Published in final edited form as:
J Commun Disord. 2008 ; 41(2): 124–145. doi:10.1016/j.jcomdis.2007.07.001.

Phonological Working Memory in Spanish-English Bilingual Children with and without Specific Language Impairment

Dolors Girbau and
University Jaume I, Castelló, Spain

Richard G. Schwartz
City University of New York, New York, NY

The identification of Specific Language Impairment (SLI) continues to be a challenge for clinicians, even in older children, (e.g., Nation, Clarke, Marshall, & Durand, 2004; Spaulding, Plante, & Farinella, 2006). Many children's language impairments still go undiagnosed and, instead, intervention often focuses on poor academic achievement and reading disabilities, which are more readily identified. Thus, a need remains for further examination of measures that can reliably identify SLI in school-aged children.

Specific Language Impairment in Spanish-Speaking Children

The number of undetected children with SLI who speak languages other than English might be larger, even with recent attempts to improve the accuracy of this diagnosis (e.g., Crespo-Eguilaz & Narbona, 2003). There are relatively few Spanish language assessment tools, despite the significant number of Spanish speakers in USA and worldwide (with more speakers than English). According to the U.S. Census Bureau, the official resident Hispanic population in the United States was more than 42 million in July of 2005, with a projection of continuous growth. New York City had the largest Hispanic population in 2000 with more than two million people ("Hispanic Population", 2005). In 2003, the U.S. Census Bureau reported that the Hispanic population had surpassed African Americans to become the nation's largest minority group; it was also the largest foreign born group (which is formed by the non U.S. citizens at birth) (Larsen, 2004; Suro, 2005). This population has greater incidence of poverty and less education than the national average (Suro, 2005). Socioeconomic Status (SES) can have negative effects on language acquisition (e.g., Schuele, 2001). If language acquisition is negatively affected by low SES, the deficits associated with SLI may be amplified.

There are several approaches to bilingual instruction employed in the United States, which are usually applied only to a limited number of grades. One of the more common approaches, the dual language program, groups native speakers of English with native speakers of the target language (e.g., Spanish). Students receive 50% of their instruction in English and 50% in Spanish in integrated classrooms, with half of the children coming from Spanish-dominant homes. Instruction is provided in English and in Spanish on alternate days, according to academic subjects, or split into half days (e.g., English in the morning and Spanish in the afternoon). The goal is that students will be able to speak, understand, read, and write in both

Correspondence: Dolors Girbau, Department of Basic, Clinical & Biological Psychology, University Jaume I, Campus Riu Sec, 12071 Castelló, Spain. E-mail address: girbau@psb.uji.es. http://www.humcom.uji.es.

languages. However, this bilingual approach has also led a certain number of children to fail to develop proficient skills in either language, and to the demand of more resources by teachers (Calderon & Carreon, 2000).

Many of them are sequential bilinguals who first learned Spanish at home and later on English at school. Previous research showed that normally developing early sequential bilinguals with Spanish as L1 (at home) and English as L2 (from English-only educational preschool), move toward English dominance in middle childhood (Kohnert, & Bates, 2002). This came significantly earlier in lexical comprehension (11- to 13-year-olds) than in lexical production (14- to 16-year-olds), and was measured through reaction time and accuracy in response. Becoming proficient in both languages or only in English depends on many variables, such as language instruction at school, language spoken at home and with friends, years of residence in countries with L1 and L2, history of language deficits, socioeconomic status (SES), and length of exposure to the English. Thus, bilingual proficiency varies across the Hispanic population living in USA.

Becoming a balanced bilingual also depends on how similar the two languages are. English and Spanish have significant phonological, morphological and syntactic differences. In Spanish, words are usually morphologically marked. For example, Spanish-speaking children's errors with verb morphology tend to be substitutions, unlike in English speakers who are more likely to omit verb inflections, (Bedore & Leonard, 2000). Also, the transparent orthography of the Spanish language contrasts with the deep asymmetrical English orthography-phonology correspondence (Pérez Cañado, 2005). English has more vowel sounds than Spanish (five vowels). These differences may pose challenges to typically developing children and adults and even greater challenges for children with SLI.

Phonological Working Memory and SLI

One task that appears to distinguish children with SLI from their peers with Typical Language Development (TLD), across languages, is the repetition of non-words. The advantage of this task is that it can be used as a screening test, which involves a shorter time than other language measures (e.g., Gathercole & Baddeley, 1996). Children with SLI have an apparent deficit in phonological working memory (PWM) as exhibited by poorer repetition of non-words, particularly as the length of the non-words increases (e.g., Dollaghan & Campbell, 1998; Gathercole, 2006a, 2006b; Gathercole & Baddeley, 1990; Marton & Schwartz, 2003). Several studies have indicated that this task is a reliable identifier of language impairment and of the risk for language impairment in primary school-aged (Archibald & Gathercole, 2006a) and preschool children (Bishop, Adams, & Norbury, 2004; Briscoe, Bishop, & Norbury, 2001; Dollaghan & Campbell, 1998; Gray 2003; Roy & Chiat, 2004). One explanation for the language learning difficulties of children with SLI is that PWM affects both the acquisition of new words (which demand the retention of new phonological sequences) and broader levels of language processing such as sentence comprehension that require the manipulation of phonological information (Briscoe et al., 2001).

Poor non-word repetition has been found to be a clinical marker of SLI with high heritability (Bishop, 2002; Bishop, North, & Donlan, 1996). In these studies, the members of monozygotic twins (genetically identical) had similar scores on the non-word repetition task, in contrast to the members of dizygotic twins. However, to date, there are no reported studies of non-word repetition by parents of children with SLI. Familial patterns of poor performance may provide further evidence of heritability and may permit the early identification of children at risk for SLI.

Non-word Repetition Tasks with English phonotactic patterns

In non-word repetition tasks, the child listens to a non-word, temporarily stores the novel phonological representation, and then produces it. The task involves the *phonological loop* which is a specialized subsystem of working memory with two components (Baddeley, 1986, 1996, 2003a, 2003b). The first component, *phonological short-term storage* maintains the incoming auditory sequence as a phonological code and the second component, *subvocal rehearsal*, holds this phonological representation avoiding its decay.

Two of the more developed non-word repetition tasks include non-words that are consistent with English phonotactic patterns: the Children's Test of Non-word Repetition (CNRep) and the Non-word Repetition Task (NRT). Performance of children with SLI/TLD on both tasks was compared by Archibald & Gathercole (2006b). The CNRep contains 40 non-words (e.g., *ballop, doppelate*), ranging in length from two to five syllables, with 10 at each length, (Gathercole & Baddeley, 1996). The non-words have English phonotactic and stress patterns. Each non-word is presented via recorded voice to the child who is instructed to repeat it exactly as it is heard. They score each whole non-word as correct or incorrect. The CNRep was normed on 612 children with typically developing language (TLD) between 4;0 and 9;0. Performance improved in the children from four to eight years old.

The Non-word Repetition Task (NRT) includes 16 non-words (e.g., *naib, doitauvab*) from one to four syllables in length, 4 non-words at each length, and it has no formal set of norms (Dollaghan & Campbell, 1998). The non-words were phonotactically English in their segmental content, but they were prosodically non-English (i.e., equal stress with all tense vowels or diphthongs). It was initially administered to 40 children (half of them with SLI) between 6;0 and 9;9 years old, using recorded stimuli. Children with SLI were less accurate than their age-matched TLD children, particularly on the three- and four-syllable non-words. Likelihood ratios revealed that a score of 70% phonemes correct or below identified children as SLI, whereas a percentage of 81% or above identified a child as typically developing, with a high degree of reliability. In a sample of children with a mean age of 7;11 with a narrower age range, the likelihood ratios were not as large (Ellis Weismer, Tomblin, Zhang, Buckwalter, Chynoweth, & Jones, 2000).

This task was also administered to monolingual English-speaking children with SLI/TLD, and to Spanish-English bilingual children with TLD (Kohnert, Windsor, & Kim, 2006). Interestingly, the performance of this bilingual group fell in between the two monolingual groups (the English children with TLD had the best performance). The authors concluded there is a need for measures that can be used with linguistically diverse children. One factor that could affect performance is the language-specific phontacttic patterns of the non-words that are employed. Thus, we created a Spanish Non-word Repetition Task to help detecting SLI in Spanish-speaking children.

Children with SLI and children with TLD have particular difficulties repeating non-words of three or more syllables (e.g., Gathercole & Baddeley, 1990; Gathercole & Baddeley, 1996; Rodekohr & Haynes, 2001). The phonotactic probabilities of target syllables also affect performance in children from 3 to 6 years of age with and without phonological disorders (Munson, Edwards, & Beckman, 2005). In this study, the non-words with low frequency segment sequences were produced less accurately than non-words with high frequency sequences by children in both groups. The children with phonological disorders were less accurate overall, but showed no larger disadvantage for the low-frequency sequences than their age peers. This variable had not been previously controlled in any other non-word repetition task. Their findings also suggested that successful repetition of a low-probability non-word relies on a rich representational system associated with having a large vocabulary. This is

consistent with models of cognitive processing that posit continuity between long-term knowledge and real-time processing.

Investigators have also examined the relationship between non-word repetition and other working memory tasks (e.g., Archibald, & Gathercole, accepted; Ardila, 2003; Kohnert et al., 2006), or a variety of language skills. The findings related with language abilities have been somewhat mixed. For example, sentence comprehension was not correlated with non-word repetition for children (6;4 to 10;5) with SLI or their typically developing peers (Montgomery, 2004). Subgroups of older children with SLI (10;11) who had the highest and the lowest non-word repetition scores differed in reading and reading comprehension, but not in their receptive or expressive vocabulary scores (Botting & Conti-Ramsden, 2001). In contrast, several studies have revealed a relationship between receptive vocabulary and non-word repetition in younger children with TLD (Metsala, 1999; Roy & Chiat, 2004). Non-word repetition has also been found to be less accurate in a smaller-vocabulary group than in a larger-vocabulary group of children (Edwards, Beckman, & Munson, 2004). Finally, children with TLD who had better non-word repetition skills produced speech with a broader vocabulary, longer utterances, and a greater range of syntactic constructions than children with relatively poor non-word repetition skills (Adams & Gathercole, 2000).

Non-word Repetition Tasks in Other Languages

It seems that PWM and information processing are less efficient in L2 than L1 (e.g., Ardila, 2003). Thus, children's non-word repetition tasks have been created for a number of languages including Spanish (Girbau & Schwartz, 2007; Le Foll et al., 1995; Maridaki-Kassotaki, 2002; Paradis, 2001; Sahlén, Reuterskiöld-Wagner, Nettelbladt, & Radeborg, 1999; van Bon & van der Pijl, 1997; Stokes, Wong, Fletcher, & Leonard, 2006). Only several of these studies administered the task in specific language impaired children (the other ones analyzed other children's issues).

In general, length effects are maintained across languages, and children with SLI perform more poorly than children with TLD (e.g., Le Foll et al., 1995). Non-word repetition in Swedish (Barthelom & Åkesson, 1995) was related to four comprehension measures (e.g., story comprehension) in preschool children with language impairment, (Sahlén et al., 1999). Dutch poor readers (9;8-11;8) had a non-word repetition deficit when they were compared with normal readers matched on word-reading abilities (7;7-9;4) (van Bon & van der Pijl, 1997). In Greek-speaking children (6;0-9;0), there were strong links between reading performance and non-word repetition scores (Maridaki-Kassotaki, 2002).

To date, the only report of an auditory non-word repetition task administered to Spanish-speaking children with SLI has focused on children from Spain, who are passive bilinguals in Spanish (primary language of use) and Catalan (which they understand but rarely use) (Girbau & Schwartz, 2007). This study analyzed the whole non-word repetition accuracy, segment (consonants, vowels and clusters) accuracy, and the types of consonant errors (substitutions, omissions and additions). We found that children in Spain with and without SLI exhibited length effects in repeating non-words with phonotactic patterns consistent with Spanish, but that these effects were more pronounced in children with SLI. We also found that non-word repetition performance distinguished these two groups of children with a high degree of accuracy and that performance was related to performance on some standardized language measures.

Aims of the Study

The present study examined the performance of sequential bilingual children with and without SLI on the Spanish non-word repetition task we developed. We focused on children with

Spanish as a first language and mother tongue (L1), and English as the L2, who were part of a larger project about Spanish-speaking children with SLI done in USA and Spain (including a study of sentence processing, Schwartz & Girbau, in preparation). Our main goal was to determine the success with which that task can distinguish children with and without SLI in this bilingual context. We were also interested in analyzing the errors children made because several studies have indicated that children with SLI may have weak or underspecified phonological representations (Edwards & Lahey, 1998; Weismer & Edwards, 2006). In addition, we examined the relationship between non-word repetition and scores from two language tests (one for each language). This could shed more light on how the deficient language processes are interrelated in children with and without SLI. We were also able to administer the same task to a subset of these children's mothers as a pilot study, to determine whether the mothers of these children with SLI tend to perform more poorly than the mothers of these children with TLD.

Method

Recruiting and Participant Selection

Most of the children were recruited from a dual language (English/Spanish) public school in New York City. This school groups native speakers of Spanish with native speakers of English. Instruction is provided both in Spanish and English languages on alternate days. Other children were recruited through speech-language pathologists and by postings on internet and newspapers. Spanish was their first language and English was their L2, according to their teachers, testing, and a parent questionnaire. They all came from Spanish-speaking homes in New York City with low/low-middle socioeconomic status, in which Spanish was the native language for both parents.

Testing

Initially, speech pathologists identified and referred children with language impairment, whose first language was Spanish. The presence of language impairments was further confirmed by the judgments of their teachers and parents, which appears to be a highly reliable indicator of language status (Restrepo, 1998). All were receiving intervention, except two children who were scheduled to start receiving language therapy at the school at the time of testing. Children received the battery of tests after parents signed a consent form.

Eleven children with SLI and 11 age-matched children with TLD (7;6 to 10;10) participated. There were five boys and six girls in each group. Each participant with SLI was matched on age (in years and months) and gender with a child with TLD, as closely as possible. Particularly, after calculating the difference in age for each pair of children, the average age difference (TLD – SLI) was $M = 3.55$ months ($SD = 3.42$). The mean age for the group with SLI was 8;10 ($SD = 13.42$ months, Range = 90 to 126) and the mean age for the group with TLD was 9;1 ($SD = 14.83$ months, Range = 90 to 130 months).

All children performed within normal limits on the TONI-3 – Test of Nonverbal Intelligence (TONI-3; Brown, Sherbenou, & Johnsen, 1997). For children with SLI, $M = 95.09$ and $SD = 6.82$ [ranging from 88 to 107], and for children with TLD, $M = 103.64$ and $SD = 12.92$ [ranging from 84 to 122].

Each participant passed a hearing screening at 20 dB at five frequencies (500, 1000, 2000, 3000, and 4000 Hz) at the laboratory, following the American National Standards Institute (1989). A parent questionnaire was used to determine the extent to which Spanish was the primary language, their socioeconomic status, the family and child's history for language deficits, and that the child did not have a history of neurological disorders, or behavior

characteristic of autism. None of the children had a phonological disorder. Both parents were monolingual speakers of Spanish (with some exposure to English) and were born in Latin American Spanish-speaking countries. According to them, all children had Spanish as a first language and English as a second one.

The English CELF-3 Screening test (Semel, Wiig, & Secord, 1996) was administered as the primary English language measure. The Spanish version of the Illinois Test of Psycholinguistic Abilities (ITPA; Kirk, McCarthy, & Kirk, 2001) was the primary Spanish language measure. This was used because norms appeared to correspond better with clinical and parental judgments of the presence of language impairments in children living in Spain, and due to the scarce availability of reliable Spanish tests with norms from USA for this age range (the alternative was a Spanish version of the CELF-R with limited normative data). So we applied the ITPA with norms from Spain (the same version we used in our previous study, Girbau & Schwartz, 2007). It consists of 11 individually administered subtests (some of them different from the English version). Although all subtests were administered, we selected four subtests as criterial for SLI, because these focused on those characteristics of language production and comprehension that most closely correspond to those tested by more contemporary language tests. In the *Auditory Comprehension* subtest, the child listens to very brief stories and responds to questions about the stories by pointing to pictures. In the *Auditory Association* subtest, the child completes sentences spoken by the examiner (e.g., "The father is big, the child is… small."). The *Verbal Expression* subtest is a lexical fluency task; the child is given a series of categories (e.g., animals, body parts) and is asked to say as many items in the stated category as possible in one minute. In the *Grammatical Integration* subtest, the child completes sentences spoken by the examiner according to related pictures (e.g., "This man is painting. He is a ____ ").

Each subtest/test raw score was converted into a z-score, which was calculated with respect to the M and SD from the corresponding age norms [(raw score – M) / SD)]. For each children's group, we calculated a mean of the z-scores for each of selected subtests (and for the average z-score of these four subtests) of the Spanish ITPA with norms from Spain, and also for the English CELF-3 Screening test, (see Table 1). The children with SLI who were included all scored: (a) below -1.94 SD on the average z-score of these four language-relevant subtests; and (b) below -1.82 SD from the mean z-score on at least two of the four selected subtests. The children with TLD who were included all scored: (a) no more than -1.35 SD from the mean z-scores of these four language-relevant subtests; and (b) no more than -1.28 SD from the mean on at least two of the four selected subtests, (see Table 1). We expected the children with TLD to have depressed scores especially because the norms were based on monolingual speakers (not bilinguals), with different academic backgrounds and probably higher SES than our participants.

As Table 1 shows, the group of children with TLD was more proficient in Spanish than in English (in which they also had mean scores significantly below the mean scores from the norms). The children with SLI had significantly lower proficiency in both languages.

Twelve of these children's mothers also volunteered to perform the same non-word repetition task. They all had Spanish as their native language. According to the parents' questionnaire responses, they were monolingual speakers of Spanish (with some exposure to English) and were born in Latin American Spanish-speaking countries. Seven of them had a child with SLI and five had a child with TLD. Almost all mothers of children with SLI (six out of seven) reported to have one or more relatives with language and/or learning disabilities. The mothers all passed the hearing screening test. We administered the English and Spanish versions of the Peabody Picture Vocabulary Test to all of these mothers, to get a comparative language measure in both languages (PPVT-III, Dunn & Dunn, 1997; *TVIP*, Dunn, Padilla, Lugo, &

Dunn, 1986). On the Spanish vocabulary comprehension test (TVIP), the mean composite standard score for mothers of the children with TLD was 96.60, *SD* = 12.17 (Range = 86 to 117). For mothers of the children with SLI, *M* = 90.5, *SD* = 24.77 (Range = 55 to 114). The English PPVT-III score for mothers of the children with TLD was *M* = 52.4, *SD* = 60.06 (Range = 2 to 118), and for mothers of the children with SLI, *M* = 45.5, *SD* = 40.41 (Range = 15 to 109).

Non-word Repetition Task

A non-word repetition task was constructed following Spanish phonotactic patterns in the syllable structure, stress, and the segments. It included 20 non-words, four at each of five syllable lengths (one, two, three, four and five syllables). All non-words began with consonants. The non-words had a total of 184 segments: 14 segments in one-syllable non-words, 25 in two-syllable non-words, 38 in three-syllable non-words, 48 in four-syllable non-words and 59 in five-syllable non-words. Sixty medium-low frequent different syllables were selected from a sample of 1,148 syllables produced by 6-10 year-old children (Justicia, Santiago, Palma, Huertas, & Gutiérrez, 1996) and 1,156 syllables produced by 6-13 year-olds (Justicia, 1995), and from a list of more than 2,500 Spanish syllables (Armario Toro, 2001). Each syllable contained only one vowel; the syllables with the highest frequency of occurrence were excluded (to avoid making the non-word too easy, especially in the one-syllable length). Syllables with medium and low frequency were combined in different orders within a non-word. None of the non-words contained any diphthongs (to avoid confusion in segmenting a non-word into syllables). Twelve non-words included at least one cluster; these non-words were distributed according to the syllable lengths: two in each of the 1- to 3-syllable non-word lists, and three at both 4- and 5-syllable lengths. The clusters that were included are very frequent in Spanish words (e.g., /bl/; /cr/, /pr/; the /r/ was always tapped). All the Spanish sounds were included on the task, except the /ɲ/ and /w/ [ñ, w], which occur very infrequently. The stress in the non-words varied across four different syllable positions (only 1 syllable in each non-word was stressed): ultimate, penultimate, antepenultimate, and before the antepenultimate, (e.g., /mún.tir/, /gi.ren.fló.nis/). More examples of the non-words at each syllable length are given in Table 2.

The instructions and the 20 non-words were digitally recorded using *Cool Edit Pro* (Syntrillium Software Corporation, 2002), by a native speaker of Spanish. The use of recorded stimuli better controlled the consistency of presentation. The average duration of a non-word at each length was: one-syllable non-words, *M* = 445 ms, *SD* = 51 ms; two-syllable non-words, *M* = 1015 ms, *SD* = 110 ms; three-syllable, *M* = 1332 ms, *SD* = 130 ms; four-syllable, *M* = 1621 ms, *SD* = 137 ms; and five-syllable, *M* = 1890 ms, *SD* = 143 ms. An interstimulus interval that was increased as the length of the non-word increased, permitted sufficient time for the child's repetition. Each non-word was presented only one time. The entire task lasted approximately three minutes.

Procedure

The sessions were audio-recorded. The non-words were presented to the participants individually through a computer with headphones so that they were seated on a side of the table without seeing the screen but the microphone for their recording. Immediately after listening to each non-word, they had to repeat it.

Instructions—Each participant was given the following instructions: "Ahora voy a decirte varias palabras divertidas que son inventadas. Después de escuchar cada palabra inventada tú tienes que repetírmela exactamente tal como la has oído; la debes repetir igual. Algunas palabras son cortas y otras largas. Escucha muy bien, porque sólo puedo decirte cada palabra una vez. Esta es la primera palabra." [I am going to say some funny made-up words. Your job

is to say them back to me, exactly the way you hear them. Some of the words are short, and others are longer. Listen carefully, because I can only say the words once. Here comes the first word].

Transcription and scoring—The participants' productions were transcribed from the tapes by the experimenter. To assess transcription reliability, a second judge independently transcribed the non-word productions of nine randomly selected children. This represented approximately 40% of the sample. The percentage of agreement between two judges for segment transcription (1,630 segments) was 98.53%.

For the children, we examined the number of correct words, the accuracy of the stress pattern as well as the frequency and types of overall consonant, consonant singleton, consonant cluster, and vowel errors. The relative frequency of error types within and across the groups permits a comparison to our previous study in Spanish (and in other languages), and may have clinical or theoretical relevance in revealing something about the nature of phonological representation in these children.

The children's productions were initially analyzed segment-by-segment as: vowels, consonant clusters, consonant singletons, and total consonants (consonants, regardless of whether they were clusters). The first step in these analyses was to determine the target of each segment in the child's production. In most cases we were easily able to match the segments in child's production to the target segments, syllable-by-syllable. In a small number of cases the syllable sequence and structure did not match that of the target. In these cases, we judged whether syllables had been transposed or whether segments had migrated. Each segment produced was categorized as one of the following: (1) correct —the child's production matched the adult target in the same serial position within the syllable (or only involves a minor distortion in pronunciation); (2) substitution —the child substituted a segment for the adult target in the same serial position within the syllable; (3) omission —a consonant or vowel in the adult target did not appear in the child's production; (4) addition —a segment that was not present in the matching target syllable was produced (e.g., /múntirs/ for /múntir/).

In a small number of cases, matching the child's produced syllables and segments with their targets was more challenging. We first attempted to align the syllable sequence produced by the child to the target, using the matching vowels (child's production/target) as syllable anchors because vowels were produced more accurately. If there were no matching vowels, the matching consonants were used as syllable anchors. If the child produced two syllables that could be matched with one target syllable, only the most similar syllable was scored. If the syllable produced had a matching cluster and it was a partial or total fusion of two target syllables, the matching clusters were used as syllable anchors and it was only scored for the target syllable with the cluster. Within a syllable, when one target segment could potentially be matched with more than one error segment in the child's production (e.g., an apparent substitution and an addition), the produced segment that was more similar to the target was classified as substitution.

For the mothers, the analysis focused only on the overall accuracy of non-word production and the accuracy of 3-4-5 syllable non-words. The errors were not further analyzed in the mothers' productions.

Results

Children's Non-word Repetition

The two language status groups of children (SLI/TLD) did not differ significantly in age, on the basis of the one-way ANOVA, $F(1, 20) = 0.31$. Thus, the age variable was not considered

in any of the following analyses. The groups did not differ significantly in their performance IQ, according to the one-way ANOVA, $F(1, 20) = 3.76$. Their reproduction of the stress pattern for the non-words was almost always correct, except for five non-word productions by children with SLI. One child pronounced 3 non-words with the stress relocated in another syllable, one child did the same with a single non-word, and one child produced a single non-word with level stress across all syllables. Thus, the analyses focused on the number or percentage of correct non-words and of correct segments. We also examined the frequency of various error types. Percentages were transformed using an arcsine function prior in all statistical analyses (ANOVAs).

Non-word Repetition Accuracy—Most of the errors occurred on the non-words that were three, four, and five syllables in length, similar to previous reports. So, in addition to the total scores typically examined in non-word repetition tasks, we examined a combined score for three, four, and five-syllable non-words (3-4-5). Two one-way ANOVAs respectively revealed that the language groups differed in the percent of total number of non-words correct [$F(1, 20) = 25.77$, $p = .00006$], and in the 3-4-5 composite percent correct [$F(1, 20) = 21.83$, $p = .0001$]. Figure 1 illustrates that the number of non-words produced correctly decreases with increases in the number of syllables. The graph includes the mean number of correct non-words and SD for each of five syllable lengths in both language groups of children. No individual statistics are reported due to floor or ceiling effects at some word lengths.

Segmental Accuracy and Types of Errors—We examined the overall correct percentages of consonants, vowels and clusters as well as the respective sub-scores across the three-, four-, and five-syllable non-words (see Table 3). Vowels were rarely produced inaccurately by children in either group. The average percent of correct vowels as well as the individual scores for the children with TLD were rather consistently at ceiling (only six scored below 100%, with a minimum score of 95%). The children with SLI made more vowel errors, with one child scoring as low as 66.67% correct. Given the consistently high performance of the children with TLD, any scores below 100% correct are noteworthy as was the case for all the children with SLI. However, because of the ceiling effects, we did not analyze these data statistically. As expected, the children with SLI made more consonant errors overall [$F(1, 20) = 17.05$, $p = .0005$] and more consonant errors in the 3-4-5 syllable non-words [$F(1, 20) = 14.98$ $p = .0009$]. This was also true when clusters were excluded, overall [$F(1, 20) = 22.03$, $p = .0001$] and in the 3-4-5 syllable composite [$F(1, 20) = 19.70$, $p = .0003$]. Thus, the pattern of more consonant than vowel errors was similar across groups. Since we didn't find any significant differences for language groups in vowels nor consonant clusters (see below), then we focused in overall consonants (also for comparison across some studies).

We also examined the percentage of consonants that were omitted or substituted (see Table 3). Substitutions were the most frequent error type in both the total set and the subset of non-words for each of the two groups of children. The children with SLI produced more substitutions than the children with TLD overall [$F(1, 20) = 6.14$, $p = .022$] and in the 3-4-5 syllable non-words [$F(1, 20) = 5.10$, $p = .035$]. The same was true for omissions overall [$F(1, 20) = 10.28$, $p = .004$] and for the 3-4-5-syllable non-words [$F(1, 20) = 9.43$, $p = .006$].

There was no group difference for: (1) the frequency of additions of consonants overall [$F(1, 20) = 2.04$, $p = .169$] and for the 3-4-5 syllable non-words [$F(1, 20) = 2.62$, $p = .121$]; or (2) the percent of clusters overall [$F(1, 20) = 3.39$, $p = .081$] and for the 3-4-5 syllable non-words [$F(1, 20) = 2.55$, $p = .126$], (see Table 3).

Likelihood ratios—We calculated likelihood ratios (Sackett, 1992; Sackett & Haynes, 2002) to determine the extent to which non-word repetition can accurately distinguish children with and without SLI. The likelihood ratios are likely to be somewhat inflated because we pre-

selected groups of children with SLI and TLD rather than testing a general population of as yet unidentified children. These ratios were calculated using the percentage of correct non-words for the subgroup of three- four- and five-syllable non-words (see Table 4). This Table also includes data from our previous study (Girbau & Schwartz, 2007) of children in Spain for comparison with the present study. They are the likelihood that a given test result would be expected in an individual with the target disorder compared to the likelihood that that same result would be expected in a patient without the target disorder. Particularly, for children with TLD, if the percentage of correct non-words (for the subgroup of three-, four- and five-syllable non-words) is greater or equal to 33.0 %, the likelihood ratio is 0.2 with a negative predictive value of 83.33 %. The negative predictive value represents the probability that a child does not have SLI following a negative test result. For children with SLI, if the percentage of correct non-words (for the subgroup of three-, four- and five-syllable non-words) is lower than 33.0 %, the likelihood ratio is 9.00 with a positive predictive value of 90.00 %. Clinically, positive predictive value represents the probability of having SLI given a positive test result. It refers to the proportion of individuals identified as positive on the screening test who actually have the disorder. The post-test probability is 90.00% (pre-test odds = 1; post-test odds = 9).

The sensitivity (or true positive rate) of the Spanish non-word repetition task is 0.82. The sensitivity of a test concerns its ability to identify people with the disorder in question, in this case SLI. It reflects the proportion of children with SLI correctly identified (“true positives”) by the test. A sensitive test is one that provides a minimum of false negatives (i.e., children with SLI who are not detected by the screening measure). The specificity of non-word repetition is 0.91. The specificity (or true negative rate) of the test refers to its ability to accurately identify people who do not have SLI. It reflects the proportion of TLD (non-SLI) children correctly identified (“true negatives”). A specific test provides a minimum of false positives (i.e., non–SLIs identified by the screening test as SLIs).

Relation to other Spanish and English language skills—Beyond the general accuracy with which non-word repetition scores identify children’s language status, we were interested in the relations between these scores and the standardized tests scores we had collected for both Spanish (ITPA) and English (CELF-3) languages. We calculated Pearson Product Moment Correlations between the overall non-word repetition percentages or the 3-4-5 syllable composite percentages and the raw scores of the CELF-3 Test, the four ITPA subtests as well as an overall mean of these subtests (see Figure 2). The mean of the four ITPA subtests highly correlated with both of the non-word repetition scores. The same was true for the individual *Auditory Association*, *Grammatical Integration*, and *Auditory Comprehension* scores. *Verbal Expression* subtest was not significantly correlated with either of the non-word repetition percentages, after using a *p*-value adjusted for multiple comparisons (see note to Figure 2). The correlation between the two Spanish non-word repetition percentages and the English CELF-3 Screening test did not reach significance either.

Mothers’ Non-word Repetition

The number of mothers who agreed to participate was small so these results should be considered preliminary. Thus, the data were not analyzed statistically. Table 5 includes the percentage of total number of non-words correct and in the 3-4-5 composite for children and the mothers of children with and without SLI. It is noteworthy that the mothers’ scores parallels those of the children for both the set and subset of items. The mothers of children with SLI performed more poorly than the mothers of the children with TLD in the non-word repetition task. The mothers’ first language was also Spanish (they all were born in Latin American countries), and they had much less exposure to English than their primary school children. On the Spanish vocabulary comprehension test (TVIP), the mothers of the children with TLD scored slightly higher on average than the mothers of the children with SLI. The English PPVT-

III scores were generally lower and more variable than the Spanish TVIP scores for all the mothers.

Discussion

The non-word repetition task identifies language status with high degree of accuracy in bilingual Hispanic children with Spanish as native and first language. Children with SLI repeated correctly a significantly lower percentage of non-words than children with TLD. The difference between these two groups (SLI/TLD) was greater in longer non-words, beginning with the three-syllable length. Our results are similar to findings for children speaking English (Dollaghan & Campbell, 1998; Ellis Weismer et al., 2000; Montgomery, 2004; Rodekohr & Haynes, 2001) and findings from other languages (e.g., Le Foll et al., 1995), including Spanish (Girbau & Schwartz, 2007).

We analyzed errors for vowels and consonants separately. The two groups of children diverged significantly in the percentage of consonant errors. The most frequent errors for both groups were consonant substitutions, as in previous reports for children of similar ages (Girbau & Schwartz, 2007; Marton & Schwartz, 2003), with a higher mean percentage in children with SLI than in their age-matched peers with TLD. The mean percentage of consonant omissions was three times higher in children with SLI than in children with TLD, and the mean percentage for consonant substitutions was almost twice as high in children with SLI compared to the children with TLD (see Table 3). There were no significant differences between groups in consonant additions or cluster errors. In our previous study (Girbau & Schwartz, 2007), Spanish-speaking children in Spain with SLI made significantly more cluster errors, consonant omissions and substitutions than their typically developing peers. The groups did not differ significantly in the frequency of consonant additions. The cluster error means for both groups in the present study were similar to the children with SLI from Spain, perhaps because of their exposure to English (a language that is more different from Spanish than Catalan is). The challenge of cluster production may reveal some phonological weakness. It is noteworthy that the children with TLD had vowel scores of 95 to 100% correct, whereas the children with SLI did not approach these ceiling scores, despite the fact that all participants produced vowels more accurately than consonants. In part, this may reflect the limited vowel inventory of Spanish (5 vowels) and the fact that vowels are fully acquired earlier in development than the complete consonant inventory. This finding replicates others indicating that vowels are preferentially preserved in this phonological working memory task in children with SLI and children with TLD (e.g., Girbau & Schwartz, 2007). Both groups also reproduced the stress pattern of the non-words almost always accurately, in the line of previous findings (e.g., Marton & Schwartz, 2003). The errors in children with SLI may reflect some underlying weakness in phonological knowledge or memory for phonological information, including the nature of phonological representations in working memory (Edwards & Lahey, 1998; Weismer & Edwards, 2006). Some detailed analyses of the types of errors could be helpful to plan the speech therapy in children diagnosed as SLI (e.g., sounds discrimination exercises according to the found substitutions).

The likelihood ratios in this study and in our previous study (Girbau & Schwartz, 2007) suggest that this Spanish Non-word Repetition Task has the potential to be a valuable screening test for detecting SLI in Spanish-speaking children. The percentage of correct non-words could be used as a SLI marker in Hispanic children. Specifically, a score lower than 33% correct in the 3-4-5-syllable non-words indicates that it is likely that the child has SLI. Conversely, if this score is greater or equal to 33% it is likely that we can rule out this diagnosis. Previous research using the English NRT, with one- to four-syllable words, adopted the percentage of correct total phonemes as cut-offs, (below 70% for SLI and above 81% for TLD children), (Dollaghan & Campbell, 1998). Using the percent of non-words correct could avoid the challenge of

transcription and thus simplify the use of non-word repetition as a clinical screening instrument. For children screening positive, additional testing can be done to determine the presence and severity of the language impairment. However, the likelihood ratios are somewhat inflated because they came from pre-selected groups of children with SLI and TLD and not from a yet unidentified group of children.

The development of a non-word repetition task in Spanish has potential clinical relevance, for Spanish-speaking children. Besides its potential value as a screening instrument, it may be revealing to compare performance across the repetition of non-words that follow English phonotactic patterns with non-words that follow Spanish phonotactic patterns. Performance differences may reflect the extent to which children's phonotactic representations influence their non-word repetition.

Non-word repetition was highly correlated with three of the four ITPA subtests. Two of the correlated subtests (*Auditory Association* and *Grammatical Integration*) require child's oral completion of a sentence presented orally by the experimenter without and with visual support respectively. Thus, these tasks have auditory working memory demands similar to the non-word repetition task. This would explain their high correlation, which was also found in our previous study of children with SLI and TLD in Spain (Girbau & Schwartz, 2007). The *Auditory Comprehension* subtest of ITPA, in which the child answered to questions by pointing to pictures after listening to stories, was also highly correlated with non-word repetition. This result agrees with previously reported correlations between non-word repetition and comprehension measures (like story comprehension) in preschool children with language impairment (Sahlén et al., 1999). However, sentence comprehension did not correlate significantly with non-word repetition for children with or without SLI (6;4-10;5) (Montgomery, 2004). Similarly, we did not find a significant correlation between performance on the Auditory Comprehension subtest and non-word repetition for the children in our previous study in Spain (Girbau & Schwartz, 2007). The relatively small numbers of children in these studies, the differences in language status, and the potential for individual differences across the samples may be the sources of these conflicting findings.

The last Spanish subtest, *Verbal Expression*, did not correlate significantly with the task, as we found in our previous study. It is a lexical fluency subtest that requires the child to produce words about particular categories. This result is not surprising because the subtest makes more demands on long-term memory than on more immediate working memory processes. In older children with SLI, non-word repetition has not been found to be related to expressive nor receptive vocabularies (Botting & Conti-Ramsden, 2001). Yet, previous research in younger children with TLD revealed an association between smaller vocabulary and lower accuracy in non-word repetition (Adams & Gathercole, 2000; Edwards et al., 2004). Perhaps the relationship between vocabulary comprehension and non-word repetition is nonlinear over the course of development. Initially, non-word repetition drives vocabulary, but at a later age (or as children become more language proficient), vocabulary may drive non-word repetition performance (cf. Gathercole 2006a, for a review).

There was no significant correlation between non-word repetition and the CELF screening test. This may be due to the fact that it assesses L2 skills in these children. However, two tasks on the CELF-3 make direct demands on working memory: sentence completion and the repetition of sentences with increasing length. This could clarify why the correlation scores with CELF-3 approached significance.

Together, these relationships between non-word repetition and performance on the language tests might explain why it is appropriate to use a working memory task following the phonotactic patterns of the child's first language, as a screening tool to detect children with

SLI. Previous research has addressed how the PWM deficit together with other related language and language-related deficits pose a challenge to language acquisition for monolingual English children with SLI (Briscoe et al., 2001). They may face an even greater challenge in acquiring a second language. The effect of PWM deficit on language skills might also vary depending on children's age. Although we did not set out to examine the impact of socioeconomic status (SES) on non-word repetition, our samples in Spain (Girbau & Schwartz, 2007) and in New York seemed to differ in SES and academic background (according to our parent questionnaire). The children in New York came from immigrant families (with lower academic background in general) who would be classified as low to low-middle class, whereas the children in Spain came from families of middle/middle-low class. In the present study, the likelihood ratios led us to set a 33% correct non-word repetition cut-off, whereas in the study conducted in Spain the cut-off was 50.0 % (see Table 4). There is evidence that SES has some effect on language development and academic achievement (e.g., Schuele, 2001). Low SES may have an even greater impact on the fragile language and working memory abilities of children with SLI.

The children in these two studies also differed in their bilingual context, despite the fact that both groups had Spanish as a first language. The children in NYC seem to face a greater challenge to become proficient in both of their languages. The children in Spain were passive bilinguals who were typically proficient in Spanish (their first language) and had Catalan as L2 (a language that they understood but they rarely used), in a bilingual region. In contrast, some Hispanic school-aged children in New York City are not fully proficient in English and Spanish as they are in transitory bilingual programs from Spanish to English proficiency. Also, their second language (English) is less similar in phonology (morphology, syntax, and semantics) to Spanish than Catalan is to Spanish. This might explain the overall lower performance of both groups in New York compared to the groups in Spain on the non-word repetition task as well as on the same Spanish version of ITPA test. Bilingual programs that continue throughout grade school rather than those that are intended to be simply transitional might lead to greater proficiency in English and Spanish. Finally, the age means for the two language groups from Spain were slightly higher (9;6 for children with TLD and 9;5 for children with SLI).

We also reported non-word repetition data from a subset of the Spanish-speaking children's mothers (seven who had children with SLI and five who had children with TLD). The mothers with SLI children performed more poorly than the mothers of the children with TLD for the set of 20 non-words and for the subset of 3-4-5 syllable non-words, following the pattern and degree of difference between the two groups of children. It is also noteworthy that six of the seven mothers of children with SLI reported to have at least one or more family relatives with language or learning disabilities. Further research is needed with a larger number of parents (mothers and fathers) to examine the potential use of this non-word repetition task in parents as another marker of SLI. It may be possible to identify parents whose children are at risk for SLI at an earlier age than the children might be testable. It might also provide further information about the heritability of a non-word repetition deficit as a clinical marker of SLI (Bishop, 2002; Bishop et al., 1996).

The present study adds to a large body of research concerning the non-word repetition skills of children with language impairments and provides additional data concerning the non-word repetition of bilingual and older children. It adds to the literature concerning non-word repetition by extending this task to bilingual Spanish-English-speaking children. Spanish data are also an important contribution because Spanish is primarily an open syllable language with a variety of prosodic patterns. Our findings confirm that non-word repetition deficits cannot be just ascribed to the closed syllable, trochaic pattern of English. With the cross-linguistic demonstration of these effects, it may be possible to compare the repetition of non-words with

native and non-native phonotactic patterns as a way of analyzing the effects of phonological representation on non-word representation. This would add some cross-linguistic perspective findings such as those that revealed effects of phonotactic probability in English (Edwards et al., 2004) and of the language proficiency of monolingual/bilingual children on the English NRT (Kohnert et al., 2006).

In summary, we found that the non-word repetition task following the phonotactic patterns of Spanish appears to be an accurate identifier of SLI for Spanish-speaking children from 8 to 10 years of age. We also found a length effect similar to previous findings in English and in other languages (e.g., Gathercole & Baddeley, 1990, 1996; Le Foll, et al., 1995; van Bon & van der Pijl, 1997). Moreover, phonological working memory abilities, as measured by non-word repetition, were strongly related to comprehension and production skills in their native Spanish language. With a set of norms and further investigation of parent performance, this task has the potential to be an efficient and accurate screening test for SLI.

Acknowledgments

Part of this work was presented at the *Symposium on Research in Child Language Disorders*, Wisconsin (Madison), in 2005. This research was funded by two grants from the "Ministerio de Educación, Cultura y Deporte" of Spain (Secretaría de Estado de Universidades e Investigación) PR2003-0061 and SAB2003-0310, to the first and second author respectively. Support was also provided by two grants from the "Instituto de Salud Carlos III – Ministerio de Sanidad y Consumo", PI041733 (D. Girbau, P.I.), and the National Institute on Deafness and Other Communication Disorders, 5R01DC003885 (R. Schwartz, P.I.). We are grateful to Ms. G. Muñoz and Dr. R. Salavert for their assistance in identifying and recruiting children.

References

Adams AM, Gathercole SE. Limitations in working memory: implications for language development. International Journal of Language & Communication Disorders 2000;35(1):95–116. [PubMed: 10824227]

American National Standards Institute. Specifications for audiometers. Washington, DC: Author; 1989.

Archibald LMD, Gathercole SE. Short-term and working memory in specific language impairment. International Journal of Language & Communication Disorders 2006a;41(6):675–693. [PubMed: 17079222]

Archibald LMD, Gathercole SE. Nonword repetition: A comparison of tests. Journal of Speech, Language, and Hearing Research 2006b;49:970–983.

Archibald LMD, Gathercole SE. Nonword Repetition and Serial Recall: Equivalent measures of Verbal Short-term Memory? Applied Psycholinguistics. accepted

Ardila A. Language representation and working memory with bilinguals. Journal of Communication Disorders 2003;36:233–240. [PubMed: 12742670]

Armario Toro J. Un listado de las sílabas del español. Cuadernos Cervantes de la Lengua Española 2001;7 (36):38–45.

Baddeley, AD. Working Memory. Oxford: Oxford University Press; 1986.

Baddeley AD. Exploring the central executive. Quarterly Journal of Experimental Psychology 1996;49A: 5–28.

Baddeley AD. Working memory and language: An overview. Journal of Communication Disorders 2003a;36(3):189–208. [PubMed: 12742667]

Baddeley AD. Working Memory: Looking back and looking forward. Nature Reviews Neuroscience 2003b;4(10):829–839.

Barthelom, E.; Åkesson, M. Unpublished master's thesis. Lund University; Lund, Sweden: 1995. Konstruktion, testning och utvärdering av nonord.

Bedore LM, Leonard LB. The effects of inflectional variation on fast mapping of verbs in English and Spanish. Journal of Speech, Language, and Hearing Research 2001;43:21–33.

Bishop DVM. The role of genes in the etiology of specific language impairment. Journal of Communication Disorders 2002;35:311–328. [PubMed: 12160351]

Bishop DVM, Adams CV, Norbury CF. Using nonword repetition to distinguish genetic and environmental influences on early literacy development: a study of 6-year old twins. American Journal of Medical Genetics 2004;129B:94–96. [PubMed: 15274048]

Bishop DV, North T, Donlan C. Nonword repetition as a behavioural marker for inherited language impairment: evidence from a twin study. Journal of Child Psychology and Psychiatry, and Allied Disciplines 1996;37(4):391–403.

Botting N, Conti-Ramsden G. Non-word repetition and language development in children with specific language impairment (SLI). International Journal of Language & Communication Disorders 2001;36 (4):421–432. [PubMed: 11802495]

Briscoe J, Bishop DVM, Norbury CF. Phonological processing, language and literacy: a comparison of children with mild to moderate sensorineural hearing loss and those with specific language impairment. Journal of Child Psychology and Psychiatry 2001;42:329–340. [PubMed: 11321202]

Brown, L.; Sherbenou, R.; Johnsen, S. TONI-3: Test of Nonverbal Intelligence. Vol. 3. Austin, TX: PRO-ED; 1997.

Calderon, M.; Carreon, A. A two-way bilingual program: promise, practice, and precautions. Report No. RR-47. Baltimore, MD: Center for Research on the Education of Students Placed At Risk; 2000.

Crespo-Eguilaz N, Narbona J. Revista de Neurología 2003;36(1):S29–S35.

Dollaghan CA, Campbell T. Nonword repetition and child language impairment. Journal of Speech, Language, and Hearing Research 1998;41:1136–1146.

Dunn, LM.; Dunn, LM. Peabody Picture Vocabulary Scale – Third Edition (PPVT-III). Circle Pines, MN: American Guidance Service; 1997.

Dunn, LM.; Padilla, ER.; Lugo, DE.; Dunn, LM. Test de Vocabulario en Imágenes Peabody (TVIP). Circle Pines, MN: American Guidance Service; 1986.

Edwards J, Beckman ME, Munson B. The interaction between vocabulary size and phonotactic probability effects on children's production accuracy and fluency in nonword repetition. Journal of Speech, Language, and Hearing Research 2004;47(2):421–436.

Edwards J, Lahey M. Nonword repetitions of children with specific language impairment: Exploration of some explanations for their inaccuracies. Applied Psycholinguistics 1998;19(2):279–309.

Ellis Weismer S, Tomblin JB, Zhang X, Buckwalter P, Chynoweth JG, Jones M. Nonword repetition performance in school-age children with and without language impairment. Journal of Speech, Language, and Hearing Research 2000;43:865–878.

Gathercole SE. Nonword repetition and word learning: The nature of the relationship. Applied Psycholinguistics 2006a;27:513–543.

Gathercole SE. Author's response: Complexities and constraints in nonword repetition and word learning. Applied Psycholinguistics 2006b;27:599–613.

Gathercole SE, Baddeley AD. Phonological memory deficits in language disordered children: Is there a causal connection? Journal of Memory and Language 1990;29:336–360.

Gathercole, SE.; Baddeley, AD. The Children's Test of Nonword Repetition. London: Psychological Corporation; 1996.

Girbau D, Schwartz RG. Non-word repetition in Spanish-speaking children with Specific Language Impairment (SLI). International Journal of Language & Communication Disorders 2007;42(1):59–75. [PubMed: 17365086]

Gray S. Diagnostic accuracy and test-retest reliability of nonword repetition and digit span tasks administered to preschool children with specific language impairment. Journal of Communication Disorders 2003;36(2):129–151. [PubMed: 12609578]

Hispanic Population of 10 Largest U.S. Cities, 2000. World Almanac & Book of Facts 2005;9

Justicia, F. El desarrollo del vocabulario Diccionario de frecuencias. Granada: Servicio de Publicaciones de la Universidad de Granada; 1995.

Justicia F, Santiago J, Palma A, Huertas D, Gutiérrez N. La frecuencia silábica del español escrito por niños: estudio estadístico. Cognitiva 1996;8:131–168.

Kirk, SA.; McCarthy, JJ.; Kirk, WD. ITPA: Test Illinois de Aptitudes Psicolingüísticas. Madrid: TEA; 2001.

Kohnert K, Bates E. Balancing bilinguals II: Lexical comprehension and cognitive processing in children learning Spanish and English. Journal of Speech, Language, and Hearing Research 2002;45:347–359.

Kohnert K, Windsor J, Kim D. Do language-based processing tasks separate children with Language Impairment from typical bilinguals? Learning Disabilities Research and Practice 2006;21(1):19–29.

Larsen, LJ. Current Population Reports, P20–551. Washington, DC: U.S. Census Bureau; 2004. The foreign-born population in the United States: 2003.

Le Foll K, Godin B, Jacques A, Taillant A. Étude comparative de la répétition de mots et de logatomes entre un groupe d'enfants de 6 à 13 ans présentant des troubles sévères du langage et un groupe d'enfants de 3 ans. Approche Neuropsychologique des Apprentissages chez l'Enfant 1995;7:11–17.

Maridaki-Kassotaki K. The relation between phonological memory skills and reading ability in Greek-speaking children: Can training of phonological memory contribute to reading development? European Journal of Psychology of Education 2002;17:63–75.

Marton K, Schwartz RG. Working memory capacity and language processes in children with specific language impairment. Journal of Speech, Language, and Hearing Research 2003;46(5):1138–1153.

Metsala JL. Young children's phonological awareness and nonword repetition as a function of vocabulary development. Journal of Educational Psychology 1999;91(1):3–19.

Montgomery JW. Sentence comprehension in children with specific language impairment: effects of input rate and phonological working memory. International Journal of Language & Communication Disorders 2004;39(1):115–133. [PubMed: 14660189]

Munson B, Edwards J, Beckman ME. Relationships between nonword repetition accuracy and other measures of linguistic development in children with phonological disorders. Journal of Speech, Language & Hearing Research 2005;48(1):61–78.

Nation K, Clarke P, Marshall CM, Durand M. Hidden language impairments in children: parallels between poor reading comprehension and specific language impairment? Journal of Speech, Language & Hearing Research 2004;47(1):199–211.

Paradis J. Do bilingual two-year-olds have separate phonological systems? International Journal of Bilingualism 2001;5(1):19–38.

Pérez Cañado ML. English and Spanish spelling: Are they really different? The Reading Teacher 2005;58 (6):522–529.

Restrepo MA. Identifiers of predominantly Spanish-speaking children with language impairment. Journal of Speech, Language, and Hearing Research 1998;41(6):1398–1411.

Rodekohr RK, Haynes WO. Differentiating dialect from disorder: A comparison of two processing tasks and a standardized language test. Journal of Communication Disorders 2001;34:255–272. [PubMed: 11409607]

Roy P, Chiat S. A prosodically controlled word and nonword repetition task for 2- to 4-year-olds: evidence from typically developing children. Journal of Speech, Language, and Hearing Research 2004;47(1): 223–234.

Sackett DL. The rational clinical examination. A primer on the precision and accuracy of the clinical examination. Journal of the American Medical Association 1992;267(19):2638–2644. [PubMed: 1573753]

Sackett DL, Haynes RB. The architecture of diagnostic research. British Medical Journal 2002;324 (7336):539–541. [PubMed: 11872558]

Sahlén B, Reuterskiöld-Wagner C, Nettelbladt U, Radeborg K. Language comprehension and nonword repetition in children with language impairment. Clinical Linguistics and Phonetics 1999;13(5):369–380.

Schuele CM. Socioeconomic influences on children's language acquisition. Journal of Speech-Language Pathology and Audiology 2001;25(2):77–88.

Schwartz RG, Girbau D. Pronoun processing in Spanish-speaking children with SLI. in preparation

Semel, E.; Wiig, EH.; Secord, WA. CELF–3 Screening Test (Clinical Evaluation of Language Fundamentals—Third Edition). San Antonio, TX: Harcourt; 1996.

Spaulding TJ, Plante E, Farinella KA. Eligibility criteria for language impairment: is the low end of normal always appropriate? Language, Speech, and Hearing Services in Schools 2006;37(1):61–72.

Stokes SF, Wong AM, Fletcher P, Leonard LB. Nonword repetition and sentence repetition as clinical markers of specific language impairment: the case of Cantonese. Journal of Speech, Language, and Hearing Research 2006;49(2):219–236.

Suro R. Special Section: Hispanic Americans. World Almanac & Book of Facts 2005;7

Syntrillium Software Corporation. Computer software: digital audio editor, recorder, and mixer. Phoenix, AZ: 2002. Cool Edit Pro.

Van Bon WHJ, Van Der Pijl JML. Effects of word length and wordlikeness on pseudoword repetition by poor and normal readers. Applied Psycholinguistics 1997;18:101–114.

Weismer SE, Edwards J. Commentaries: The role of phonological storage deficits in specific language impairment: A reconsideration. Applied Psycholinguistics 2006;27(4):556–562.

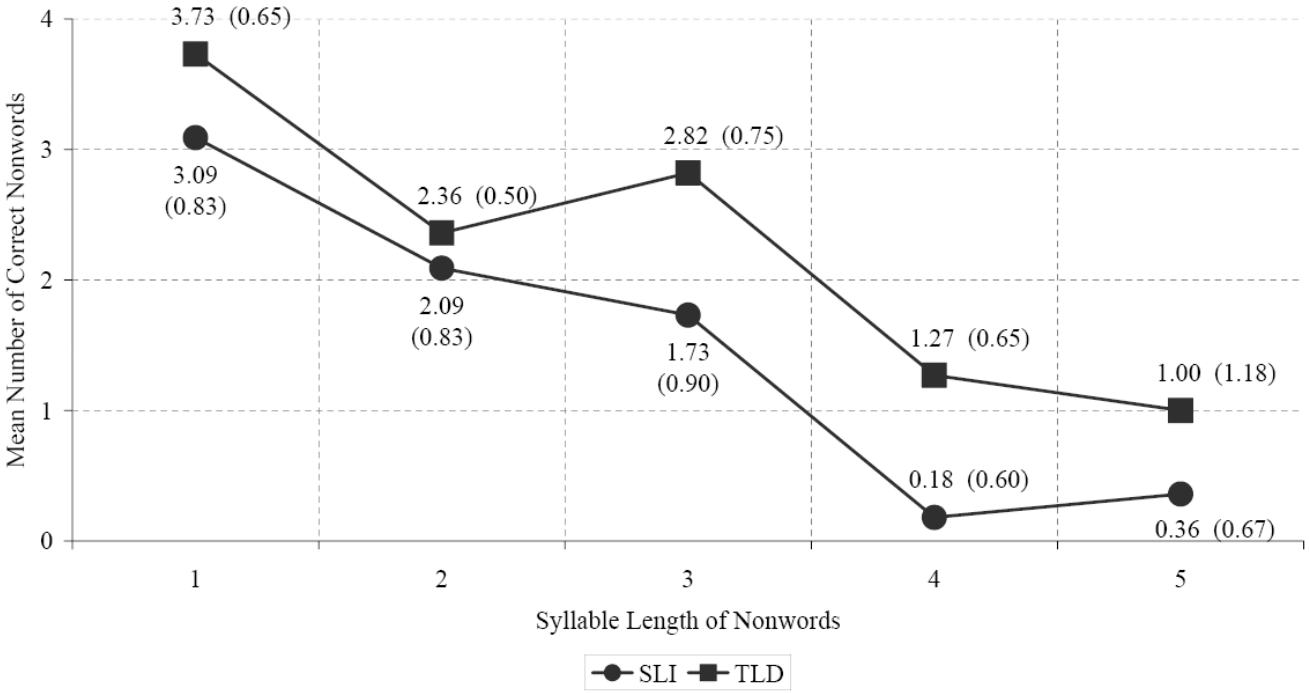

Figure 1.
Mean number of correct non-words (SD) for each of five syllable lengths: Children with SLI and TLD.

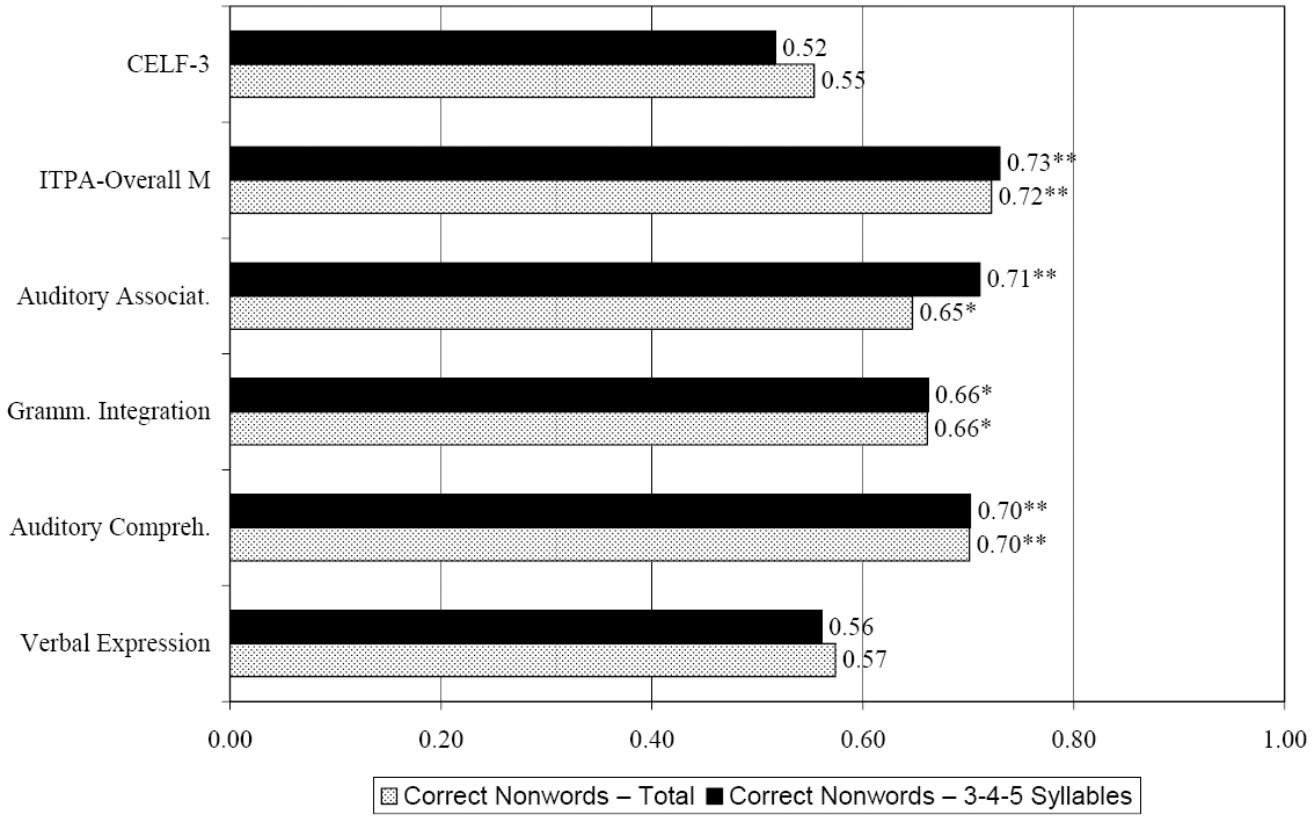

Figure 2.

Pearson correlations between the four subtests of Spanish ITPA test (including the overall mean), the English CELF-3 Screening Test scores, and the percentage of correct non-words in the Non-word Repetition task.

Note. * $p < .001$ ** $p < .0003$. For all correlation scores, according to the Bonferroni correction, the significant p-value starts at $p = .004$ (i.e., the probability of .05 divided by the 12 correlations we performed). According to this, the correlations between the Verbal Expression subtest scores and both the composite 3-4-5-syllable percent of correct non-words ($p = .007$) and the total percent correct non-words ($p = .005$) were not significant. The correlations of CELF-3 scores with the composite 3-4-5-syllable percent of correct non-words ($p = .014$) and the total percent correct non-words ($p = .008$) were not considered significant either.

Table 1

Mean Standard Deviations, in relation to mean scores from the norms, (and Standard Deviations) for the Spanish ITPA and the English CELF-3 Screening Tests scores

	ITPA					CELF-3
	Auditory Comprehension	***Auditory Association***	***Verbal Expression***	***Grammatical Integration***	**Overall *M***	**Total**
SLI	-3.73 (2.44)	-2.15 (1.50)	-1.71 (0.75)	-4.34 (1.85)	-2.95 (1.09)	-2.42 (0.67)
TLD	-0.04 (0.66)	-0.05 (0.51)	-0.24 (0.67)	0.04 (1.16)	-0.07 (0.55)	-1.19 (1.42)

Table 2

Examples of the Non-words for each syllable length

Phonetic Transcription	Ortographic Transcription
[flín]	flín
[θolér]	zo.llér
[konscenbrál]	cons.cen.brál
[girenflónis]	gui.ren.fló.nis
[kleptasmaθórfun]	clep.tas.ma.zór.fun

Table 3

Mean (Standard Deviation) Accuracy for Non-word Repetition

	Total Non-words		3-4-5- Syllable Non-words	
	SLI	**TLD**	**SLI**	**TLD**
Correct items				
Non-words	37.27 (8.76)	55.91 (8.61)	18.94 (13.48)	42.42 (9.47)
Consonants	73.31 (10.17)	87.46 (3.96)	70.53 (12.08)	86.31 (4.57)
Vowels	91.06 (9.08)	98.18 (2.03)	90.06 (10.39)	98.14 (2.07)
Clusters	73.33 (17.64)	83.64 (9.12)	68.69 (23.84)	80.20 (11.65)
Errors in consonants				
Substitutions	14.88 (6.57)	9.16 (3.84)	15.73 (7.81)	9.48 (4.28)
Omissions	10.85 (6.91)	3.52 (2.08)	12.66 (7.93)	4.28 (2.66)
Additions	4.64 (2.87)	3.18 (1.78)	4.27 (2.80)	2.73 (1.49)

Note. For the consonants categories, each cluster was counted as 2 consonants. All categories are presented as percentages except additions, which are presented as frequencies.

Table 4

Likelihood ratios for the percentage of correct non-words from the subgroup of three-, four- and five-syllable non-words in Children with SLI and TLD: samples from USA and Spain (Girbau & Schwartz, 2007)

	SLI		TLD		
	Number	**Proportion**	**Number**	**Proportion**	***Likelihood ratio***
Children from USA					
< 33.0 %	9	9/11 = 0.8182	1	1/11 = 0.0909	0.8182/0.0909 = 9.00
≥ 33.0 %	2	2/11 = 0.1819	10	10/11 = 0.9091	0.1819/0.9091 = 0.20
Children from Spain					
≤ 50.0 %	11	11/11 = 1	1	1/11 = 0.0909	1/0.0909 = 11.00
> 50.0 %	0	0/11 = 0	10	10/11 = 0.9091	0/0.9091 = 0

Note. Data are based on: (a) 22 participants recruited in New York City, USA, (11 children with SLI and 11 children with TLD); and (b) 22 participants recruited in Castelló, Spain (11 children with SLI and 11 children with TLD; Girbau & Schwartz, 2007). These data from Spain are reported here to allow comparison between both studies.

Table 5

Mean (Standard Deviation) Accuracy for Non-word Repetition in a Subgroup of Children with SLI and TLD and their Mothers: Percentage of correct non-words

	Total Non-words		3-4-5- Syllable Non-words	
	SLI	**TLD**	**SLI**	**TLD**
Mothers	39.29 (13.36)	51.00 (4.18)	23.81 (16.96)	36.67 (7.46)
Children	34.29 (7.87)	57.00 (7.58)	15.47 (10.13)	43.33 (6.97)

Note. Data are based on 12 mothers and their respective 12 children (7 children with SLI and 5 children with TLD).