition transcription were done by trained bilingual students. The sentences were scored using the guidelines provided in the CELF-4 (English and Spanish). When there were word omissions, the remaining words were matched to target words and scored on the target sentences. The score reported was the scaled score provided in the manual for examiner of the CELF-4 for each language.

The story tells in English and Spanish were transcribed by trained bilingual students in the program SALT (Miller & Iglesias, 2010). Each sentence in the transcript was identified as grammatical or ungrammatical. Also, the root words in the transcripts were coded. A sample of scores was compared with the scores of a second trained bilingual student to establish inter-rater reliability. Reliability was established with 20% of the transcript samples at 89% in English and 92% in Spanish. This procedure was part of the criteria used to determine group membership (i.e. BILI or BITD).

Individual data was not made available to the general public in any way. Data being entered in electronic format or hard copy was not connected with the participants’ identities to ensure anonymity of reporting of results by the researcher. Results of the research are presented in terms of group qualities or with a two alphanumeric code assigned to each of the participants (e.g. 5A, 5B). Data was stored using a random two-digit alphanumeric code for each participant. The electronic voice and audio files were stored in a password protected computer. The hard copies of the test protocols, interviews and any document related to the study were stored in a
locked file cabinet. Both the computer and file cabinet are located in the Bilingual Language Laboratory, which is a locked office.
Results

There were no significant differences in the performance of the BILI group and the BITD group in the UNIT, ROWPVT or measures of grammaticality in English or Spanish (see Table 2). However, the BITD group showed an advantage in performance in all tasks. However, as shown in Table 3 for all dependent measures, except for Spanish nonword repetition, the variability in BITD performance is also higher compared to that of the BILI group.

Table 3. Performance of BILI and BITD children on language processing measures

<table>
<thead>
<tr>
<th>Measure</th>
<th>Language impaired</th>
<th>Typically developing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>ENWR</td>
<td>.524</td>
<td>.057</td>
</tr>
<tr>
<td>SNWR</td>
<td>.434</td>
<td>.068</td>
</tr>
<tr>
<td>ESR</td>
<td>1.800</td>
<td>1.304</td>
</tr>
<tr>
<td>SSR</td>
<td>3.600</td>
<td>1.673</td>
</tr>
</tbody>
</table>

Note. ENWR = English nonword repetition; SNWR = Spanish nonword repetition; ESR = English sentence repetition; SSR = Spanish sentence repetition.

In order to answer the first research question about group difference in nonword and sentence repetition a 2x2 mixed factorial ANOVA were conducted to determine the effects of language (English vs. Spanish) and ability (BILI vs. BITD) on the nonword repetition and sentence repetition tasks. Language (English vs. Spanish) was a within-subjects variable, while ability (BILI vs. BITD) was a between-subjects variable.

Nonword Repetition Results

With regard to the nonword repetition, results demonstrated a significant main effect for ability, such that those students who were typically developing scored significantly better than students who were language impaired, \( F(1,8) = 16.164, p = .004, \eta^2_p = .669 \). Further, results demonstrated that there was no main effect for language tested, \( F(1, 8) = .675, p = .435, \eta^2_p = \).
showing that all students did equally well in both English and Spanish on nonword repetition. Results also indicated that there was not a significant interaction between language and ability $F(1,8) = 1.338, p = .281$. In other words, the performance of each group did not change as a result of the interaction of the two languages.

However, Pair-wise comparisons between all groups were conducted and revealed that when students were tested in English there was not a significant difference between BITD and BI LI students, $t(8) = 1.360, p = .211$ on nonword repetition. On the other hand, when students were tested in Spanish BITD students scored significantly better than BILI students, $t(8) = 6.497, p < .001, d = 1.73$ (see table 3). Given the differences found in the pair-wise comparison tests, it could be that an interaction between language and ability on the nonword repetition might approach significance with more participants in the study. Further, the pair-wise comparisons indicate that there is not a significant difference between English and Spanish scores for BITD students, however BILI students perform significantly better in English compared to Spanish, $t(4) = 2.883, p = .047, d = 1.26$ (see Figure 1).

![NWR Results](image)

**Figure 1.** Results of NWR performance of BILI and BITD children

*Note.* Error bars represent standard errors.
Sentence Repetition Results

For the Sentence Repetition task, results again demonstrated a significant main effect for ability, such that those students who were typically developing scored significantly better than those students with language impairment, $F(1,8) = 26.286, p = .001, \eta_p^2 = .767$ (see Table 3). Further, results demonstrated that there was a main effect for language tested, $F(1, 8) = 8.760, p = .018, \eta_p^2 = .523$, suggesting that all students performed significantly better in Spanish than they did in English. Results also indicated that there was not a significant interaction between language and ability $F(1,8) = 1.117, p = .321$ (see Figure 2).

![SR Results](image)

Figure 2. Results of SR performance of BILI and BITD children

Note. Error bars represent standard errors.

A Pair-wise comparison showed that there was a significant differences for English sentence repetition between BILI and BITD students, $t(8) = 2.683, p = .038, d = 1.3$. Also, there was a significant difference for Spanish sentence repetition between BILI and BITD students, $t(8) = 4.427, p = .003, d = 1.6$. 

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Relationship between NWR and SR

To address the second research question with regard to how the nonword repetition and sentence repetition are associated with each other, results demonstrated that, across ability levels, there was a significant correlation between students’ scores in Spanish on the nonword repetition and the sentence repetition $r = .778, p = .008$ (see figure 3). This is, as scores on the Spanish nonword repetition (SNWR) increased they also increased on the Spanish sentence repetition (SSR). With regard to language impaired students, results demonstrated a marginally significant negative correlation between scores on the SNWR and the English sentence repetition (ESR) $r = -.861, p < .061$. This means that as scores increased on the SNWR they were likely to decrease on the ESR. Finally, with regard to BITD students, results demonstrated a negative correlation between scores on the SNWR and the English nonword repetition (ENWR), $r = -.878, p = .050$. This means that as scores on the SNWR increased they decreased on the ENWR.

![Correlations across ability](image)

Figure 3. Correlations for all participants in Spanish tasks

*Note:* SNWR = Spanish nonword repetition; SSR = Spanish sentence repetition
Figure 4. Correlations across task and language for the BITD group

Note: SNWR = Spanish nonword repetition; ENWR = English nonword repetition
Discussion

The current study investigated how bilingual children with and without language impairment performed in two measures related to working memory, nonword repetition and sentence repetition. It was proposed that children with language impairment would be outperformed by children without language impairment. Secondly, the relationship between these two measures across and within languages was investigated. The purpose of the second question was to examine the role of phonological working memory and its relationship with language impairment.

Group Differences

The research questions wanted to find out if bilingual children performed lower than typically developing bilingual children as would be expected from other studies. Overall, students who were typically developing performed better on the nonword repetition tasks than students in the language impairment group. This finding is consistent with those of other studies previously discussed (Dollaghan & Campbell, 1998; Graf-Estes et al., 2007; Gutierrez-Clellen & Simon-Cereijido, 2010; Windsor et al., 2010). The performance of the participants was not affected by the language tested (English or Spanish) which means that all participants did equally well in both languages. In addition, the patterns of performance across language and ability remained the same for all participants. The pattern was that BITD participants performed better than the BILI participants in both languages (see Figure 1).

It was only on the SNWR task that there was a significant difference in performance between the groups. It may be that this advantage of the BITD group was due to their ability to capitalize on their phonological memory for Spanish, the language in which they had the most experience. This is an interesting finding given that the input and output in English and Spanish
for both groups were very similar (see table 2). The use of Spanish and English appeared to be balanced for both groups. The BILI group might not be using their phonological working memory as efficiently as the BITD group. For that reason, they have lower performance on language processing tasks, in this case, nonword repetition. Also, it could be observed that the performance of the BILI students in nonword repetition is significantly different across languages and it is better in English. This is also an interesting finding taking into consideration that the use and experience with both languages appeared to be balanced within all participants. Again, this is indication that the BILI group did not make use of their phonological working memory as efficiently as the BITD group for language acquisition.

In terms of the sentence repetition task BITD students again outperformed the BILI students as a group without regard to the language tested. Contrary to the findings for nonword repetition tasks where the performance of the participants was not affected by the language tested, the performance of the students on the sentence repetition task was significantly better in Spanish than in English. Between subject comparisons showed that there were significant differences in the performance between the BILI group and the BITD group. If, as suggested by Willis and Gathercole (2001), the children with superior phonological skills perform better in sentence repetition tasks, then it appears that the BILI from this study have poorer skills compared to the BITD children. From another perspective, suggests that the receptive grammar skills were better for the BITD group when compared to the BILI group (see Stokes et al., 2006). Also, this confirms the findings of Archibald and Joanise (2009) which asserted that sentence repetition is overall a stronger predictor of language impairment than nonword repetition.
Correlations between Tasks

To answer the second question, a significant correlation across ability levels was found in Spanish for the nonword repetition and sentence repetition scores but not in English. As scores on the SNWR increased, scores on the SSR also increased. These results corroborate the findings of Windsor et al. (2010) who found within language correlations in sentence repetition and nonword repetition. However, it is worth mentioning that the association is only seen when all participants were included and it was not present when the two groups were analyzed separately. In addition, the association found in Spanish tasks was not found in the English tasks. Experience with language might have impacted the performance of the students. It may be that English is not yet as well established as a language for the students as Spanish. A significant correlation across languages for nonword repetition tasks was found within the BITD group (i.e. SNWR and ENWR). This finding is similar to that of Windsor et al. (2010) where a correlation across languages was found on nonword repetition.

Summary and Conclusions

As expected, the BILI students were outperformed by the BITD students in nonword repetition and sentence repetition. This could mean that the underlying processes that mediate language in bilinguals are working less efficiently in children with language impairment. In addition, the finding that all students did equally well in English and Spanish in the nonword repetition task is further evidence that when phonological memory is impaired, performance will also be impaired regardless of language (English or Spanish). These two findings combined could explain how impairments in phonological working memory are associated with language impairment and therefore the difference found in performance for BILI and BITD children.
An unexpected finding that deserves further investigation is the performance of BILI students across languages. They performed significantly better in English nonword repetition than in Spanish nonword repetition. This finding was unexpected considering that for many of the bilingual children in the El Paso area Spanish is their native language and English is usually learned in school. Therefore, they are assumed to have less experience with the latter. It would be important to determine if there were any associations between current use and previous experience in the language(s) and performance in language processing measures as it was found in the Gutierrez-Clellen and Simon-Cereijido (2010) study. For clinical purposes it would be important to determine how the experience with the language is associated with the degree of impairment.

Due to the small sample size this is a preliminary study. In order to ensure that these results are representative of bilingual children, the sample size should be increased. Another limitation of the study was the lack of control for experience in the language (i.e. native Spanish speakers vs. native English speakers). It could very well have been that when the participants were matched on all the other variables (i.e. age, gender, academic year) their performance was instead affected by their experience with the language.

The main finding of this study was that bilingual children that have been identified as having language impairment perform lower on measures associated with vocabulary acquisition and receptive grammar skills than their typically developing peers. We did not determine if performance in either of the measures was influenced by children’s experience with language(s). Determining to what degree experience influences the performance on the measures used could provide more information to make a more accurate comparison between the two groups of children (i.e. BILI and BITD).
Finally, the results of this study support the findings of other studies that in order to understand language impairment in bilingual children, more than one measure is necessary and relying only on knowledge based measures is not sufficient. This is also an important finding for clinicians. This is to say that more research should be done about the role of phonological working memory so that language interventions in bilinguals with language impairment are better targeted to remediate this disorder.
References


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Curriculum Vita

Marcela Susa was born in Mexico. She completed her schooling in Mexico up to high school. She entered the University of Texas at El Paso in the fall of 1996. While pursuing a bachelor’s degree in business administration she studied French and went twice on study abroad trips to France with a scholarship. After graduation, in the fall of 2001, she worked for a consulting firm with small businesses in Cd. Juárez, Mexico. She returned to school to earn a graduate degree in business administration while working for a real estate company in Mexico. She graduated with a Master’s in business administration in the spring of 2005. She returned to school to earn a degree in speech language pathology in the fall of 2010. She co-authored a publication on Student Life Stress in the spring of 2011. Also, she presented a poster on Macrostructure Analysis of English and Spanish Narratives in Bilingual Children at the American Association of Speech Language and Hearing Convention in the fall of 2011.

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