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An Analysis of the Relationship between English Non-word Repetition and Morphosyntax in Bilingual Children

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An Analysis of the Relationship between English Non-word Repetition and Morphosyntax in Bilingual Children

by

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Dedication

To my Mom and Dad, I would not be where I am today without your love and support.

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Abstract

An Analysis of the Relationship between English Non-word Repetition and Morphosyntax in Bilingual Children

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This study evaluates the relationship of between phonological short-term memory, as measured by a non-word repetition task (NWR), and the performance on morphosyntax language tasks, as assessed by grammatical priming and the Bilingual Spanish Assessment (BESA)/Bilingual English Spanish Assessment Middle Extension (BESAME) morphosyntax subtest in English. Sixty-nine Spanish-English first graders were selected from a previous study. A correlational analysis indicated there was no relationship between phonological short-term memory and performance on the BESA or the priming task. A moderate significant relationship occurred between the two morphosyntax tasks. The results imply that children may require a foundation of grammatical knowledge before they are able to benefit from grammatical priming. Performance on the BESA suggests that children's ability to learn new grammatical forms was not dependent on their phonological short-term memory.

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Introduction

The Hispanic population is largest and fastest growing minority group in the United States (U.S Census Bureau, 2011) and represents 75% of all English language learners in the U.S school systems (Shatz & Wilkinson, 2010; Swanson, 2009). Thus there is a high probability that a speech-language pathologist (SLP) will have an English-Spanish bilingual on his/her caseload. In order to design effective intervention for this growing population, SLPs need to better understand how bilingual children learn to perform language-based tasks. By studying the relationship between non-word repetition (NWR) and grammatical priming, we can gain insights into learning that would potentially inform our understanding of effective intervention programs for this population.

NWR TASK

NWR is a task that requires a child to repeat nonsense words that vary in length. In order for a child to be successful in the task, the child needs to use related processing and memory skills to repeat the non-word. The underlying mechanisms that are thought to play a role in NWR include phonological processing (Bowey 1996, 1997), articulation skills, speech perception (Frisch, Large, and Pisoni, 2000), and phonological short-term memory (Gathercole, Willis, & Emsile, 1992; Masoura and Gathercole 2005; Gathercole 2006). Results of various studies about NWR in different languages have suggested that the skills required to repeat non-words are also those that may support language learning (Bortonlini, Arfe, Caselli, Degasperi, Deevy, & Leonard, 2006; D'Odorico, Assanelli,

Franco, & Jacob, 2007; Girbau and Schwartz, 2007; Radeborg, Barthemlom, Sjöberg, and Salhlén, 2006; Masoura & Gathercole, 2005; Klein, Watkins, Zatorre, & Milner 2006; Santos, Bueno, & Gathercole, 2006; Stokes, Wong, Fletcher, & Leonard, 2006). As a group, these studies have shown that these underlying skills support learning of new words and morphemes (e.g., Summers, Bohman, Gilliam, Peña, & Bedore 2010).

WHY USE NON-WORDS INSTEAD OF REAL WORDS?

Repeating real words involves activation of the phonological form of a lexical representation in long-term memory (Dispaldro, Leonard, & Deevy 2013). This lexical representation requires phonological and semantic knowledge, which NWR attempts to minimize (Dispaldro et. al, 2013). The long-term effect of knowledge of real words increases overall repetition accuracy compared to NWRs (Chiat & Roy, 2007; Metsala & Chisholm, 2010; Roy & Chiat, 2004; Casalini et al., 2007; Disoaldro et al., 2009, 2011; Sahlen et al., 1999). Because repetition of real words requires background knowledge, using NWR allows us to better understand how children learn under conditions that do not require specific background knowledge and experience to be successful.

Dollaghan and Campbell (1998) designed a list of non-words to eliminate biases between children who may have different language experiences. They selected non-words that did not correspond to English lexical items, minimized predictability of individual phonemes within the non-words, and only included phonemes that are acquired in early development. In a task of this type, NWR is a processing-dependent measure because performance on this task can be attributed to the child's fundamental language processing skills and not their experiential history. Unlike NWR, norm-

referenced tests, such as vocabulary test that require semantic knowledge, can be biased against test takers from minority backgrounds because standardized test depend on specific conceptual vocabulary knowledge (Campbell, Dollaghan, Neddleman, & Janosky, 1997).

REATIONSHIP OF NWR, GRAMMATICAL KNOWELDGE, AND LANGUAGE EXPERIENCE IN BILINGUAL CHILDREN

Even though Dollaghan and Campbell (1998) attempted to minimize effects of experiential history through NWR, studies that have involved bilingual children demonstrated that bilingual children's accuracy on the NWR task may still be dependent on their language experiences. For instance, Summers et al. (2010) reported that performance on NWR tasks seemed to be influenced by the phonological and phonotactic structures of the particular language a child is learning. For example, children learning languages that frequently use multisyllabic words appear to be better at producing longer nowords than children from languages where multisyllabic words occur less frequently (Girbau & Schwartz, 2007; Masoura & Gathercole, 1999;2005; Radeborg et al. 2006; Santos et al. 2006; Summers et al. 2010; Gibson, Summers, Peña, Bedore, Gilliam, and Bohman, 2014).

Gibson et al. (2014) specifically examined the impact of language experience on NWR performance. Gibson et al. (2014) matched children based on age of first exposure to English and percent of language exposure of their current languages. For example, a child whose current exposure to English was 70% was matched with a child whose current exposure to Spanish was 70%. Gibson et al. (2014) proposed that Spanish-

dominant children performed NWR tasks better than English-dominant children in both Spanish and English as a result of the extra practice that the Spanish speakers had in saying multisyllabic words.

Summers et. al. (2010) and Gibson et al. (2014) provided further evidence that Spanish-English bilinguals, who were predominately Spanish speakers, may be demonstrating effects due to their language experience, in four-syllable non-words in English and Spanish non-words. The effect due to language experience may have occurred because increased experience in Spanish provided the children more opportunities to practice language specific structures, such as repeating longer multisyllabic words. Summers et al. (2010) explained that the interaction between first exposure to English and syllable length correlated with the child's ability in manipulating syllables. Similar to monolingual children (Dolloghan, Campbell 1998; Weismer, Tomblin, Zhang, Buckwalter, Chynoweth, & Jones, 2000), the performance of bilingual children in English tasks revealed a length effect, where accuracy decreased as the syllable length increased (Gibson et al., 2014, Clellen & Simon-Cereijido, 2010; Kohnert et. al, 2006; Windsor et al., 2010).

NWR performance in the child's second language (L2) is lower when compared to their monolingual peers (Engel de Abreu, Baldassi, Puglisi, & Beli-Lopes 2013; Kohnert, Windsor, & Yim, 2006; Pardis, Emmerzael, & Sorenson Duncan 2013; Windsor, Kohnert, Lopitz, & Pham, 2010). Duncan and Paradis (2016) explained that monolingual children have a greater frequency of exposure to the target language (English) than English Language Learning children, which could, in part, explain the

group difference. Another reason for bilinguals having a lower performance score than monolinguals is that the phonological structure of one of the bilinguals' languages may effect performance of the other (Gibson et al. 2014).

Language experience not only effects children's phonological knowledge, but also their grammatical knowledge. Bohman, Bedore, Peña, Mendez-Perez, and Gilliam (2010) assessed the factors that contributed to Spanish and English language development in bilingual children. They included 757 Latino children in the study. Participants' parents completed an interview about their child's language experience. The child's language experience was compared to their scores on the *Bilingual English Spanish Oral Language Screener* (BESOS; Peña, Bedore et al., in preparation). The results indicated that Morphosyntax was influenced by both language input and output. In English, input was just as important as output because the children seemed to require exposure and practice.

Bedore, Peña, Gilliam, and Ho (2010) also studied the language ability of Spanish –English bilingual kindergartners. The participants were required to tell a story based on two wordless picture books in each language. The children's utterances were coded into the *Systematic Analysis of Language Transcripts* (SALT) (Miller & Iglesias, 2008). SALT calculated the number of utterances, mean length utterance, number of different words, and grammaticality. Bedore et al. (2010) observed that English learning children demonstrated higher rate of grammatical errors compared to Spanish learners. The children were able to produce stories of equal complexity, but produced more Spanish-influenced utterances in English, the less proficient language.

The research has shown that language experience in Spanish-English bilinguals does effect NWR scores and grammatical knowledge in the less proficient language. Multiple studies have demonstrated an effect due to language experience for Spanish-dominant bilinguals because they have had more practice producing multisyllabic words. Studies also have shown that bilinguals' performance on NWR is lower than their monolingual peers, which may be due to language experience in the target language or the phonological structures of each language effecting the performance of the target language.

GRAMMATICAL PRIMING TASK

Grammatical priming, also known as structural priming in the literature, describes the phenomenon when sentences produced by speakers are influenced by the sentences that they just heard (Leonard, 2011). For example, if the speaker hears, "The house was painted by boy", the speaker is more likely to describe a picture with the sentence "The car was hit by the truck". The sentence heard by the speaker is referred to as the prime sentence and the sentence produced by the speaker is the target sentence. In the example mentioned above, both sentences are using the passive voice.

Leonard (2011) argued that the structural priming literature could help us study grammatical development and language intervention with children. Multiple studies have provided evidence that children's sentence productions are subject to priming (Leonard,

2011). For example, Huttenlocher, Vasulyeva, and Shimpi (2004) used a structural priming task with four- and- five year- old children. Huttenlocher et al. (2004) completed three experiments with the participants. During the first experimental task, Huttenlocher et al. (2004) presented the participants with 20 prime-target pairs. For the trials, the participants viewed a drawing. The examiners recited a sentence about the drawing and the participants were required to repeat the prime sentence. Afterwards, the examiners presented the participants with a new drawing and asked the participants to describe it. Huttenlocher et al. (2004) found a priming effect for structures that were primed when the children were describing the new drawing. Even when Huttenlocher et al. (2004) changed their procedure for the structural priming task, by having the children only listen to and not repeat the examiner's sentence, they found similar results that children continued to use the primed structures in their spontaneous speech, while describing a drawing.

Studies have also shown that implicit learning occurs during structural priming tasks because input effects are seen without the participant having recalled the influencing linguistic material (Leonard, 2011). Ferreira, Bock, Wilson, and Cohen (2008) demonstrated this phenomenon with eight adults, four with antergrade amnesia and four serving as controls. Ferreira et al. (2008) observed that individual with amnesia showed structural priming effects when describing target pictures, even though they could not recall the priming sentence.

Leonard (2011) also suggested that grammatical priming is linked to grammatical intervention because clinical grammatical intervention involves using the grammatical

targets with increased frequency in different contexts with the child. The purpose of grammatical intervention is to speed up the acquisition of the grammatical target by making relevant information and clear and frequent as possible (Leonard, 2011). Structural priming is similar to current grammatical intervention strategies because it involves the frequent presentation of grammatical material in unambiguous contexts (Leonard, 2011).

Structural priming tasks can help reinforce the use of particular treatment approaches that require the clinician to frequently use the target form, such as in modeling, focused stimulation, and conversational recast. Also structural priming can be used to allow researchers to understand how children develop grammatical forms and the effects of implicit learning.

Proctor-Williams and Fey (2007) examined children's ability to learn grammatical structures through conversational recast. Similar to structural priming, conversational recast targets a specific grammatical form. During conversational recast the adult is required to repeat the child's utterance and correct or modify the morphologic or syntactic form. They compared 13 children with SLI and 13 children who were typically developing, in order to examine the rate at which children acquired the target grammatical form. The results indicated that the children, who were typically developing, benefitted from the conversational recast, but children with SLI did not significantly improve their verb accuracy. Proctor-Willams and Fey (2007) explained that in order for children with SLI to show clinical effects, recasts needed to be presented at a rate between .70-1.78 recast per min. The recast rate in the study was .47 per minute,

which may have been too low to meet the attention and processing needs of children with SLI.

Proctor-Williams and Fey's (2007) have helped demonstrate that in order for forms of structural priming to be beneficial to the child, the child needs to have the processing capabilities to interpret the prime. Also the target grammatical form needs to be extremely salient to the child with SLI.

RELATIONSHIP OF PHONOLOGY AND LANGUAGE

The majority of studies have focused on the relationship between vocabulary size and NWR in monolingual and bilingual children (Baddeley, Gathercole, & Papagno, 1998; Edwards et al., 2004; Gathercole, 2006; Gathercole et al., 1992; Thorne & Page, 2008; Adams and Gathercole 1995; Roy & Chiat, 2004). These studies have indicated that receptive vocabulary can affect NWR performance especially in the early stages of language learning (Duncan & Paradis, 2016). However, Summers et al. (2010) reported no significant correlations between NWR in both Spanish and English with semantics. Cooperson, Bedore, and Peña (2013) found similar results in their study, when they compared phonology scores, in which children produce real words, and the Bilingual English Spanish Assessment (BESA) semantic scores. Cooperson, et al. (2013) suggested that the low association between phonology and the BESA semantics might be due to the fact that the BESA semantics subtest assesses knowledge of word meanings and forms, not vocabulary size.

There is also evidence that phonology not only provides the foundation for vocabulary, but also for morphosyntax (Gerken, 1996; Morgan, Shi, & Allopenna, 1996;

Storkel, 2006). Compared to the research examining the relationship between vocabulary and phonology, there are even fewer studies that have compared phonology and morphosyntax, especially studies that have included bilinguals.

Summers et al. (2010), Cooperson et al. (2013), and Dispaldro, Deevy, Altoé, Benelli, and Leonard (2011) compared phonology to other language domains, such as semantics and syntax. Summers et al. (2010) compared 62 Latino children's NWR scores to their BESA morphosyntax scores in English and in Spanish. In English, Summers et al. (2010) reported that there was a positive relationship between NWR scores by number of syllables and morphosyntax scores. They found a positive relationship between NWR percentage correct for two and three syllables, but only showed a minimal relationship for four syllable NWRs. Summers et al. (2010) suggested that the positive relationship between NWR and morphosyntax scores showed that the better children are at manipulating morphemes, the better they are at repeating non-words, consistent with the effect due to language experience.

Cooperson et al. (2013) also aimed to determine the relationship between phonology and other language domains. An exploratory analysis focused on determining if bilingual children with lower and higher phonological production differed in their production of grammatical structures. To answer the first research question, Cooperson et al. (2013) analyzed the semantics, morphosyntax, and phonology scores acquired from the BESA in English and Spanish. Cooperson et al. (2013) also collected a language sample from a story retell task, in order to determine number of different words (NDW), mean length utterance (MLU), and number of grammatical utterances.

Correlational analysis showed phonology was more strongly related to measures of morphosyntax than to measures of vocabulary or semantics (Cooperson et al., 2013). English phonology performance was most highly associated with English grammaticality and the BESA Spanish morphosyntax (Cooperson et al., 2013).

Dispaldro et al. (2011) explored the relationship between non-word repetition and grammatical ability in three-and-four-year old children. The study consisted of 78 children, 48 were monolingual Italian speakers and 30 were English monolingual English speakers. Dispaldro et al. (2011) adapted their NWR stimuli from the *Preschool Repetition Test* (PSRep) (Chiat and Roy, 2007). Dispaldro et al. (2011) used the *Test of Early Grammatical Impairment* (TEGI; Rice and Wexler, 2001) to elicit the third-person singular inflection and the past tense form in English. The results showed the NWR significantly predicated grammatical ability in English and Italian. However, the relationship was stronger in English. Dispaldro et al. (2011) explained that English morphology appeared to rely, to a greater extent, on the ability to encode and retain small infrequent phonological differences in words because English includes less inflectional morphology than Italian.

Summers et al. (2010) Cooperson et al. (2013), and Dispaldro et al. (2011) have contributed to the literature that a relationship exists between phonology and other language domains, specifically morphosyntax. Even though Summers et al. (2010), Cooperson et al. (2013), and Dispaldro et al. (2011) used different phonology stimuli, they came to similar conclusions. These studies suggested that a child's morphosyntax skills may be dependent on their ability to manipulate morphemes.

THEORY BETWEEN PHONOLOGY AND MORPHOSYNTAX

Two theories that have described the link between phonology and morphosyntax are the surface hypothesis described by Leonard (1998) and Chiat's (2001) mapping theory. Both these theories discussed patterns of grammatical impairments observed with children with Specific Language Impairment (SLI).

The surface hypothesis has suggested that processing morphemes of low-phonetic salience has been a source of difficulty for children with SLI. Also the surface hypothesis has suggested that grammatical deficits are manifested differently across languages because low-phonetic salience occurs differently in each language. For example, in Spanish, children with SLI have difficulties with direct object clitic pronouns, plural markers, adjective agreement and articles (Bedore & Leonard, 2001). In contrast, English-speaking children with SLI have difficulties with third-person present singular verb form, past tense, couplas, and articles (Leonard, 1998).

Similarly, Chiat's (2001) mapping theory has suggested that children with SLI have difficulty processing morphemes with low phonetic salience and that are abstract in meaning, such as tense markers in English. Chiat (2001) hypothesized that children with SLI have reduced access to phonological details within rhythmic structures, which are required for the establishments of lexical forms and syntactic structures.

The surface hypothesis (Leonard, 1998) and mapping theory (Chiat, 2001) have helped explain the relationship between phonology and morphosyntax because children with SLI are less accurate with grammatical structures with low-phonetic saliency. This may reflect, that morphosyntactic production is dependent on the child's phonological

capabilities and their ability to hypothesize grammatical function (Cooperson et al. (2013).

Chiat (2001) and Leonard's (1998) theories can also be applied to a child's outcome on a NWR task. The NWR task has required children to use their working memory and phonological processing skills to retain and accurately repeat small phonological details, which according to Chiat (2001) and Leonard (1998) has been difficult for children with SLI. Low NWR scores may indicate that a child has difficulty using the processes that are required for learning grammatical structures.

THE CURRENT STUDY

The research has shown that NWR and grammatical priming are tasks that have involved learning new words and morphemes. Because of relationship of phonology and morphosyntax demonstrated in previous studies, we hypothesize that there is relationship between phonological short-term memory (as assessed by NWR) and the performance of morphosyntax language tasks (as assessed by grammatical priming and the BESA/BESAME morphosyntax subtest). By examining the relationship between these two tasks, we hope to gain a better understanding on how bilingual children learn.

Methods

PARTICPANTS

Sixty-nine first graders were selected from a previous longitudinal study, Bilingual Outcomes. The aim of the Bilingual Outcomes study was to analyze language development in Spanish-English bilingual children. In the larger study, 360 participants were recruited from two predominantly Hispanic Central Texas school districts.

Participants' ages ranged from 72- 90 months. Information collected from detailed parent interviews showed that participants input and output in English ranged from 10% to 100% and that average mother education ranged from no education (0.00) to completing a college degree (6.0). The age range when participants began to use English ranged from 0-5 years old. See Table 1 for descriptive demographic information on the participants.

Table 1. Average Descriptive Demographics for Participants

Participant Characteristics	Mean	Standard Deviation
Average Age	82.32	3.92
Input/Output English	38.82	15.30
Mother's Education Level	2.66	1.77
Age of First Exposure to English	2.36	1.64

Note: Age is recorded in months; daily English exposure is recorded in average percentage; Mother's education level is a score based on the Hollingshead scale; age of first English exposure is recorded in years.

SAMPLING PROCEDURES

As part of the parent study, Bilingual Outcomes, all participants were classified into three groups, Typically Developing (TD), Low Normal (LN), and Language Impaired (LI). During phase 1 of the larger study, participants were screened with the

Bilingual English Spanish Oral Screener (BESOS) in Spanish and English a year before phase 2 began. Participants who met the criteria for Phase 2 were invited back to the study. In order to be classified as TD, LN, or LI, participants completed confirmatory testing.

Confirmatory testing included the *Test of Narrative Language* (TNL; Gilliam & Pearson, 2004), *Test of Narrative Language- Spanish Adaptation*, *Universal Nonverbal Intelligence Test* (UNIT; Bracken & McCallum, 1998), and *Bilingual English Spanish Assessment: phonology, semantics and syntax subtests* (BESA; Peña, Gutierrez, Iglesias, Goldstein, & Bedore, 2014) or the *Bilingual English Spanish Assessment-Middle Elementary* (BESAME; Peña, Bedore, Igelsias, Gutierrez-Clellen, & Goldstein, n.d.) in Spanish and English. Parents and teachers completed detailed questionnaires to describe the child's language ability.

Participants were excluded from the study if they received a score below 70 on the UNIT (Bracken & McCallum, 1998) during confirmatory testing or if the child's parent reported a history of brain injury, severe social-emotional problems, intellectual disability, autism spectrum disorder, or hearing loss. Also, in order to qualify for testing, the participants needed to have their first English exposure by kindergarten.

The parent study also included other standardized and experimental measures to track language development in both English and Spanish. Participants were tested on the BESA (Peña et al., 2014) or the BESAME (ages 7 and above), *The Expressive One Word Picture Vocabulary Test-3rd Edition* (EOWPVT; Brownell, 2000), *Expressive One-Word Picture Vocabulary Test: Spanish-Bilingual Edition* (EOWPVT:SBE; Brownell, 2001),

and nonword repetition tasks in English and Spanish each year of the study. Experimental tasks included tongue-twisters, a semantic processing task, and grammatical priming. Each year, parents and teachers completed a language profile questionnaire about the child's language ability and environment.

In the current study, the participants were in their second year of testing for the parent study. The current study focused on the BESA/BESAME morphosyntax, NWR in English, and the experimental grammatical priming task in English. The 69 first graders included all three groups, TD, LN, and LI. Based on the participant's age, 38 were administered the BESA and 31 were administered the BESAME.

STIMULI

The focus of this analysis was based on 16 non-words (Table 3) from Dollaghan and Campbell (1998) that were used for the Bilingual Outcomes study. The 16 non-words included 4 words at each 4 syllable lengths (one, two, three, and four syllables). All non-words began and ended with consonants. Also to minimize articulatory difficulty, the non-words excluded the consonants described as the "Late eight" (i.e., /s, z, l, r, ʃ, θ,ð, ʒ), as well as consonant clusters (Dollaghan & Campbell, 1998).

The current study used the grammatical priming experimental task and the morphosyntax subtest of the BESA (Peña et al., 2014) or BESAME (Peña et al.,n.d) in English. The grammatical priming task included 6 sets (3 control sets and 3 test sets). The English grammatical priming task tested for past tense, 3rd person singular, and copulas. Each set contained 10 phrases for the child to complete. Table 4 provides examples of priming sequences in English.

The BESA (Peña et al., 2014) and BESAME (Peña et al., n.d) morphosyntax subtest included cloze set phrases and sentence repetition. A child received the BESA (Peña et al., 2014) if they were below the age of 7 and received the BESAME (Peña et al., n.d) if they were 7 and above. The morphosyntax subtest examined possessive, 3rd person singular, regular past, plural nouns, present/past auxiliary and progressive, copula, negatives, and passives.

Table 2. Examples of NWR Stimuli

One Syllable	Two Syllables	Three Syllables	Four Syllables
/neɪb/	/teɪvak/	/tʃinoɪtaʊb/	/veɪtatʃaɪdoɪp/

Table 3. Example of Grammatical Priming Sequences

	Model	Target
Past Tense	Yesterday, the dog chewed the shoe.	Yesterday, the girls **hugged.**
3rd person singular	Today, the bird flies.	Today, the baby **smiles**.
Copulas	The horses are brown	The pants **are** blue

ADMINSTRRATION

Bilingual Spanish-English examiners administered, NWR, English grammatical priming, and the BESA/BESAME morphosyntax subtest (Peña et al., 2014) for the original study.

For the NWR task, the examiner instructed the child to repeat exactly what they heard on the recording. Examiners provided an auditory example of a nonword that was not included on the list. The examiner then placed the headphones on the child and played the audio recordings on an ipad. The examiner audio recorded the child's

responses on a recorder, so an undergraduate/graduate research assistant could phonetically transcribe the child's responses.

Testers administered the English grammatical priming task through a computer-based program using MATLAB. Examiners placed the headphones that included a connected microphone on the child. The grammatical priming task included pre-recorded instructions and stimulus. The examiner instructed the child to listen to the computer's instructions. If the child failed to respond to a stimulus, the program paused. The examiner prompted the child to try their best and then restarted the program from where the participant left off. During the control set, the child was presented with a photo, while an audio recoding recited a phrase. For example, if the photo was of a boy jumping, the audio recording would say "Yesterday, the boy_____". The child was required to complete the phrase. In the test set, the program presented the child with two pictures. The first picture provided the child with an example phrase for the picture. The second picture required the child to complete the phrase. Once the child completed the phrase, the child clicked the space bar to receive the next stimulus. Each set contained 10 phrases for the child to complete. For instance, during the third person singular subtest, the participant listened to 10 phrases in the baseline section and 10 phrases in the primed condition section.

During the BESA/BESAME morphosyntax subtest, (Peña et al., 2014), the examiner read a sentence while pointing to the corresponding picture on the Ipad. The examiner then pointed to the second picture on the ipad and asked the child a corresponding question or stimulus cloze phrase. The examiner scored online with either

a 1 for a correct response or 0 for an incorrect response. Testing was discontinued when the child completed all test items or did not respond to five items in a row. The child was audio recorded for reliability purposes.

SCORING

Bilingual graduate and undergraduate students trained in phonetic transcription, broadly phonetically transcribed the recorded NWRs for each participant. The participant received a score of 1 or 0 for each phoneme. A score of 1 meant the phoneme was correctly produced, while a score 0 meant the phoneme was omitted or that the wrong phoneme was produced. A percent phoneme correct was the calculated by dividing the number correct phonemes by the total number of phonemes (x/96).

In MATLAB, graduate and undergraduate students orthographically transcribed each response for the grammatical priming task. If the participant answered with the target response, the participant was given a score of 1. Articulation errors were not marked incorrect if it did not change the word grammatically. For example, if the target word was “ran”, but the child said “wan”, the child’s response would still be marked as correct because the child was still using the irregular past tense form. The participant received a score of "0" if they answered incorrectly or had a no response. To generate a subtest score, a difference was calculated between the baseline and primed condition. A participant could receive a negative score, if the participant had fewer correct responses in the model condition than the baseline condition. The maximum score a participant could receive for each subtest was a score of 1. After each subtest score was calculated, the three subtests were averaged together to generate a composite score.

The BESA/BESAME morphosyntax was scored online and then scores were transferred into an excel spreadsheet. The excel spreadsheet was used to calculate raw scores and percent correct scores.

Results

The purpose of the study was to explore the relationship between NWR performance and morphosyntax language measures in English to determine if phonological learning as measured by NWR influences grammatical learning in bilingual children.

DESCRIPTIVE STATISTICS

In order to understand the pattern of results, descriptive statistics were generated to calculate mean scores and standard deviation for all measures. Participants' scores on the BESA/BESAME morphosyntax ranged from 0.00% to 93.14%. NWR scores ranged from 31.25%-85.42% and grammatical priming average accuracy scores ranged from -13%- 43%. Table 4 presents a summary of the current study's participant performances based on selected measures.

Table 4. Participants' Average Scores on Phonology and Morphosyntax Measures.

	Average Scores (n=69)	Standard Deviation
BESA/BESAME-Morphosyntax	48.40 (0.00-93.14)	25.43
NWR	58.58 (31.25-85.42)	10.86
Grammatical Priming Average Accuracy	11.4 (-13-43)	14.2

Note: Objective data are presented as means and ranges in parentheses.
BESA/BESAME Morphosyntax scores are recorded as percent correct; NWR are recorded as percent phoneme correct; Grammatical priming average accuracy is recorded as a percentage.

STATISTICAL ANAYLSIS

Pearson correlation coefficients were computed to explore the relationship between phonological short- term memory and grammatical learning in English. Three

variables were included in the correlation analysis, which included NWR percent consonant correct scores, BESA and BESAME morphosyntax percent correct scores, and grammatical priming average accuracy scores.

The first analysis explored the relationship between BESA/BESAME percent correct scores to NWR PCC scores and grammatical priming average accuracy scores. There was a moderate correlation between BESA/BESAME scores and grammatical priming scores, r=.572, n=69, p=.001 However, there was no correlation between BESA/BESAME scores and NWR PCC scores, r= .226, n= 69, p= .062.The second analysis explored the relationship between NWR PCC scores and grammatical priming average scores, which indicated that there was no correlation between the two variables, r=.103, n= 69, p=.399 (Table 5).

Table 5. Correlations Between NWR Scores and Morphosyntax Language Measures.

		NWR Percent Phonemes Correct	**Grammatical Priming Average Accuracy Scores**
BESA/BESAME Percent Correct	Pearson Correlation	.226	**.572****
NWR Percent Phonemes Correct	Pearson Correlation		.103

Discussion

The literature has shown that NWR and grammatical priming are both measures that can be used to measure a child's ability to learn. For instance, NWR has been considered a measure of phonological short-term memory because the underlying skills required to complete this task are important in learning new words and morphemes (Summers, Bohman, Gilliam, Peña, & Bedore 2010). In the literature, grammatical priming has been shown to involve implicit learning because input effects from the stimuli are seen without the participant having recall of the influencing material (Leonard, 2011). Since NWR and grammatical priming have attempted to understand how children develop language, the aim of the current study was to determine if a correlation existed between phonological short-term memory as measured by NWR, and grammatical knowledge, as measured by the BESA morphosyntax subtest and grammatical priming task in English. To explore these relationships, we examined how Spanish-English bilingual first graders performed on NWR, grammatical priming, and the BESA morphosyntax.

The results from this study revealed that a moderate relationship existed between the BESA and grammatical priming score. However, contrary to expectation based on the literature, no relationship was observed between phonological short-term memory and the grammatical knowledge measures. For example, Summers et al. (2010) showed a correlation between NWR scores and the BESA morphosyntax in Spanish-English bilinguals. The results indicated that the better a child performed on the BESA morphosyntax the better their performance was on two and three syllable NWRs.

Summers et al. (2010) suggested that this correlation existed because the better children are at manipulating morphemes, the better they are at repeating NWR. Unlike Summers et al. (2010), we did not analyze NWR syllable length score, but instead compared grammatical measures to the overall PCC scores. By using the overall PCC scores, there might not have been enough variability in the scores to determine a significant relationship between NWR and the grammatical measures.

Another explanation for lack of correlation between NWR and the grammatical measures in English is that the participants were Spanish dominant. The literature has shown that scores on English grammatical measures were dependent on the child's input/output measures (Bohman et al. (2010). Even though the literature has shown that Spanish-dominant children perform NWR tasks better than English dominant children (Gibson et al., 2014), it does not indicate that the children have learned and mastered the grammatical forms required to complete the BESA morphosyntax and grammatical priming task. Scores on both these measures were relatively low with the average score in the BESA morphosyntax being 48.40 % and 11.4% on the grammatical priming task. The performance on the grammatical priming task demonstrated that the child's performance from the baseline to model condition was not dependent on phonological working memory, but more dependent on overall knowledge of the grammatical system.

Proctor-Williams and Fey (2007) demonstrated that in order for typically developing children to benefit from recasting, which is similar to structural priming, the recast rate needed to be .47 per min. This may explain that briefly hearing the models on

the grammatical priming task was not enough information to increase the child's accuracy on the task.

The moderate relationship between the BESA morphosyntax and the grammatical priming task demonstrated that the better a child performed on the BESA morphosyntax, which indicated that the child has sufficient knowledge and command of grammatical forms in English, the better the child was at understanding and implementing the prompts modeled in the grammatical priming task.

LIMITATIONS AND FUTURE RESEARCH

The grammatical priming task used in the current study focused on production of grammatical markers. Previous studies that showed priming effect focused on sentence construction instead of the individual grammatical makers. Due to the differences in tasks, this may have been why similar results were not found in the current study.

Also, in the current study, we chose 1st graders because, when compared to kindergartners, the 1st grade group had greater exposure to English. Also, since the participants were only in their 2nd year of testing in the parent study, the NWR task and grammatical measures tasks were relatively new, which could help limit a practice effect to the tasks. Due to the current participants' limited exposure and mastery of English, future research should attempt to examine an older age group. At an older age, children should have a greater mastery of grammatical knowledge in English. Since children will have a better understanding of the tasks, more variable scores may be observed.

CONCLUSION

The current study demonstrated that bilingual children required a foundation of grammatical knowledge in order to benefit from grammatical priming. Also children's scores on grammatical measures were not dependent on their phonological short-term memory. Even though the current literature has suggested a link exist between phonology and morphosyntax, its correlation was not observed in this study. Further research, with an older age group, may help us understand the connection between phonology and morphosyntax in bilingual children.

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