2009

Spanish-specific patterns and nonword repetition performance in English language learners

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SPANISH-SPECIFIC PATTERNS AND NONWORD REPETITION PERFORMANCE

IN ENGLISH LANGUAGE LEARNERS

by

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A dissertation in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy
Department of Psychology
College of Arts and Sciences
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Keywords: Wordlikeness, Phonotactic Probability, Type Frequency, Phonological
Learning, Stress Patterns

Dedication

My dissertation is dedicated to my four cardinal points:

To my husband, Erik, my best friend and partner-in-crime, for his undying faith in my abilities, his unmatched patience, his respect for my essence, and his unconditional love. Thank you for listening to my doubts, for celebrating my little milestones, and for helping me become a better "me."

To my father, Julio, for teaching me the love for speaking, reading, and learning and for instilling in me the values of perseverance and commitment to my goals.

To my Mother, Margarita, for not being afraid to break stereotypes while becoming my first example of a hard-working woman with high professional aspirations. Thank you for being at all times of my life my rock and my soft place to land on and for *never* doubting I would get *here*.

And finally, to my daughter, Lía Michele, for her insatiable curiosity and her ability to marvel at the seemingly unimportant aspects of our everyday. Thank you for allowing me to see the world through your eyes. It is in those eyes that I continue to melt, while rediscovering the wonder and magic in language-learning and life.

Acknowledgements

This dissertation would not be complete without acknowledging a few instrumental individuals. First and foremost, I'd like to thank my mentor and friend, *Judy Bryant*, for her unparalleled support and encouragement, superb sense of objectivity, and, most importantly, for her presence in my life. Thank you, also, to my dissertation co-supervisor, *Stefan Frisch*, for his willingness to take a chance on me late in my doctoral training career, for maintaining the perfect balance between sincerity and humor, and for always helping me acquire perspective, while considering the many sides of every choice. Thanks to *Elaine Silliman* for the many years of guidance, support, and friendship; my thinking has been especially shaped by you. "Gracias" also to my other Committee Members, *Lisa Lopez*, for your cultural awareness, for sharing a passion in my topic, and for becoming a strong community advocate for my project. And to *Michael Brannick*, thank you for your unparalleled sense of humor and statistical wisdom in this creative endeavor.

To my dear friend and sister in life, *Ania Seoane*, thank you for donating your time and expertise during the assessment and coding phases of this study. Special gratitude to the Redlands Christian Migrant Association and Hillsborough County Head Start daycare/ preschool centers for opening their doors without reservations to me, to the teachers for donating their time and input, to the parents for allowing me access to your precious possessions, your children. Finally, thank you to the little ones, who trusted me enough to partake and make possible my first *original* idea.

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Spanish-Specific Patterns and Nonword Repetition Performance in English-Language Learners

María R. Brea-Spahn

ABSTRACT

Nonword repetition tasks were originally devised to assess the efficiency of the phonological loop (Baddeley & Hitch, 1974), a component of the working memory system, where verbal information is temporarily stored and translated to support activities like phonological processing during early word-recognition (Snowling, 1981; Wagner et al., 2003), speech production (McCarthy & Warrington, 1984), and articulation (Watkins, Dronkers, & Vargha-Khadem, 2002; Yoss & Darley, 1974).

From a practical perspective, there is a significant need for a systematically-designed Spanish nonword repetition measure that is equivalent to currently-available English measures. For this study, a database of nonwords that considered phonotactic and phonological properties of Spanish was devised. In a preliminary study, Spanish-speaking adults provided wordlikeness judgments about a large set of candidate nonwords. A subset of the rated nonwords was used in the development of a Spanish nonword repetition measure. The aim of the main experiment was to explore the contributions of participant factors (age, gender, and vocabulary knowledge) and item factors (word length, stress pattern, and wordlikeness) to Spanish repetition performance in this group of Spanish speaking, English language learning children. From a theoretical perspective, this investigation allowed a first observation of how experience with listening to and producing Spanish words influences the acquisition of Spanish-specific phonological patterns.

A total of 68 children, ages four to six years with varying degrees of Spanish language knowledge participated in this study. Results revealed significant age and word length effects. However, stress pattern did not exert significant effects on repetition performance, which is not completely consistent with previous literature. That is, participants repeated nonwords from both the more frequent and the less frequent stress pattern with similar accuracy. Wordlikeness, a previously uninvestigated variable in nonword repetition was found to affect repetition accuracy. For all participants, nonwords rated as high in wordlikeness were more accurately repeated than were nonwords with low wordlikeness ratings. Findings of the study are discussed in terms of how they relate to working memory and usage-based models of phonological learning. Finally, the clinical relevance of nonword repetition in the assessment of coarse- and fine-grained mappings of phonological knowledge is suggested.

CHAPTER 1

Introduction

Some variation in linguistic skill within the typical population may be attributed to differences in language exposure (MacDonald & Christiansen, 2002). One component of language exposure is the frequency of a particular phonological pattern (e.g., syllabic and subsyllabic word components) within a language, as well as the regularity of the pattern, or its similarity to other patterns in the language. Evidence of the shaping of behavior by the relative likelihoods of language-specific phonological patterns has been documented in the speech perception and production literature. For instance, as early as nine months of age, infants can distinguish between frequent and infrequent English phoneme sequences (Jusczyk, Luce, & Charles-Luce, 1994). Similarly, Vihman (1993) noted that, in their transition to saying their first words, infants exposed to the English language produce more monosyllabic variegated babbles and syllables ending in consonants compared to infants exposed to other languages, reflecting the predominance of this syllable shape in English.

Frequency effects on phonological processing have also been reported (e.g., Storkel, 2001; Storkel & Rogers, 2000). Adults provide higher acceptability ratings to stimulus items made up of phonetic patterns that are well represented in a variety of words in their lexicons, i.e., have high phonotactic probability (e.g., Coleman & Pierrehumbert, 1997; Frisch, Large, & Pisoni, 2000; Ohala & Ohala, 1987). Similarly, children progressively 'build up' to achieve adult-like phonetic precision in their productions, as measured in their repetitions of made-up words, by gradually refining their stored phonological information about words, a process that could take place as vocabulary breadth increases (Edwards, Beckman, & Munson, 2004).

Measures of language processing, such as nonword repetition, provide a dynamic medium for analyzing the effects of language-specific patterns on production. The nonwords used in these tasks, like real words, are composed of pronounceable strings of phonemes and syllables; however, nonwords are unlike real words because they are devoid of an associate lexical or grammatical meaning (Campbell, Dollaghan, Needleman, & Janosky, 1997; Gathercole, 1995). Originally devised to assess the functionality of a component of working memory, nonword repetition measures require that listeners perceive a nonword, rehearse it in working memory to maintain phonetic traces that are active only for a short period of time, and orally repeat it to match the presented input target.

Recent evidence suggests that English-speaking children's performance on nonword repetition tasks may be mediated by the degree to which the nonwords resemble real words in the lexicon, or their wordlikeness (Edwards et al., 2004; Gathercole, 1995). A nonword's degree of wordlikeness, in turn, is related to the frequency of occurrence of the nonwords' prosodic structure and constituent syllables, onset-rimes, and phonemes (i.e., the phonotactic probability in the language). As a result, wordlikeness is language-specific because phonemes and syllables do not occur with the same frequency in all languages. While most nonword repetition studies have been conducted with English speakers, some nonword repetition studies have been conducted with Spanish-speaking children acquiring English as a second language; however, these studies have two major limitations. One restriction is that these tasks tend to be administered in English only (e.g., Chiappe, Siegel, & Gottardo, 2002; Gottardo, 2002). The second issue is that item construction of Spanish measures of nonword repetition has not consistently considered variables such as wordlikeness and the frequency of Spanish phonotactic patterns (Calderón, 2003; Danahy, Kalanek, Cordero, & Kohnert, 2008; Girbau & Schwartz, 2007; 2008). Therefore, there exists considerable need for the systematic development of a nonword repetition task that may be utilized for revealing the associations between Spanish-specific phonotactic patterns, specifically stress assignment and wordlikeness, and nonword repetition performance.

The first step in the systematic development of nonword stimuli for a repetition task is obtaining access to a representative set of real words from oral and written registers of a particular language or dialect. According to the American Community Survey of the US Census Bureau (2008, September 23), Latinos living in the United States represent a variety of countries. Of over 300,000,000 survey respondents, 44,252,278 considered themselves Latinos. The following areas of origin (in order of frequency) were reported by this group: Mexico, Puerto Rico, Cuba, Dominican Republic, Central, and South America. Surprisingly, available Spanish nonword repetition tasks have been developed from Castilian Spanish corpora. Castilian Spanish is the variety of Spanish spoken in north and central Spain, which differs in phonology and semantics from other varieties of Spanish used in Latin America. As a result, the development of a nonword repetition task in Spanish to be used in the United States must take into account the linguistic characteristics of Latin-American Spanish dialects and registers prevalent in the United States.

The following review of the literature has been organized into four major sections. In the first section an overview is conducted of a well-known model of working memory. Although there exist other models of working memory (e.g., Montgomery & Windsor, 2008), Baddeley and Hitch's (1974) interpretation of a phonological working memory has been most often utilized as the paradigm driving the study of nonword repetition, and in turn, is the focus of this overview. Particular attention is given to related theoretical paradigms that have attempted to explain component processes embedded in nonword repetition measures. A synopsis of related research in lexical access in bilinguals follows, along with a summary of results from nonword repetition studies with English monolinguals and Spanish-speaking, English language learners. Second, there is a discussion of the purposes and methodological foci of various nonword repetition measures. The third section addresses the theoretical linguistic framework, grounded in probabilistic phonology, that may guide research on relationships between language-specific lexical patterns and performance on language processing tasks, like nonword repetition, in Spanish speaking children. Finally, the research hypotheses for the current study are provided.

Nonword Repetition and Vocabulary: The Supportive Role of Working Memory

A growing body of research has emphasized the linkage between performance in nonword repetition tasks and word learning. Data from those investigations suggest that word learning may be supported by the rehearsal and phonological representation/storage processes underlying verbal working memory (Gathercole & Baddeley, 1989; 1990; 1993). Using as a framework Baddeley and Hitch's (1974) phonological loop working memory model, Gathercole (1995) and colleagues (Gathercole, Service, Hitch, Adams, & Martin, 1999) have documented the relationship between vocabulary knowledge and the repetition of novel word forms. Results from their studies have led to the hypothesis that phonological working memory mediates the breadth of children's vocabulary learning, at least before age 5 years. Gathercole and colleagues, in fact, have suggested that nonword repetition simulates the word learning process experienced by young children. That is, the lexical and phonological representations of a spoken word, whether real or nonword, are stored temporarily in the storage component of the phonological loop. According to Gathercole (2006), this relationship between nonword repetition and vocabulary seems intuitively plausible since every unfamiliar word a language learner acquires "may have begun its journey into our mental lexicon via such a repetition attempt" (p. 513).

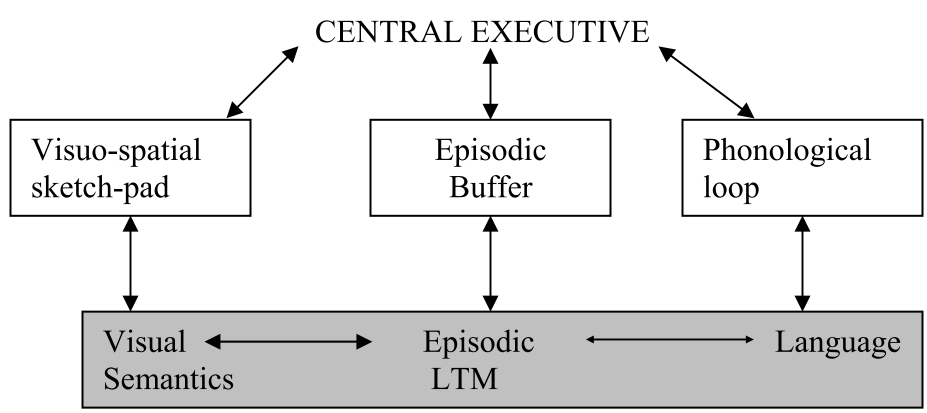
The Phonological Loop Model

Phonological working memory, an active memory system that functions to store phonological information on a short term basis, has been found to support speech perception, language learning, and word recognition during reading (Baddeley & Hitch, 1974). The proposal of a multiple component memory system dates back to the 19th century (James, 1890); but Baddeley & Hitch's (1974) phonological loop model is famously credited with the current definition of the limited-capacity storage and information processing mechanism known as working memory. Baddeley and Hitch's working memory model represents an elaboration of previous non-unitary models of short-term memory proposed by Broadbent (1958) and Atkinson & Shiffrin (1968). This construct differs from short-term memory. Working memory refers to the structures and processes that are involved in temporarily storing and manipulating information. On the other hand, short-term memory generally refers in a theory-neutral manner to the short-term storage of information. The two are related in the sense that there are short-term memory elements involved in working memory, particularly in the working memory model proposed by Baddeley and Hitch.

The original Baddeley and Hitch (1974) model consisted of three components: A central control system called the central executive and two subsidiary systems called the visuo-spatial sketchpad and the phonological loop. As proposed by Baddeley and Hitch (1974), the central executive is in charge of manipulating the episodic buffer while providing the attentional control to accomplish the task of processing information. The visuo-spatial sketchpad is responsible for integrating visual, nonverbal information. Finally, the phonological loop is the subsidiary system specialized for the storage of verbal material.

As depicted on Figure 1, a fourth component, the episodic buffer, was added to the model more recently (Baddeley, 2000). The inclusion of an episodic buffer came as a result of the need to understand the process by which information from various subsystems was combined into a temporary representation. Thus, the buffer is deemed responsible for integrating and temporarily storing information from different modalities (e.g., visual or auditory) into a single episode. It also has connections with long-term and semantic memories. Baddeley (2000) suggests that the episodic buffer accomplishes the essential function of feeding information into and retrieving information from long term memory, under the direction of the central executive. The central executive is the main component of working memory that has the capability of retrieving, reflecting upon, and manipulating stored information. The current model emphasizes the bidirectional link between the subsidiary systems and their corresponding long-term memory stores. In this way, the subsidiary systems are not only responsible for feeding long-term memory; rather, they are assisted by gradually accumulated semantic and spatial knowledge. Baddeley (2002) envisioned that the working memory system would change over time, becoming more fluid and effective at manipulating incoming and outgoing novel information and, as a result, facilitating learning.

Figure 1.1. Revised Baddeley and Hitch Working Memory Model (Baddeley, 2000)



The function of the phonological loop and nonword repetition. The phonological loop was conceptualized as the subsidiary component responsible for maintaining active phonological representations in memory for short periods of time. To accomplish this process, it utilized two subcomponents of its own. The subcomponents are a temporary storage system and a subvocal rehearsal system. The temporary storage system could hold episodic memory traces over approximately two seconds, during which they decayed, unless they were refreshed by the subvocal rehearsal system (Baddeley, 2002). Decay of memory traces was also influenced by the phonological similarity of the items

(Conrad & Hull, 1964). For example, a list composed of the spoken letters B, V, C, D, and T (e.g., all ending in the vowel /e/) would be more difficult to recall than a list including the letters W, Y, M, K, and R (e.g., consonant names all ending in different vowels). The rehearsal mechanism had the function of maintaining memory traces 'fresh' and also translating the nonphonological inputs, such as pictures or printed words used in text-related activities, into their phonological form so that they could be held in the memory store. The rehearsal mechanism, being episodic, is affected by the length of the items being rehearsed. Specifically, longer items (e.g., multisyllabic words) resulted in slower rehearsal times, which allowed increased forgetting (Gathercole & Baddeley, 1989, 1990; Gathercole, Willis, Baddeley, & Emslie, 1994).

To test the storage and the rehearsal capabilities of the phonological loop in a typical experiment, participants recall words or digits in sequential order. When immediate serial recall is required, the phonological loop rehearses the set of activated sequences in order to maintain the phonological representations in an active state. This active state is supported by established representations in long-term memory (e.g., the lexicon).

Nonword repetition as a measure of working memory. In their study involving children with and without language impairment, Gathercole and Baddeley (1990) employed two working memory tasks. One procedure involved the serial recall of digits (i.e., digit span), while the other measure involved the repetition of made-up words (i.e. nonwords). Performance in their nonword repetition task was highly correlated with performance in the digit span task. They interpreted this finding as suggesting that the two measures shared a common underlying construct. They viewed the nonword repetition task as having an advantage over traditional digit span measures because it used "nonlexical material" (Gathercole & Baddeley, 1989) and presumably allowed for the elimination of familiarity with the to-be remembered items. As a result, it was determined that the nonword repetition task would be an appropriate alternative to immediate serial recall tasks in subsequent experiments.

Providing an illustration of how nonword repetition could be employed to assess phonological working memory, Gathercole and colleagues (Gathercole, Willis, Emslie, & Baddeley, 1991) posited that successful repetition of nonwords involved the access of lexical and phonological representations active in long-term knowledge through analogical processes, using vocabulary items similar in phonological construction to the nonwords as the scaffold. For example, a child presented with the nonword *bip* might be more successful at repeating it if she had redundant experiences with the production of words that were phonologically similar, like *bit* and *hip*. Gathercole and colleagues also identified an effect of stimulus length on repetition performance. Longer nonwords elicited more errors in repetition, regardless of participant age (Gathercole & Baddeley, 1989; Gathercole et al., 1991). Therefore, it was determined that the task of nonword repetition could be used to measure both the storage and rehearsal phonological loop components of Baddeley and Hitch's (1974) working memory model.

Summary

The work of Baddeley (2000) and Gathercole and colleagues (1991) has made substantial contributions to the understanding of the functional organization of working memory and, particularly, the developmental progression characterizing the efficient use of the phonological loop in children with typical and atypical language and literacy skills. For example, with their studies, word-length and phonological similarity have been identified as influential variables in the rehearsal and storage subcomponents of the phonological loop.

In addition to rehearsing and storing verbal information, the phonological loop has also been proposed to serve as a facilitator of language acquisition (Baddeley, Papagno, & Vallar, 1988). Particularly, as a new word is encountered for the first time, the loop keeps its phonological representation active in order to optimize learning in subsequent encounters with the word. The assumption is that children with better functioning phonological loops will be more successful at repeating unfamiliar nonwords. Data suggest that skill at repeating nonwords, in turn, predicts level of vocabulary development (Gathercole & Baddeley, 1989), which may highlight the assumption that there is a common processing system underlying vocabulary acquisition and working memory. As a result, there is a need for a unified theoretical framework within which to explain the phenomena involved in both word learning and verbal working memory. In devising such a framework, it is important to obtain an understanding of the processes involved in lexical access.

Lexical Access and Nonword Repetition: Frameworks

To the extent that nonword repetition simulates word learning, detailing how words are selected for language production becomes important. The premise is that similar mechanisms might be at play during the selection of language units to produce a nonword. As a result, describing the mechanisms involved in the processing of nonwords engenders a discussion of four conceptually related frameworks dedicated to the study of lexical access. Two of these frameworks have their basis in adult connectionist models of language perception and production, while the last two have been generated considering the interaction of linguistic context with the development of semantic and phonological categories.

Spreading activation model. The first line of inquiry stems from the psycholinguistic literature (e.g., Dell, 1986). In his 'spreading activation' model, Dell (1986) proposes that the lexicon consists of interconnected nodes for phonetic features, phonemes, syllable constituents (such as onsets and rimes), syllables, morphemes, and words. In order to be selected for production within a sentence, multiple nodes of a word must be activated. Activation of the nodes takes place within and across levels. At the lexical level, semantically and phonologically related items may receive some activation. For example, if the target word is *dog*, the words *hog* (phonologically related) and *cat* (semantically related) may be activated. Dell (1986) also suggested that activation may occur from the bottom-up, particularly in the case of speech perception. That is, if a listener hears the segments [k] [æ] [t], these could activate the sub-syllabic nodes of onset [k] and rime [æt], pass to the syllable node [kæt], continuing on activation to the word node 'cat' and the concept node CAT (i.e., the four-legged, domestic animal that meows). Although Dell did not address how a novel word form, such as *tiften,* with an absent lexical representation or lemma, might be processed, it may be inferred that the repetition of such a nonword could undergo a similar set of structured propagated activations at multiple levels.

Serial activation model. Integrating the psycholinguistic and cognitive frameworks, Gupta (2005) has reiterated that nonword repetition ability, like word learning, relies on long-term phonological storage. Furthermore, Gupta (2005) indicated that, in order to recall a word or a nonword, it is necessary to immediately retrieve "the serial order of a novel phonological sequence" (p. 565). In nonword repetition, the novel phonological sequence occurs at the sublexical level as a phoneme or a syllable. Thus, phonological serial ordering must be capable of representing lexical and sublexical units. In Gupta's studies, short term recall of sublexical sequences varied with regard to the serial position of the to-be-recalled sequences within the nonwords. Primacy and recency effects were encountered in a series of adult nonword repetition studies. Primacy effects refer to the advantage in recall of syllables in the first few positions within a nonword, while recency effects refer to advantages in recall for the last few syllables in a nonword. Primacy and recency effects take place in nonword repetition as a result of short-term connections between a sequence memory component and the lexical and sublexical phonological levels of representation in long-term memory (Gupta, 2005). Gupta suggested that, because short words are more prevalent in early vocabulary learning contexts, long nonwords would potentially be more unfamiliar than short nonwords to a language learner. As a result, the serial position effects might be weaker when comparing the repetition of nonwords with shorter length with that of longer nonwords. In summary, Gupta's account of serial processes in repetition may be viewed as providing a detailed description of the architecture of rehearsal mechanisms within the phonological loop. Gupta has also suggested that since words and nonwords can be composed from the same pool of phonological units, there may be similarities in how they are processed.

Computational model. Gupta (1996) and Gupta and MacWhinney (1997) proposed a computational model to explain how nonword repetition and word learning might be based on phonological storage and canonical serial ordering, and how there are multiple processes supporting access to a nonword and/or a real word. In their model of word learning, word form repetition, and immediate serial recall of words and nonword lists, there are several layers of activation. When a familiar or unfamiliar word form is encountered, the chunk layer in the model will activate. The chunk layer contains groupings of one or more syllables. To repeat the nonword, the phonological store avalanche node (containing a list of chunk layers – within word elements) activates the appropriate chunk layer node, which in turn, gradiently activates the appropriate phoneme layer. The activation of the phoneme layer supports articulation of the word form.

Following findings from Gupta's studies, the model also accounts for the role of sequence memory: "The greater the number of syllables in a [nonword], the greater will be the decay of weights between the phonological store and the chunk layer [and phoneme layer] nodes" (Gupta & MacWhinney, 1997, p. 297). The sequence memory layer is analogous to the phonological store proposed by Baddeley and colleagues (Baddeley, Gathercole, & Papagno, 1998), with one contrast: In Gupta's model, the store did not house representations; rather, it organized the series of activations found within the lexical system. Gupta (2003) suggested that there are direct connections between this sequence (short-term) memory and the sublexical level of representation, indicating that sequence memory directly supports the correct serial repetitions of sublexical (syllabic) constituents in a nonword. The sequence memory layer, then, is responsible for encoding the serial order of the activations at any and all levels of representation (e.g., semantic, syllabic, phonemic) with which it is connected. In this framework, long-term linguistic knowledge is instantiated by the strength of the connections between the units in the various layers.

In simulations, the model has successfully depicted key characteristics of nonword repetition, such as the word-length effect previously found in Gathercole et al. (1991). Similar to the process of learning a real word, nonword repetition is believed to be dependent on a sequence memory layer. Simulations within the model also resulted in the support of other processes scaffolding nonword repetition. For example, the relationship between long-term memory storage and repetition performance may be accounted by effectiveness in accessing long-term knowledge of syllables and word forms, which in the model was explained by simulations of connections between the syllable and the phoneme layers, as well as the word form to the syllable layers. In this model, the connections between the processes of working memory and the long-term store of lexical-phonological information mean that linguistic experience is a factor in working memory performance. This approach diverges from the original Baddeley and Gathercole (1991) and Dollaghan and Campbell (1998) conception of using nonword repetition as a test of phonological processing skills that is independent from real word knowledge.

Two significant concerns arise when attempting to integrate these connectionist lexical access models with the study of language processing in children. First, the obvious issue of extrapolating adult to child abilities is a challenge. The previously discussed models are generally based on mature lexical systems, with established and integrated phonological and semantic knowledge that may supervise the process of lexical selection and nonword production. Young children do not have in place at birth established error-monitoring mechanisms, nor are they provided with regular feedback regarding what is correct or incorrect in their speech. Secondly, these and other models of language acquisition have not included a method for modeling the incremental nature of lexical growth (Li & MacWhinney, 1996; MacWhinney, 2001). Following the vocabulary spurt between the ages of 18 and 20 months, children's lexicons expand gradually by adding a few words each day. Currently, only one connectionist model has attempted to explain the flexible and protracted expansion of vocabulary.

DevLex model. Li, Farkas, and MacWhinney's (2004) DevLex model is a self-organizing neural network model of lexical acquisition. It was developed with the intent to simulate three phenomena in language acquisition: (a) the emergence of topographically organized representations for linguistic categories over time, (b) the occurrence of early lexical confusion/competition as a function of semantic and phonological similarity within the network, and (c) age-of-acquisition effects in the developing lexicon. The model suggests a process of emergent lexical organization with semantic density becoming the source of competitive processes in word selection. Specifically, the authors propose that the activation of semantically related words may result in competition and confusion during lexical access. They hypothesize that semantic errors that are commonly produced by young children are the result of such competition.. Although the model holds promise in explaining the mechanisms of word learning, particularly the involvement of accumulated semantic/phonological knowledge in prompting cycles of network reorganization over time, it fails to consider the effect of language-specific phonological pattern frequency in word learning.

Probabilistic phonological models. Ongoing research by Munson and colleagues (Edwards, Beckman, & Munson, 2004; Munson, 2006) represent a step in that direction. Grounded in findings from the study of probabilistic phonological knowledge in adults, their studies argue directly for the role of linguistic experience as a variable in nonword repetition performance. Probabilistic phonological accounts of language sound structure have explored the influence of frequency distributions on the cognitive representation of phonological forms. Specifically, this framework suggests that the frequency of the sound structure of a language constitutes 'linguistic experience' and can become a mediator in the acquisition of perceptive and productive phonological and phonetic competence (Pierrehumbert, 2001). Therefore, operations performed on a word (or nonword), including segmentation for the purposes of recall/repetition, will be supported not only by long-term memory and prior experience with the particular word, but by prior experience with other words with similar phonetic constituents, particularly when the specific phonetic pattern is regular and frequent in the language (Gathercole, Frankish, Pickering, & Peaker, 1999).

The focus of the Edwards et al. (2004) study was to explain the precise mechanisms by which prior knowledge of the probabilistic structure of English is brought to bear in the task of nonword repetition. This investigation, as well as other studies conducted by Munson and colleagues, focused on the study of lexical factors such as phonotactic probability, or the frequency of occurrence of a sequence of phonemes within the lexical items of a language. In these investigations, monolingual English-speaking children with typical and atypical speech and language exhibited more accurate repetitions of nonwords with high probability phonetic segments, compared with nonwords that contained low probability segments (Munson, Edwards, & Beckman, 2005; Munson, Kurtz, & Windsor, 2005).

Although the impact of language-specific patterns on repetition performance has been investigated in English, a study of how similar variables might influence Spanish nonword repetition performance has not been conducted. Prior to analyzing how language-specific patterns affect Spanish nonword repetition, however, it is essential that potential variation in the mechanisms involved in language processing is discussed in relation to bilingual individuals.

Lexical Learning and the Bilingual Adult

Psychometrically speaking, the simplest model of individual differences in language processing would predict success in second language (L2) processing entirely on the basis of skills that had already been demonstrated in first language (L1) learning. As previously discussed, one hypothesis is that activated conceptual representations spread their activation down to their lexical and phonological representations (Dell, 1986). As a result of spreading activation, it would be assumed that the process of selecting a word is competitive in nature. Thus, the fluidity with which a particular lexical node is activated will not only depend on its own activation level, but on the activation level of similar (competing) items. In bilingual speakers, it has been hypothesized that every concept is associated with synonymous lexical nodes. Models that describe speech production and lexical access in bilingual adults presuppose that, when individuals who speak and understand two languages attempt to retrieve a word, there exists increased competition because additional lexical nodes are connected across the two languages relative to the nodes of a monolingual (Finkbeiner, Almeida, Janssen, & Caramazza, 2006).

Language proficiency, which has been operationalized in a variety ways in the literature, had been identified as an important variable mediating an adult bilingual's ability to inhibit interference from the lexical representations belonging to a "nonresponse language" in a language-switch task. Studies that use the language-switch paradigm require that participants alternate between their two languages during picture-naming (Hernandez & Kohnert, 1999; Hernandez, Martinez, & Kohnert, 2000). The response language is signaled to the participant by a visual cue (e.g., a colored card). There are trials in which naming of the stimulus is required in the same language as the preceding trial (i.e., nonswitch trials) and trials in which the switch to the other language is required. Naming latency between a switch and nonswitch trial is the dependent variable and it is termed the "language-switching cost."

Using this paradigm, Meuter and Allport (1999) found that more difficulty with inhibitory processes took place when the participants were asked to switch to their first language from a trial that had required picture naming in the second language when compared to a switch trial from naming in the first language to naming in the second language. The proposed explanation for the asymmetric inhibition was that the switch back into the first language involved more difficulty because native language lexical representations had to be more strongly inhibited during L2 production as a result of the previous trial. Recent research by Finkbeiner et al. (2006) and Costa, Santesteban, and

Ivanova (2006) found that, asymmetrical switching costs appear in their labeling tasks, regardless of the age at which the second language was acquired, the proficiency in use of both of the languages, the linguistic similarity between the two languages spoken by an individual, and the languages of the task. Costa et al. (2006) suggested that, for their bilinguals (which included Spanish-Catalan and Spanish-Basque users), the robustness of the lexical representations and their integration with long-term memory in a lexicon "supervises" the lexical selection process and helps in avoiding inhibition. Of importance is that robust representations are those that result from "familiar and frequent [encounters] leading to greater automaticity of retrieval" (Costa et al., 2006, p. 1068). There can be a language-specific selection mechanism at play when accessing words; however, this mechanism is dependent on the existence of an established language-specific lexicon. In the case of bilinguals who may be less "balanced" in their language use, a required name might be retrieved from the lexical representations of the stronger language and translated into the less developed language. During this translational process, however, inhibition of lexical representations in the strong language is still necessary but, in this case, it takes place at the level of motor planning for its production.

Absent in this account is an explanation of how lexical inhibition processes might differ between proficient bilingual adults, who may frequently use a language in its different modalities, and emerging bilinguals, who may be in the process of developing lexical and phonological representations in one or both of their languages. In the case of adults who are beginning to learn a second language (L2), one cannot perfectly predict L2 performance from L1 skills, particularly if the definition of bilingualism departs from the traditional, two monolinguals-in- one head, perspective (Grosjean, 1997).

Specifically, it may be that, for these language learners, in the period of time between basic L1 acquisition and the emergence of L2, L1 literacy skills, for example, may have fallen into disuse or may have atrophied altogether (Johnson & Newport, 1991; Werker, Gilbert, Humphrey, & Tees, 1981). Additionally, the effect that familiarity with a particular word and its frequency within the languages of the bilingual may have on lexical learning and language production are not discussed. Moreover, the explanation of the process by which lexical and phonological representations in two languages are developed in an emerging bilingual child is an understudied topic in the literature.

A separate line of research considered the influence of language-specific patterns on language production in bilingual children. Thorn and Gathercole (1999) conducted word and nonword recall experiments with English-French bilingual children in an effort to determine whether the phonological loop functioned as a language-independent or language-specific system. In their study, children demonstrated superior performance for stimuli spoken in the language in which they were most competent, either English or French. Additionally, there were strong within-language correlations between vocabulary breadth and repetition of lexical and nonlexical items. The authors hypothesized that extensive experience with the phonological and phonotactic patterns of a language supports a child's ability to reconstruct incomplete representations (as the representations reconstructed in never-experienced nonlexical stimuli) in the phonological loop. As a result, "nonword repetition accuracy is closely related to an individual's language-specific knowledge" (p. 321). However, measures of nonword repetition have not consistently been created with this purpose in mind.

Interim Summary

Although a great majority of studies have used nonword repetition tasks as a measure of phonological working memory (e.g., Gathercole & Baddeley 1989), there exists little agreement about what nonword repetition tasks actually measure. In fact, the task of repeating nonwords has been used for the measurement of acquisition of phonological patterns in a native language (e.g., Edwards et al., 2004), phonological segmentation skills (e.g., Snowling 1981), acquisition of stress assignment patterns (Hochberg, 1988), speech production (e.g., McCarthy & Warrington 1984), and motor planning and coarticulatory abilities (e.g. Woodward, Macken, & Jones, 2008). The following section summarizes the outcomes of a variety of English studies of nonword repetition into major patterns.

Nonword Repetition Studies with Monolinguals and Bilinguals

English nonword repetition studies: An overview

Over the last 20 years, nonword repetition has become a popular research measure for the study of monolingual English-speaking children who are typically developing and/or who may be suspected of having an oral language disability (Beckman & Edwards, 2000; Bowey, 2001; Coady & Aslin, 2004; Edwards et al., 2004; Gathercole, 1995; Gathercole & Baddeley, 1990; Michas & Henry, 1994). Tasks are usually selected to support one of two major theoretical purposes: a) To explore the efficiency of the phonological loop and document changes in its function across language acquisition or b) to investigate the perceptual, lexical, phonological, and articulatory elements involved in vocabulary learning. These two purposes are represented in studies of monolingual

English-speaking children with typical and atypical language development (Archibald & Gathercole, 2006; Campbell & Dollaghan, 1998; Edwards & Lahey, 1998; Ellis Weismer et al., 2000; Munson et al., 2005; Snowling, 1981; Snowling, Goulandris, Bowlby, & Howell, 1986).

In studies with monolingual English-speaking samples, the use of nonword repetition tasks is widespread because they are diagnostically sensitive in identifying children with language impairment (Campbell & Dollaghan, 1998; Ellis Weismer et al., 2000) and/or a reading disability (Snowling, 1981; Snowling et al., 1986; Wagner, Francis, & Morris, 2005; Wagner & Torgesen, 1987). Several participant and stimulus characteristics have been found to affect nonword repetition performance.

Age effects. In terms of participant characteristics, longitudinal and cross-sectional studies have identified an increase in nonword repetition accuracy with age (Edwards et al., 2004; Gathercole & Baddeley, 1989; Gathercole et al., 1991). Alloway, Gathercole, Willis, and Adams (2004) suggest that young children's capacity to repeat novel forms is consistent with the existence of a phonological loop structure, which "is in place between the ages of four- and six-years in children" (p. 100). Age effects have been attributed to two factors: (a) increased efficiency in the temporary storage of word-forms and (b) improved control over articulation, which supports the subvocal rehearsal function of the phonological loop. Subvocal rehearsal, in turn, aids in the active maintenance of phonological memory traces in the store (Gathercole & Baddeley, 1989).

Language ability. Performance on nonword repetition tasks is also influenced by language ability. Specifically, children with language impairment (LI) are typically less accurate on nonword repetition tasks than are their age-matched and language ability-matched peers (Edwards & Lahey, 1998; Munson et al., 2005). Three hypotheses have been advanced to explain this divergence. One proposal is that children will perform considerably worse than age-matched controls because they sacrifice working memory resources for linguistic processing. That is, as a result of the complexity and unfamiliar nature of nonword stimulus items, children allocate more resources to comprehension processes, thereby failing to "rehearse" the nonword item sufficiently for active maintenance of the word's representations for retrieval purposes (Ellis-Weismer, 1996; Montgomery, 2002). A second perspective draws on the quality of phonological representations. The proposal is that children with LI do not have sufficiently integrated phonological representations necessary for parsing the unfamiliar phonological patterns that support the repetition of nonwords (Munson et al., 2005). A third account suggests that perceptual, articulatory, and phonological encoding task demands are difficult for children with LI to coordinate simultaneously (Edwards & Lahey, 1998).

Vocabulary breadth. Another participant variable influencing nonword repetition is vocabulary breadth, or the estimate of how many words a child has in his or her mental lexicon. Children with typical language development who obtain high scores on vocabulary measures (and thus are assumed to know a larger variety of words) tend to have better nonword repetition performance in comparison to children with low vocabulary scores (Bowey, 1996; Edwards et al., 2004; Gathercole & Baddeley, 1989, 1990; Gathercole et al., 1991). The connection between vocabulary knowledge and non-word repetition ability becomes stronger as children's vocabularies increase in breadth (size). That is, the relationship between phonological working memory and vocabulary knowledge transforms itself throughout development. First, Gathercole and Baddeley

(1990) proposed that, if learning new words involves learning new phonological structures, then a critical process in vocabulary acquisition involves the temporary retention of these sound structures (e.g., syllables or phonemes) in memory. In their fast-mapping study, children who were better at repeating nonwords exhibited faster learning rates for novel names than did the children who were less proficient at nonword repetition.

In later studies, Gathercole (1995) and Gathercole and Baddeley (1991) qualified their argument by asserting that children's accruing knowledge of the phonological structure and semantic content of words supports their ability to retain novel phonological structures. That is, children with low repetition accuracy exhibited low scores in receptive vocabulary knowledge. Similarly, children who exhibited better performance in their nonword repetition task achieved high vocabulary scores in the standardized measures they administered (Gathercole, 1995; Gathercole & Baddeley, 1991). These results denote the bidirectional nature of the relationship between working memory and long-term knowledge of words and word parts.

Nonword length. In relation to item-level features, studies have found a robust effect of nonword length (indexed by number of syllables) on repetition performance (Gathercole & Baddeley, 1989, 1990; Gathercole et al., 1994). In these studies, longer nonwords have typically resulted in more repetition errors than shorter nonwords. One exception to this otherwise robust finding was encountered in Gathercole and Baddeley (1989), in which a group of four-year-old and five-year-old children exhibited lower performance on one-syllable nonwords than on two-syllable nonwords. The intrinsic phonological constitution of the monosyllabic nonwords was hypothesized to be a factor in this finding. However, Gathercole and Baddeley suggested that more systematic analyses of the stimulus corpus were necessary prior to determining the factors impacting these results.

Degree of wordlikeness. In addition to nonword length, the degree of wordlikeness between the nonwords and the phonological form of words stored in a child's lexicon contribute to variation in performance across stimuli (Dollaghan, Biber, & Campbell, 1995; Edwards et al., 2004; Gathercole, 1995). Findings from a variety of studies (e.g., Gathercole, 1995; Gathercole & Adams, 1994; Gathercole et al., 1999) suggest that the more wordlike the item, the more accurate its repetition. In addition, Gathercole (1995) also indicated that the beneficial effects of wordlikeness on nonword repetition were available to all children as they became older and their experiences with print became more frequent.

Stress patterns. A final factor contributing to the perception of wordlikeness is stress pattern. Dollaghan et al. (1995) created a set of nonwords which included syllables corresponding to real words. Additionally, Dollaghan et al. manipulated stress assignment in those stimuli. In half of the nonwords, the syllable carrying primary stress was the real word. The other half had a nonsense syllable stressed. Results suggested a beneficial effect of stress. That is, nonwords with stressed syllables corresponding to real words were repeated more accurately than nonwords with stress on syllables that were not identical to real words. Despite the significance of this finding, no other study has analyzed the effect of stress pattern on nonword repetition performance.

Interim Summary

Nonword repetition measures have been identified as promising tools for "leveling the (diagnostic) playing field" (Kohnert, Windor, & Yim, 2006). Specifically, nonword repetition is seen as potentially providing a less biased view of children's accumulated phonological knowledge about words in a specific language, regardless of their linguistic or cultural background. However, it is important to note that the available nonword repetition measures may measure different constructs, depending on: (a) the theoretical paradigm guiding the purpose of the measure, (b) the characteristics of the selected items, and (c) the population for whom the measure was developed. The following discussion addresses these factors in relation to their impact on measures of nonword repetition used with English language learners.

Nonword Repetition with English Language Learners

Not all reading and language assessments of bilingual children include nonword repetition (e.g., Cisero & Royer, 1995; Durğunoglu, Nagy, & Hancin-Bhatt, 1993). Some studies utilize nonword reading to evaluate decoding skills only and not phonological memory (e.g., Quiroga, Lemos-Britton, Mostafapour, Abbott, & Berninger, 2002). Seven studies to date have assessed working memory skill in Spanish-speaking children with typical and atypical language development. These studies (Calderón, 2003; Chiappe et al., 2002; Danahy et al., 2008; Girbau & Schwartz, 2007, 2008; Gottardo, 2002; Gottardo, Collins, Baciu, and Gebotys, 2008) are examined below. Table 1.1 provides a summary and separates the studies into three categories: a) Assessment of nonword repetition ability only in English to determine relationships between phonological working memory and English broad reading outcomes (*n* = 3), b) assessment only in Spanish to establish whether a nonword repetition task might be diagnostic of phonological working memory problems in children with LI (*n* = 3), and (c) assessment only in Spanish to obtain preliminary performance data and develop a set of stimulus items that may be applied in clinical and research settings (*n* = 1).

Assessment in English only. As displayed in Table 1.1, the Chiappe et al. (2002) study involved a large multilingual sample of kindergarteners with a mean age of 5 years, 4 months. A variety of languages and proficiency levels was represented, from native-English-speaking children to emerging bilinguals who spoke two languages, including English in the home, to English language learners, who had a home language different from English. Children were assessed with measures targeting phonological awareness, syntactic awareness, print awareness, verbal short-term memory, and nonword repetition assessed with the Sound Mimicry subtest of the Goldman, Fristoe, and Woodcock Sound Symbol Test (Goldman, Fristoe, & Woodcock, 1974).

Table 1.1

Nonword Repetition Studies with English Language Learners

Study	**Language of Administration**	**Participants/ Language**	**Nonword (Language Processing) Measures**
Chiappe, Siegel, and Gottardo (2002)	English only	*N* = 659 Sub-groups: *n*= 540 English *n* = 59 Bilingual (English and another language as home languages) *n* = 60 second language learners (home language other than English)	Phonological processing purpose; • Sound Mimicry Sub-test (Goldman et al., 1974)

Study	Language of Administration	Participants/ Language	Nonword (Language Processing) Measures
Gottardo (2002)	English only	*N* = 92 Spanish Sub-groups: *n* = 42 females *n* = 43 males	Phonological processing purpose; • *N* = 18 nonwords • Based on Dollaghan et al. (1995), Gathercole et al. (1991), and Goldman et al. (1974) • 2-to-4 syllables in length
Gottardo, Collins, Baciu, and Gebotys (2008)	English only	*N*=72 Spanish-English bilingual Grade 1 children (retested in Grade 2) Sub-groups: *n* = 42 females *n* = 37 males	Phonological processing purpose; Same task as above
Calderón (2003)	Spanish only	*N* = 32 Spanish, low English proficiency, Mexican descent Sub-groups: *n* = 16 Typical language development *n* = 16 Impaired language development	Diagnostic purpose; • *N* = 22 nonwords • 2-to-4 syllables in length • Adapted Dollaghan and Campbell's (1998) scoring criteria.
Girbau and Schwartz (2007)	Spanish only	*N*= 22 Spanish – Catalan bilinguals Sub-groups: *n* = 11 Typical language development *n* = 11 Impaired language development	Diagnostic purpose; • *N* = 20 nonwords, 1-to-5 syllables in length • Medium-low frequency syllables • No diphthongs, but permissible Spanish clusters used
Girbau and Schwartz (2008)	Spanish only	*N*= 22 Spanish-English bilinguals Sub-groups: *n*=11 Typical	Diagnostic purpose; Same task as above

Study	Language of Administration	Participants/ Language	Nonword (Language Processing) Measures
		language development *n*=11 Impaired language development	
Danahy, Kalanek, Cordero, and Kohnert (2008)	Spanish only	*N*= 14 Spanish-English bilinguals Sub-groups: *n*=7 older *n*=7 younger Older: 4;3-5;6 years Younger: 3;6-4;0	Obtaining normative data on performance • *N*=20 nonwords, 1- to 5-syllables in length • Adapted Dollaghan and Campbell's (1998) criteria • Construction of syllables and assignment of primary stress followed typical patterns for Spanish • No later acquired consonants • No abutting consonants or consonant clusters

Significant differences in nonword repetition ability were not found among the three major language groups; that is, the ELL group performed similarly to the bilingual and the native English speaking children in their reproduction of English nonwords. The participants in the three language groups showed growth in phonological processing, with the monolingual group outperforming the bilingual and ELL groups. Performance on the Sound Mimicry task predicted spelling ability, but not phonological awareness skills or other linguistic processing skills (e.g., syntactic processing). The absence of a relationship between phonological working memory and phonological awareness may contradict findings of previous studies, which have suggested that, to develop proficient decoding skills, an efficient and accurate set of phonological encodings is necessary (e.g., Snowling et al., 1986).

Unlike the multilingual sample of Chiappe et al. (2002), Gottardo et al. (2002) included only Spanish-speaking children of Mexican origin, ages 5 to 8 years. Similar to Chiappe et al., nonword repetition was assessed only in English. The rationale for the assessment of phonological memory in English only was its similarity to the process of English vocabulary acquisition that bilingual children faced daily. However, no significant correlations emerged between performance in the repetition task and raw scores on a standardized vocabulary test. Performance on the nonword task was related only to phonological awareness and syntactic processing. Phonological awareness is a precursor to decoding abilities that was measured by a phoneme deletion task in this case. Syntactic processing was measured by a sentence completion measure. The association between nonword repetition and syntactic processing provided further support for the suggestion of a relationship between working memory skill and decoding, while at the same time contradicted the findings by Chiappe et al.

Nevertheless, Gottardo presented only correlative data between nonword repetition performance and other measures of phonological awareness. No additional information detailing the quality of the participants' productions was provided. Studies with English-speaking monolinguals have found error analyses to be useful in identifying the underlying processes involved in the task of repeating nonwords. Edwards and Lahey (1988), for example, analyzed perceptual difficulties in children with LI and determined that the children in their sample had phonological encoding difficulties. These difficulties manifested themselves in the children's repetitions in that children produced more syllable structure errors and phoneme deletion errors, but fewer phoneme substitution errors. Therefore, error pattern analysis may be helpful in distinguishing typical mispronunciations that children may make from production errors induced by the level of phonological complexity characterizing the nonwords (Edwards et al., 2004). In the case of Spanish-speakers who may be assessed with nonword repetition in two languages, an error analysis may provide a point of comparison for the types of phonological patterns that are being learned in the first and second languages.

The disparity in results between the studies by Chiappe et al. and Gottardo et al. is a good illustration of how task outcomes are influenced by item characteristics (Graf Estes, Evans, & Else-Quest, 2007). For example, a tentative explanation for the absence of a relationship between phonological working memory and phonological awareness is that the nonwords employed by Chiappe et al. (2002) contained linguistic components, such as syllables and phonemes, which were prearranged in a manner that violated English rules for phoneme placement within words. If so, this nonword repetition test might involve more articulatory complexity and, as a result, might be tapping into skills other than working memory and language-specific exposure.

Gottardo et al. (2008) attempted to determine whether L1 or L2 nonword repetition and phonological awareness abilities predicted advances in word reading and vocabulary knowledge in school-age children who were English-as-a-second-language speakers. A sample of 115 children was assessed in Grade 1, while a year later, in Grade 2, 79 participants from the original sample were reassessed. Measures of phonological awareness, rapid automatized naming, receptive vocabulary, and syntactic processing were administered in both languages. An English nonword repetition task that was identical in description to the one utilized in Gottardo's (2002) investigation was also used. Gains in vocabulary in the L2 appeared to occur more consistently for children with "strong Spanish skills in the same area" (Gottardo et al., 2008, p. 20). However, in Grade 1, a great majority of the children obtained vocabulary standard scores categorically identified as "low." Additionally, little growth on these vocabulary breadth scores was found from Grade 1 to Grade 2. Finally, nonword repetition accuracy was found to predict L2 vocabulary knowledge in Grade 2. While the authors suggested that Spanish-speaking children who performed poorly on the English nonword repetition were "good candidates for vocabulary-based interventions" (Gottardo et al., 2008, p. 22), they also cautioned that a nonword repetition test that is valid, reliable, and diagnostically sensitive for use with Spanish-speaking English-language learners has not been developed thus far.

Assessment of repetition ability in Spanish only. To date, only a few studies have assessed nonword repetition in languages other than English (e.g., Papagno & Vallar, 1995; Stokes, Wong, Fletcher, & Leonard, 2006; Thorn & Gathercole, 1999). Of the studies including Spanish-speaking children, only three (Calderón, 2003; Girbau & Schwartz, 2007, 2008) have used nonword repetition as a diagnostic measure to identify children at risk for a language impairment.

The Calderón (2003) measure, the Spanish Nonword Repetition Test (SNRT), was designed to differentiate 5-year-old Spanish-speaking children of Mexican descent with LI (n = 16) from Spanish-speaking children with typical language development (n = 16). Significant main effects were found for group and word length. The LI group performed significantly differently from the typically developing language group. A length effect was also observed, with longer nonwords being produced less accurately than shorter nonwords. However, a group by length interaction was not significant, which contradicted previous results with English speaking monolingual children. Calderón (2003) attributed this outcome to language-specific features of Spanish. The more frequent occurrence of multisyllabic words in Spanish may have resulted in children being more attuned to repeating longer words, eradicating the potential difference between the groups in the repetition of the longer nonwords.

Although the SNRT appears to be sensitive to the identification of children with LI in a small sample, the power of the instrument is limited by at least two critical omissions in nonword construction: a) Prior ratings of wordlikeness for the nonwords were not obtained, and b) the effect of Spanish dialect patterns on the pronunciation of the nonwords was not considered. These variables singly or in combination could be the reason for the absence of a length interaction in this study.

The second study, Girbau and Schwartz (2007), assessed Spanish nonword repetition in two groups of Spanish-Catalan bilingual children, ages 8; 3 to 10; 11 years, one group with a reported LI (n = 11) and another group consisting of age- and gender-matched controls (n = 11). The nonwords adhered to Spanish syllabification and stress patterns. Syllable frequency was manipulated in the construction of the items. Results replicated studies with English monolinguals: An effect of length in syllables was significant. Regardless of language ability, children had more difficulty accurately repeating 3- , 4-, and 5- syllable nonwords than repeating 1- and 2-syllable nonwords. Children with typical language development outperformed children with LI. Moreover, children with LI made more errors on vowels, consonants, and clusters via substitutions in comparison to the typically developing children, who did not produce any vowel errors. The relevance of this study is that a Spanish nonword repetition task containing items consistent with Spanish phonotactics may be a potentially valuable screening assessment for LI. However, the influence of syllable frequency on these patterns of performance was not analyzed and possible linguistic correlates for the error patterns remained unexplained.

In a subsequent study in which 22 bilingual, Spanish-English, children with and without LI participated, Girbau and Schwartz (2008) replicated the findings from their study in Spain. An effect of syllable length was observed with accuracy of repetitions decreasing progressively from three-, to four-, and to five-syllable nonwords. Children with LI exhibited significantly less accurate repetitions than did children with typical language development. The authors suggest that their nonword task appears to be an accurate identifier of language ability in the groups of children sampled, as represented by a true positive likelihood rate of .82 and a false positive likelihood rate of .91. However, the underpowered sample size and the small number of nonword instances at each syllable length are caveats that these results should be interpreted with caution. In addition, the reliability of likelihood ratios obtained from such a small sample is questionable.

More recently, Danahy and colleagues (2008) developed a set of 1- to 5-syllable Spanish nonwords. They administered their task to a small sample of typically-developing Spanish-speaking preschoolers in an effort to obtain normative data on performance. Age and word-length effects were observed, although there were no significant differences in the repetition of one- to three-syllable nonwords. Rather, errors in repetition only occurred for the longer nonwords. Also, the authors emphasized that generalizations about age effects in their study are limited by the small number of participants in each sub-group. The nonwords developed by Danahy et al. (2008) followed the phonotactic and phonological patterns of Spanish. However, these items did not represent a range of wordlikeness. Because they used penultimate stress as the only prosodic pattern and embedded true monosyllabic words as constituent syllables in 12 of the nonwords, their stimuli are all likely to be relatively high in wordlikeness.

Danahy et al. (2008) is the only study to date that has analyzed nonword repetition error patterns in a sample of typically developing, Spanish-speaking, English language learners. They divided errors into three types: consonant, vowel, and syllable. Consonant errors were the most predominant error type, accounting for 21.4% of phoneme errors and over 70% of the syllable errors. Vowel errors accounted for 4.9% of all errors encountered. Although this study uncovered some interesting patterns, it did not specify the types of consonantal errors that were made, for example, whether substitutions were more prevalent than deletions, which were more prevalent than additions, as has been reported in the LI literature.

Findings from Spanish Nonword Repetition Tasks: Summary and What is Next

Three discernable findings about nonword repetition performance emerge from the research to date with Spanish-speaking English language learners. These are summarized below.

Repetition accuracy improves with age. In one cross-sectional study with 14 Spanish-speaking English language learners (Danahy et al., 2008), older preschool age children exhibited more accurate repetition than did younger preschool participants.

Repetition accuracy varies with length. Length effects on nonword repetition appear to be less stable in Spanish. For instance, in two of the seven cited studies (Danahy et al., 2008; Girbau & Schwartz, 2007), there were no differences in repetition of the shorter stimulus items. In fact, repetitions of these short items approached 100% accuracy, so this may be nothing more than a ceiling effect. On the other hand, this result may reflect the phonotactic differences between Spanish and English, or other factors may be at play (e.g., wordlikeness of the items).

Language ability predicts nonword repetition skill. Spanish-speaking children with language impairment exhibit less accurate repetitions of novel meaningless words than do their chronological age- and language age-matched cohorts (Calderón, 2003; Girbau & Schwartz, 2008). Reduced accuracy has been attributed to limited working memory resources or even multi-tasking demands (Graf Estes et al., 2007). An example of multi-tasking in nonword repetition tasks occurs for children with LI when they attempt to recruit underdeveloped phonological and lexical representations that, simultaneously, must be mapped into and programmed onto complex articulation patterns.

One variable known to affect performance in the English-speaking nonword repetition literature has not yet been investigated in Spanish nonword studies: Wordlikeness. As previously explained, wordlikeness is the degree to which a nonword resembles the real words in an individual's lexicon. A nonword's degree of wordlikeness is related to the frequency of occurrence of the nonword's prosodic structure and constituent syllables, onset-rimes, and phonemes (i.e., the phonotactic probability in the language). As a result, wordlikeness of nonwords can be used to create stimuli that vary in the extent to which an individual will have had experience with the components in the nonword. An individual's sensitivity to wordlikeness for nonwords thus reflects the developmental state of phonological experience for the individual. Although ideally a complete model of probabilistic phonotactics would provide relative values of wordlikeness for different nonwords, in the absence of such a model, wordlikeness judgments by native speakers can be used to determine which stimuli are more similar to the real words in the lexicon and which are more dissimilar. Prior to embarking on the study of this factor, an analysis of current Spanish nonword repetition tools is warranted.

Analysis of Nonword Repetition Tasks

Current Spanish nonword repetition tasks vary in the degree to which they have focused on the manipulation of language-specific variables such as wordlikeness. Some repetition tasks have been developed with attempts to factor out the influence of linguistic knowledge (Calderón, 2003), while other measures have been designed to control the variance explained by linguistic factors through their systematic manipulation in the nonwords (Girbau & Schwartz, 2007, 2008). For other measures, uncovering the purpose guiding their construction is difficult (e.g., Chiappe et al., 2002; Gottardo, 2002). The five distinct tasks used in the seven studies summarized by Table 1.2 (two in English and three in Spanish) are described below in terms of their potential applicability for the study of language-specific phonological patterns that may support word learning.

Factoring out experience. Chiappe and colleagues administered the Sound Mimicry Subtest from the *Goldman, Fristoe, and Woodcock Sound Symbol Test* (Goldman et al., 1974). The validity of their findings may be a concern, since knowledge of English phonology did not guide the item selection process. The Sound Mimicry measure requires that children repeat nonsense words of increasing difficulty and length; however, item construction does not conform to rules governing the permissible ordering of phonemes in English (syllable contact constraints). The outcome is nonwords that are low in wordlikeness (Gathercole, Willis, Baddeley, & Emslie, 1994). For example, a nonword in the test is *bafmotbem*, which contains two consonant sequences that are infrequent in real English words (*fm* and *tb*). As a result, errors in repetition may be an artifact of including uncommon phoneme sequences in the nonwords. Additionally, the polysyllabic word *batmofbem* could have been processed as three English monosyllabic nonwords (or three morphemic units) strung together. That is, it is possible that the participants in the study treated it like a phrase, and its repetition may have included a high proportion of errors as a result. However no information regarding the nonword's stress patterns and its detailed phonetic structure (i.e., inclusion of the neutral schwa vowel in unstressed syllables) was included in the study, thus precluding such generalizations from the data.

Table 1.2.

Nonword Repetition Tasks: Controlling For Language-Specific Variables or Not?

Language-Specific Patters	Variable Length in Syllables	Age Appropriate Phoneme Sequences	Phonotactic Patterns	Degree of Wordlikeness	Phonotactic Probability
ENGLISH NONWORD REPETITION TASKS					
Chiappe et al. (2002)	X				
Gottardo (2002) **Gottardo et al. (2008)**	X	X			
SPANISH NONWORD REPETITION TASKS					
Calderón (2003)	X	X	X		X
Girbau and Schwartz (2007, 2008)	X	X	X		
Danahy et al. (2008)	X	X	X		

Table adapted from Brea-Spahn & Silliman (in press)

Similarly, the Calderón (2003) SNRT contains nonwords low in wordlikeness. Although some Spanish phonotactic patterns like stress assignment were maintained, infrequently occurring syllables (i.e., syllables that did not occur in more than 200 words in a corpus of approximately 2 million words) comprised the nonwords. Infrequently occurring syllables were selected to account for the potential effect of the transfer of phonological knowledge across Spanish and English. Because the Sound Mimicry Task and the SNRT were intentionally designed to include only nonwords low in wordlikeness, neither measure may be suitable for examining the impact that language-specific phonological patterns may have on bilingual word learning.

Including language experience as a factor. The items from Gottardo (2002) and Gottardo et al. (2008) were created by combining and adapting several lists of nonwords already available (Dollaghan et al., 1995; Gathercole et al., 1991a; Goldman et al., 1974). The items were designed to follow English syllabic patterns and relevant differences between the Spanish and English phonological systems. For example, in devising the nonwords, authors in both studies reported not including phonemes that were unshared between Spanish and English, such as the unvoiced /θ/ (as in 'think') and voiced /ð/ (as in 'the'). However, all dialects of Spanish use the voiced fricative /ð/, as it appears intervocallically as an allophone of the phoneme /d/. Also, it is important to note that multi-syllabic English nonwords (and words) with variable stress patterns inevitably include neutral vowels in their unstressed syllables. In Spanish, all vowels are tense. Therefore, the nonwords in this study might have posed additional demands on the Spanish-speakers by including vowel phonemes which were different between the two languages. The authors also noted that they accepted nonwords as correctly repeated, even when children substituted Spanish vowels for English vowels in their repetitions. Beyond stating that non-Spanish phonemes were not considered in item construction and adapting scoring procedures to some phonological differences between the languages, specific characteristics of the nonword items, such as the inclusion or exclusion of consonant clusters, were not disclosed.

The influences of first language phonology were considered in the scoring. Vowel productions characteristic of the Spanish language, as in the production of “the Spanish form of the vowel ‘o’ that is of slightly shorter duration than the English version of the vowel” (Gottardo, 2002, p. 55) were accepted as correct. Although the effects of first language phonology on nonword pronunciation were included, correct scores were assigned, for the most part, to exact repetitions. Responses were scored only as correct or incorrect and information about individual error patterns was not reported. Identical procedures were used in the Gottardo et al. (2008) study.

The Spanish nonword repetition task developed by Girbau and Schwartz (2007, 2008) takes into account phonotactic likelihood and includes nonwords constructed with low and medium frequency syllables (See Table 1.1). In addition, frequency of occurrence of individual phonemes was considered: “All the Spanish sounds were included on the task, except the /ɲ/ and /w/ [ñ, w], which occur very infrequently” (Girbau & Schwartz, 2007, p.66). Furthermore, nonwords adhered to Spanish phonotactic regularities as 12 of the 20 items had one of the permissible clusters. In Spanish, two segment onsets (or clusters) must contain a single obstruent (e.g., b, p, t, d, k, g, f) followed by liquid consonants (i.e., l or r) (Harris, 1983). Examples of these two-segment onsets occur in such Spanish words as *fresa* ('strawberry'), *trabajo* ('work'), and *principio* ('beginning').

A major constraint of the Girbau and Schwartz nonwords is that frequency information and the syllables used in the nonword repetition task were acquired from corpora of Castilian Spanish words. As a result, their nonwords may include phonemes not produced by other dialects of Spanish. As just one example, the item *zo.llér* in this measure was phonetically transcribed as /θoλéɾ/. However, the *z* is often produced as a /s/ in Latin American varieties of Spanish (Green, 1990). Because of this factor, these nonwords may not be appropriate to administer to children in the United States where a variety of Spanish dialects are spoken.

The most recent measure of nonword repetition in Spanish was developed by Danahy et al. (2008). The authors systematically described their stimulus construction process and the variables manipulated. One- to five-syllable nonwords were developed, which were constituted only of early acquired phonemes, excluding clusters and abutting medial consonants. The authors indicated that their stimuli were wordlike (and easier to repeat) because of their: (a) use of canonical pattern of penultimate stress, (b) adherence to the most common Spanish syllable pattern (consonant-vowel), and (c) inclusion of frequently occurring Spanish consonant phonemes and exclusion of infrequent consonants in many of their nonwords. However, Danahy et al. (2008) did not obtain a measure of phonotactic probability for their nonwords' constituent syllables, onsets and rimes, or phonemes, nor did they obtain wordlikeness ratings for their stimulus items. Furthermore, the use of only penultimate stress assignment may have resulted in a narrow range of difficulty in the items.

Summary: What Counts in the Construction of a Spanish Nonword Repetition Task?

Nonword repetition tests are versatile in that they permit the manipulation of language-specific patterns when the assessment aim is to modify the level of complexity and the types of phonological knowledge to be included. Some of the language-specific features that could be manipulated in nonword repetition tasks are length in syllables, syllabification and stress assignment patterns, familiar language units (e.g., morphemes), and phonemes representing a particular probability range in a language. Tasks utilized in studies with English language learners vary in their inclusion of language-specific variables, such as phonotactic probability or stress pattern. In fact, to date, there is no study of Spanish nonword repetition that has investigated degree of wordlikeness, which would reflect language experience, as a source of variability in performance.

Importance of Accounting for Language Experience in Nonword Repetition

As previously explained, a great majority of the literature on Spanish nonword repetition has been undertaken under the premise that the phonological loop, a modular component of working memory, is responsible for remembering novel phonological patterns in language learning. However, the repetition of a nonword involves more than merely memory. The perception of phonetic units which vary in frequency of occurrence within a specific language, the translation of these units into a motor plan, and the assembly of the appropriate sequence of gestures to articulate these units in the order they were perceived, are among some of the processes involved in repeating a nonword. MacDonald and Christiansen (2002) suggested that differences in performance in traditional memory measures, like nonword repetition, may not be the result of working memory capacity limitations; rather, they could be linked to variability in language experience. One component of language experience, in the case of the present study, is the frequency of occurrence of a pattern of phonemes within a language (Bybee, 2001). This explanation of experience focuses on the essential role of 'repetition' in shaping language familiarity and, specifically, phonological representations.

Does Frequency Count for Phonological and Lexical Learning?

Children learn about phonotactic patterns, including existing, possible, and impossible-to-produce phonological sequences, as they learn the words in which these patterns are embedded. Mastered articulatory routines scaffold the production of new words that have similar phonological constituents. Thus, one account of word learning is that vocabulary grows while individuals accrue words that are phonologically similar to those already established (Storkel, 2001). This account of rapid acquisition would suggest that children become knowledgeable about the distributional regularities of the linguistic input and that this knowledge, in turn, has consequences for word-learning (Hollich, Hirsh-Pasek, & Golinkoff, 2000)

The within-word phonological patterns that influence vocabulary learning vary in their frequency of occurrence in a specific language. There are two ways for counting frequency of occurrence in language: token frequency and type frequency. The frequency of occurrence of a word (i.e., how often it is used) is token frequency. For example, the Spanish determiners *el* and *la* have high token frequency because they are frequently used in speech. On the other hand, the incidence of occurrence of a particular pattern (e.g., a syllable onset, a consonant cluster, or a stress pattern) is type frequency. Thus, type frequency is “based on the number of items matching a particular pattern” (Bybee, 2001; p. 13). Type frequency would be obtained, for example, by counting all the possible words which begin with the /b/ phoneme in Spanish.

The effects of type frequency on the acquisition of phonological patterns abound in the literature (Jusczyk, Cutler, & Redanz, 1993; Juczyk, Luce, & Charles-Luce, 1994; Saffran, Aslin, & Newport, 1996; Saffran, Newport, & Aslin, 1996). At a perceptual level, for instance, Juczyk et al. (1994) found that nine-month-old infants prefer frequent over infrequent phonotactic patterns (i.e., the rates with which certain phoneme sequences occur in particular orders and positions within syllables and words), in their language. Similar findings have been documented from studies with bilingual infants (Sebastián-Gallés & Bosch, 2002). In bilingual studies, however, phonotactic pattern frequency in learning must be considered within the frequency of exposure to a particular language. That is, infants do not show parallel sensitivity to the phonotactic patterns of two simultaneously developing phonological systems. Rather, the infants in Sebastián-Gallés and Bosch’s study were most sensitive to phonotactic patterns in their to-be-dominant language (i.e., the language to which the babies were most often exposed).

The frequency of specific phonotactic patterns also affects children’s learning of new words. For example, in Storkel (2001), a group of 34 typically developing preschool children more accurately identified the referents for novel nouns with common sound sequences than novel nouns with rare sound sequences. The common sound sequence advantage in referent identification was larger for children with greater recognition vocabulary breadth, suggesting that the children were drawing upon phonological regularities in their lexicons. Parallel findings were documented in a second study of verb-learning in English (Storkel, 2003).

Does Frequency Count in Performance in Language-Processing Tasks?

Findings similar to the aforementioned speech perception and fast-mapping literature have emerged from language processing studies that use nonwords. For instance, Treiman, Kessler, Knewasser, Tincoff, and Bowman's (2000) nonword rating study found that, regardless of age, participants gave the higher frequency rimes higher wordlikeness ratings than the lower frequency rimes. In their study, child and adult participants judged consonant-vowel-consonant (CVC) embedded, English rime constituents of different frequencies as more wordlike (e.g., *-up* in /rup/) or less wordlike (e.g., *-uk* in /ruk/). Therefore, adults also are sensitive to the use of language-specific frequency information.

In fact, in a variety of language processing tasks, adults have been found to generalize linguistic patterns to novel forms if these patterns are well represented in a variety of words in their lexicons; that is, if these patterns are frequent and regular (Frisch et al., 2000; Nimmo & Roodenrys, 2002; Ohala & Ohala, 1987). Nimmo and Roodenrys (2002) found a facilitative syllable frequency effect in a nonword repetition recall task when they examined whether recall accuracy was influenced by the frequency of monosyllabic nonwords within multi-syllabic English words. Also, in a wordlikeness study, adults rated nonwords with high probability onset and rime constituents as more like real words than nonwords with low-probability constituents (Frisch et al., 2000). The same frequency effect was replicated when adult Spanish-English bilinguals rated

Spanish nonwords (see Chapter 2 as well as Brea-Spahn & Frisch, 2006; Frisch, Brea-Spahn, & Orellana, submitted). The frequency effect was evident in ratings of nonwords that varied in terms of stress pattern, a previously uninvestigated phonotactic pattern. Adult bilinguals rated nonwords containing the most probable stress pattern (or penultimate stress) as more wordlike, suggesting a tendency to generalize about phonotactic patterns that recur across words of their language.

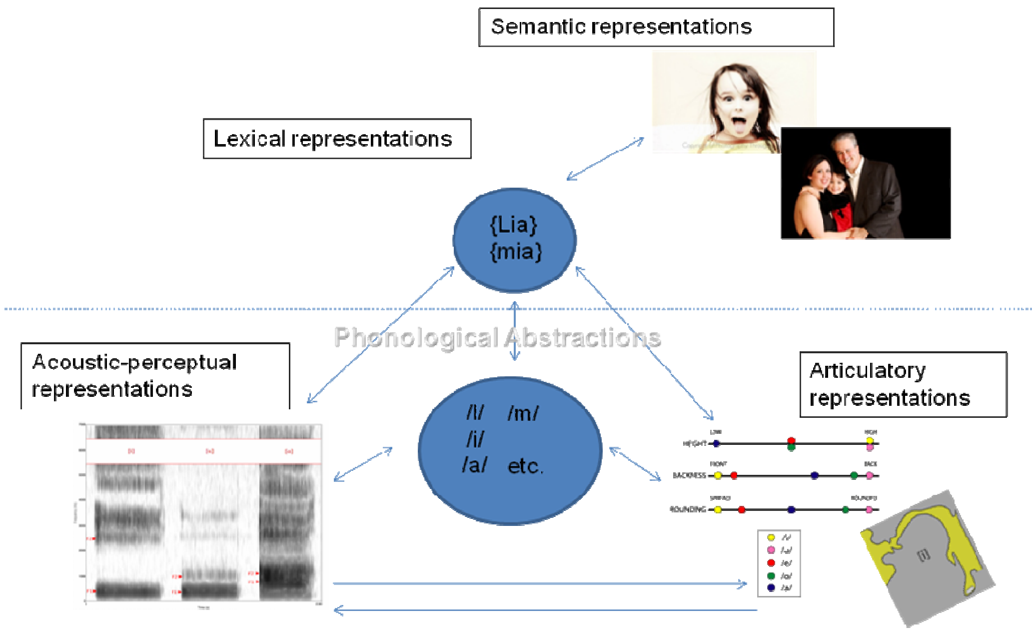
Summary

The previous literature attests that both children and adults use distributional information when perceiving, producing, and judging language tokens. It has been posited that from this distributional information, infants and young children induce sets of patterns that exemplify the underlying organization of their native language. Awareness of those patterns allows for the generation of novel words, utterances, and discourse. Children are known to be sensitive to phonotactic patterns therefore it is important to identify how mastery of the phonotactic patterns of a native language facilitates the expansion of the lexicon as new words are learned.

Learning Phonotactic Patterns: Holistic-to-Specified or Multiple Levels of Abstraction?

To encode a word, a hierarchy of different types of phonological information might be present, which will support multiple levels of abstraction about the word (Pierrehumbert, 2003). Figure 1.2 provides an illustration of these multiple levels of knowledge. As seen on the figure, at the perceptual level, infants must develop the ability to recognize the constituents in a word-form (e.g., a /l/, an /i/, and an /a/) regardless of the voice that speaks it, the intonation used to express it, and the linguistic context in which it occurs (Beckman et al., 2004). As infants become speakers, this acoustic-perceptual abstraction should be mapped to its corresponding articulatory gestures and allow the child to discriminate between this particular form and other phonologically-close neighbors (e.g., *Lía*, the proper name and *mía* the possessive feminine pronoun).

Figure 1.2. Types of Phonological Information Associated with Word-Learning (Adapted from Munson, Edwards, & Beckman, 2005)



Initially, the mapping between the phonetic properties of the form and its articulatory gesture may be underspecified. Support for the claim that children's speech perception/production abilities and patterns of lexical organization are holistic in comparison with the more mature, adult systems comes from a vast body of research. For example, Nittrouer and colleagues (Nittrouer & Studdert-Kennedy, 1987; Nittrouer, Studdert-Kennedy, & McGowan, 1989) found that young children's speech perception and production are influenced more by the overall acoustic shape of syllables than by the individual phonemes that make up the syllables. Charles-Luce and Luce (1990) reported that the lexicons of young children contain fewer phonological neighbors (i.e., similar sounding words) than do the lexicons of adults. Findings from these studies have converged to demonstrate that children may not be sensitive to the fine-grained phonetic detail that hypothetically characterizes adult lexical entries. A group of researchers has also suggested that words in the developing lexicon are holistically stored until the early school years (e.g., Walley, 1993), when as a result of exposure to metalinguistic tasks like phonological awareness, restructuring occurs.

Although children's first word productions are coarse approximations of adult's words, it does not follow that the corresponding acoustic-articulatory mappings to such lexical representations remained underspecified during the preschool years. This assumption ignores the effect of biological variables such as memory and attention, as well as experiential variables of repetition, familiarity, and practice with language. It seems unlikely that after the vocabulary spurt, around 18 months of age, toddlers' lexicon would be underspecified, particularly because the number of similarly articulated forms must exert pressure on the lexicon to become more differentiated (Metsala & Walley, 1998).

The theoretical framework exemplified in the figure, then, supports the notion that there's a lexical basis to the development of higher-level phonological knowledge (i.e., sensitivity to frequency distributions in the language of a variety of acoustic and perceptual parameters). For instance, a toddler may have acquired a vocabulary that contains several instances of forms that match in articulatory gestures, but contrast in their connotations: /gaga/ for *gato* versus /gaga/ for *agua*. When using these words in spoken language, young speakers must reorganize established word-forms to develop novel articulatory representations for each similar instance; that is, older forms are restructured with new functions (Gupta & MacWhinney, 1997). Caregivers provide the toddler with feedback in the appropriate contexts, while the language distributional properties interacting with memory and attentional resources are the foundation from which schemas or phonological abstractions emerge. Schemas, in this scenario, may be organizational patterns across lexical items or the use of long-term established representations in the scaffolding of new phonological forms and gestures.

These phonological abstractions or schemas, as seen on Figure 1.2, may be the result of two levels of encoding. Beckman, Munson, and Edwards (2007) and Munson, Edwards, and Beckman (2005) suggest that, when learning a new word, its *form* (i.e., phonological structure) is encoded at two different levels. First, there exists a coarse-grained level of encoding, which is based on the similarity of a word-form to other word-forms in the language. Coarser grained encodings (higher-level phonological knowledge) result in frequency effects in language tasks. For example, using this level of encoding, a child might recognize that a novel Spanish word that ends in a vowel should be stressed in the penultimate syllable. This level of encoding is considered coarse in nature because it is related to the frequency of individual words that share the pattern, which determine whether the pattern is common, uncommon, or prohibited. A second, more fine-grained level of encoding includes specific phonetic-articulatory representations of a Spanish word with penultimate stress pattern. Specificity at the level of phonetic-articulatory representations depends on an adequate sample of exemplars at the coarse-grain level, but also on sufficient experiences with hearing and saying (practicing) the specific instances of the word. Abstractions of lower-level phonological knowledge, despite depending on each other to develop, may not necessarily emerge simultaneously. Thus, there might be sufficient experience (auditory-phonetic encoding) with a variety of words with penultimate stress in Spanish, but not enough instance-based articulatory encoding of the pattern to support its accurate production. The disparity between the two encoding levels (articulatory and auditory) can be used to explain nonlinearities in emerging phonological and lexical knowledge. Very young children exhibit the perceptual skill of differentiating between word-forms that may be common and uncommon in their language, although they cannot reliably reproduce these forms (Munson et al., 2007). Similarly, very young children may initially produce a few referential tokens, over-extending their meaning until more specific representations are available for use (Hudson & Nelson, 1984).

Advantages of Phonotactic Patterns for the Learner and the Researcher

There are at least two advantages related to the accumulation of fine-grained information about the phonological constitution of words and the phonotactic patterns that are common in a language. One such advantage is that children improve in their word-recognition and speech fluency. That is, an increase in automaticity of speech production results from practice with listening and speaking words in multiple situations (Bybee, 2001). Then, the mapping of the lower-level (auditory – articulatory) representations could be viewed as a form of fast-mapping of phonological structure, or the integration of how words sound and how they are produced, which supports individual production of word constituents, as well as word learning. The fast-mapping of phonological structure might be helpful for the child in the process of word learning as it allows for the recognition of categories or patterns within words. Secondly, from a language generation standpoint, schemas or patterns shared by many lexical items (tokens) gain strength as a result of their type frequency. More frequent schemas become stronger than less frequent schemas. Stronger schemas are also more productive in that they might be more likely to be used in learning new words.

For the researcher, important benefits accrue from obtaining a detailed understanding of how the probabilities of a language's phonological patterns (phoneme co-occurrences, onsets, rimes, and syllables) affect language behaviors. One benefit of understanding the specific phonotactic patterns of a language is the determination of whether the absence of certain phoneme sequences (as in the nonexistence of the sequence /np/ in word-medial position in English) is systematic in nature (Pierrehumbert, 2001). By verifying how many English words actually have have word-medial /np/, and comparing this to *expected* likelihood given the individual frequencies of /n/ and /p/, one can determine whether its nonoccurrence in English is the result of a phonotactic constraint. A second advantage relates to language performance. Knowing the patterns specific to English and Spanish allows the investigation of how they are manifested in any kind of language performance, including performance on nonword repetition tasks.

The Future in Spanish Nonword Repetition

Studies provide evidence for the effect of language patterns on English language processing, nonword repetition tasks (Dollaghan et al., 1995; Edwards et al., 2004; Gathercole & Baddeley, 1989; Gathercole et al., 1991). The variables under investigation in these studies included the presence of singleton consonants versus consonant clusters, the degree of wordlikeness of the nonwords, the presence of embedded real words, and the presence of attested phoneme sequences. All of these factors can be grouped under the term phonotactics. As previously mentioned, phonotactics refers to the rules governing the arrangement of allowable speech sounds within a given language. The study of phonotactics has been further refined to include not just categorically possible or impossible patterns, but also probabilistic phonotactics, where the relative frequencies with which the sounds occur and co-occur in the syllables and words of the language is investigated. Probabilistic phonotactics is reflected in the type frequency of patterns across the lexicon.

To the extent that repetition accuracy depends on the degree of overlap between a nonword and existing words in a language and to the degree that other factors (e.g., motor planning, ease of articulation) can be controlled by conforming to the phonotactics of Spanish, the nonword repetition task appears to be a fruitful medium through which children's coarse-grained encoding of phonotactic structure in Spanish can be investigated. The first step in such a research program is to develop a nonword repetition task in Spanish. To date, no study of Spanish nonword repetition has been undertaken with that aim. Investigating the types of coarse-grained phonological knowledge that Spanish-speaking, English language learners abstract from their experiences with oral language might be important in identifying the phonotactic patterns that emerge from the set of known real words and that may aid in the selection of targets for vocabulary instruction and phonological intervention.

The Present Study

From a practical perspective, there is a significant need for a systematically-designed Spanish nonword repetition measure that is equivalent to currently-available English measures. For this study, a database of nonwords that considered the phonological properties and phonotactic patterns of Spanish was developed. In a preliminary study, a large set of candidate nonwords was developed, and wordlikeness judgments from Spanish-speaking adults were obtained. A subset of the rated nonwords was then used in the development of a Spanish nonword repetition measure for Spanish-speaking English language learners. Children ages 4 to 6 years old participated in the main experiment, whose primary purpose was studying the influence of Spanish-specific patterns (i.e., wordlikeness and stress pattern) on nonword repetition performance.

Based on the previous literature, the following hypotheses were generated:

Hypothesis 1: Nonword repetition performance, as measured by the average proportion of incorrect constituent (onset and rime) productions, will be affected by participant age and vocabulary breadth, but not by participant gender.

Hypothesis 2: Repetition performance will be affected by word length and wordlikeness (i.e., stress pattern and wordlikeness ratings).

Hypothesis 3: When participants make errors in their repetitions, these will represent the following patterns:

a) Errors affecting the length in syllables of the nonword will be more common than errors affecting stress pattern.

b) Errors from consonant substitutions will be more frequent than errors from consonant deletions, which will be more frequent than consonant additions.

CHAPTER 2

Preliminary Study 1: Stimulus Development and Wordlikeness

This preliminary study involved the development of a corpus of real Spanish words, the University of South Florida Spanish Frequency Lexicon (USFL) used to create the nonword stimuli. The USFL is a computerized lexicon used for calculation of lexical and sublexical probabilities (e.g., phonotactic probabilities) in Spanish. Currently, no similar Spanish lexical corpus is available and, thus, it is a valuable addition to the research literature.

The following discussion is organized into three major sections. In the first section, some background on the USFL database and its creation is provided. Then, linguistic factors that were considered and controlled for in the development of the Spanish nonwords for the current study are included. Next, a summary of the adult wordlikeness study is provided. In the fourth section, a description is provided of the final stimulus set utilized in the study of nonword repetition performance in a group of school-age typically-developing English-language learners.

Development of the USFL Corpus of Spanish Words

Method: Database Creation

The first step in the systematic development of nonword stimuli is obtaining access to a representative set of real words, varying in frequency information, from oral and written registers of a particular language. Accessing a characteristic set of real words allows the extraction of constituent sequences (e.g., onset and rimes) that are typically found in the language of interest. These constituents can then be utilized to develop nonwords that reflect the probabilistic distribution of constituents in the lexicon. There are a number of Spanish frequency lists or dictionaries available for this purpose (Alameda & Cuetos, 1995; Buchanan, 1927; Davies, 2006; Eaton, 1940; Garcia Hoz, 1953; Rodriguez Bou, 1952; Sebastian, Martí, Carreiras, & Cuetos, 2000). However, these databases all share significant limitations. First, most of these dictionaries are based only on written Spanish texts and thus would not render a representative description of oral language (Alameda & Cuetos, 1995; Buchanan, 1927; Eaton, 1940; García Hoz, 1953; Rodriguez Bou, 1952; Sebastián et al., 2000). Second, adding to the lack of representativeness, most of these dictionaries include only Castilian Spanish texts, excluding Latin American Spanish varieties. Third, of the dictionaries that focused on written texts, many were based on written materials from the 1950s, and thus would be less representative of the current language, especially since the eventual use for this study involves generating stimuli for children. One dictionary created by Davies (2006) did overcome the limitations of its predecessors by including a variety of words from Spain and Latin American oral and written texts; however, since it was designed as a vocabulary teaching tool, it only published data on the 5,000 most frequently encountered words. Finally, only one of these dictionaries (Sebastian et al., 2000) is available in electronic format. However, the Sebastian et al. (2000) corpus is extremely difficult to acquire outside of Spain. Using any of the printed corpuses would require a lengthy data-entry process prior to the analysis and extraction of the lexical data. Due to the aforementioned methodological limitations, the constituent onset and rime sequences that make up the nonwords in the current study were derived from a lexicon of real Spanish spoken words that was created for this study.

To develop the USFL, words were extracted from a different sort of online dictionary, the Linguistic Data Consortium (LDC) CALLHOME Spanish lexicon (Garrett, Morton, & McLemore, 1996). The CALLHOME Spanish lexicon database was compiled as part of an investigation funded by the U.S. Department of Defense. The focus of the LDC Large Vocabulary for Speech Recognition (LVSR) investigation was to compile samples of telephone conversations by native Spanish speaking adults to be used in speech recognition studies. The CALLHOME Spanish lexicon consists of 45,582 words and contains separate information fields with the phonetic transcriptions, morphological features, and frequency information for each word (Garrett et al., 1996). For the CALLHOME Spanish lexicon, a variety of Latin American dialects was sampled. However, the only information available in reports associated with this data collection is the countries in which the phone calls were received. These countries include Chile, Argentina, Venezuela, Dominican Republic, Nicaragua, Honduras, Guatemala, Mexico, Paraguay, Colombia, Uruguay, Ecuador, Peru, and Spain (Linguistic Data Consortium Catalog, LDC96T17, 2006). Data on the specific Spanish dialects sampled were not available.

A methodological issue in using adult corpora for studies with children is whether the statistical patterns derived from a set of adult lexical and phonological entries, as is the CALLHOME lexicon, would be compatible with the emerging properties of Spanish-speaking children's lexicons (Coady & Anslin, 1993; Dollaghan, 1994). In a recent study of phonological generalization in English, Gierut and Dale (2007) used adult and child

English corpora. Findings suggested that lexical corpora from either children or adult sources were compatible. That is, the adult and child databases used to calculate word frequency yielded similar results.

To create the USFL, a series of exclusionary analyses were performed on the real words in the CALLHOME lexicon, to develop a database comparable to those used for lexical studies of English phonotactics. In most cases, only monomorphemic words (i.e., *perro*, not *perros*) were included in USFL. The rationale behind the omission of a majority of suffixes was to avoid the overrepresentation of particular phonetic constituents that could result in morphological confounds during the judgment study (e.g., the inflectional morpheme *–amos* appears attached to many verbs). Thus, word types in most cases were included within the USFL lexicon in their simplest possible form, without most morphological derivations and inflectional markers. The final USFL corpus has a total of 11,644 words including the categories displayed in Table 2.1. The singular case and masculine gender were used to represent adjectives, pronouns, and cardinal numbers. Masculine and feminine genders were maintained for nouns.

As indicated in the table notation, some words belonged to more than one grammatical category in the lexicon. For instance, the word *sabio* ('wise') could be either a singular, masculine noun, as in the sentence *El sabio le dijo al rey que se escondiera* ('The wiseman advised the king to hide'), or it can be a singular, masculine adjective as in the phrase *El abuelo sabio* ('the wise grandfather').

Table 2.1

USFL Items by Lexical Category

Category	**Total**
Nouns	7,680
Adjectives	2,903
Infinitival Verbs	1,973
Adverbs	125
Interjections	82
Pronouns	77
Conjunctions	24
Prepositions	24
Quantifiers	14
Determiners	9
Interrogatives	3
Grand Total:	12,919*

Note: *Grand total differs from the total number of words in the lexicon because some words belonged to more than one category.

Syllabification in Spanish. After all included lexical items were identified, the words were syllabified following the parsing and stress guidelines of Spanish. The reader is referred to Table 2.2 for condensed descriptions of the Spanish syllabification rules that are explained in detail in the following discussion. Spanish contains marginal or isolated phonemes, which cannot by themselves constitute syllables (e.g., consonants), and syllabic phonemes which can stand independently as syllables (e.g., vowels or vocoids). Examples in Table 2.2 suggest that syllabification in Spanish varies when syllabic constituent are adjacent to one another. For instance, diphthongs, composed of a semivowel, /j/ or /w/, and the vowels /a/, /e/, or /o/, remain in the same syllable. As seen in Table 2.2, the word *aire* (air) is syllabified in the following manner: [áj.re]. Otherwise, vowel sequences that involve combinations of stressed versions of the vowels /a/, /e/, and /o/, or that include one of these vowels and stressed versions of the vowels /i/ or /u/, are separated into different syllables. Illustrations of such vowel combinations are found in the adjective *feo* ('ugly') and the name *Lía*, which are syllabified in the following manner: [fé.o] and [lí.a]. Therefore, to an extent, division of syllables constituted by vowels is dependent on stress-assignment (Alarcos Llorach, 1994).

Like in English, the consonants and vowels within a syllable can be divided into onset and rime constituents. Typically, onsets are the first consonant in a syllable, while rimes are the vowels and consonants that follow it. As seen in Table 2.2, syllables in Spanish do not require the presence of an onset consonant (Kattan-Ibarra & Pountain, 1997). Because onsets are optional syllabic constituents, "empty" or onset-absent syllables occur often. For example, the word *ahí* ('there') consists of two empty onset syllables ([a.í]). Singleton consonants in word internal positions become the onsets to the following syllables (e.g., *casa* [ka.sa], 'house').

When clusters of consonants appear in word medial position they are separated; that is, one consonant is the coda of the preceding syllable and the other is the onset of the following syllable, unless the consonant pair is one of the so-called 'indivisible clusters'. Indivisible consonant clusters are made-up of a single obstruent (e.g., b, p, t, d, k, g, f) followed by a liquid consonant (i.e., l or r) (Harris, 1983). Examples of these indivisible two-segment onsets are found in the following Spanish words: *abrigo* ('coat'), *cable* ('cable'), and *electricidad* ('electricity'). An example of a divisible consonant cluster is *sp* in the word *español* ('Spanish'), in which the /s/ becomes the coda of the first syllable and the /p/ the onset of the second syllable. Word-final codas can contain one or a group of two consonants. However, only a few consonants can be codas (i.e., d, n, l, r, and s) in Spanish words (Hualde, 2005, p. 75).

Stress assignment. As in English, stress in Spanish has been described as phonetically contrastive (Goldstein, 2004; Harris, 1983; Hualde, 2005). Stress falls on the penultimate syllable in words that end in vowels or the consonants /n/ or /s/ (e.g., *báte* - bat). When words end in a consonant other than "n" or "s," stress falls on their final syllables (e.g., *felicidad*, 'happiness'). Approximately 95% of all nouns and adjectives in Spanish follow these two patterns. Words that do not fall under the two categories described carry an orthographic accent, which indicates the syllable that receives phonetic stress (e.g., the antepenultimate syllable in *brújula*, 'compass') (Guion, Harada, & Clark, 2004). Stress rules apply to both underived and derived forms of words (*páto*/*patíto*, 'duck/duckie'). Moreover, stress remains constant in uninflected and inflected forms (*páto*/*pátos*) (Harris, 1983). Only one research study (Hochberg, 1988) has analyzed the development of stress assignment patterns in Spanish speakers. In this study, children who were predominantly Spanish-speaking demonstrated knowledge of native language "stress rules" (p. 704) as early as three years of age. They produced few errors (~30%) in their repetitions of nonwords with frequent, infrequent, and unattested stress patterns. Hochberg (1988) indicated that this finding supports the claim that the suprasegmental aspect of language is among the first mastered by children.

Table 2.2

Spanish Syllabification Guidelines

Syllable	Guideline	Word/Example	English Gloss
Involving Vowels	Empty onsets can be syllables	*Ahí* [a.í]	There
	Diphthongs are never separated	*Aire* [áj.re]	Air
	Vowel sequences involving combinations of /a/, /e/, and /o/, or one of these vowels and stressed versions of the vowels /i/ or /u/ are separated into different syllables	*Lía* [lí.a] *Feo* [fé.o]	Leah Ugly
Involving Consonants and Vowels	Obstruent-liquid clusters are always onsets and never separated	*Cable* [ká.ble]	Cable
	Consonant sequences not involving obstruents followed by liquids are separated	*Español* [es.pa.ɳól]	Spanish
	Prefixes ending in obstruents and followed by liquids can be separated	*Subrayar* [sub.ra.jár]	Underline

Notes. IPA symbols have been used in the broad transcriptions in this table. /ɳ/ is the notation for orthographic ñ.

In the USFL, syllables and stress assignment are marked on the phonetic transcriptions of the words. The phonetic transcriptions use an ordinary ASCII character representation rather than IPA symbols, following a modified version of the scheme used in the CALLHOME lexicon. The CALLHOME scheme was modified so that the ASCII strings could be manipulated using Microsoft Excel, which does not readily differentiate uppercase and lowercase letters. For example, the word *abuela* (‘grandmother’) is separated into three syllables and stress is marked by entering a “0” or a “1” before the syllable it represented: 0[<a>]1[B+<we>]0[l<a>]. Brackets (‘[ ]’) are used for syllable boundaries, and pointed brackets (‘< >’) were used to separate onset, nucleus, and coda consistutents in each syllable. In the case of *abuela*, the second syllable is stressed and contains a vocalic on-glide. The B+ in this case is the ASCII character code for the bilabial fricative /β/, with the “+” character added to the CALLHOME transcription in order to differentiated it from the b used for /b/ in Excel.

Spanish Nonwords: Calculation of Phonotactic Probability

Before developing the Spanish nonwords, the onset and rime constituents’ frequency of occurrence within the lexicon, or their phonotactic probability, was calculated. To do this, the probabilities of sub-syllabic onset and rime constituents were calculated following the guidelines of Coleman and Pierrehumbert’s (1997) stochastic grammar. Coleman and Pierrehumbert studied the correlation of adults’ acceptability (as potential real words) of nonwords that included illegal phonetic sequences in the English language. Their results indicate that, although illegal segments affected the participants’ judgment of wordlikeness, variability in their ratings existed that could not be explained only by the presence of these grammatical violations alone. Specifically, a probabilistic measure that considered (log) cumulative word probability was correlated with adult ratings of acceptability (Coleman & Pierrehumbert, 1997). Therefore, the occurrence of a single illegal constituent in a nonword did not result in the nonword being deemed unacceptable. With these results, the authors suggested that: (a) the unacceptability of illegal phonetic sequences could be improved if their surrounding phonetic contexts were more frequent in a lexicon and (b) the determination of a novel word's acceptability may not involve categorical decision; rather, it may develop from the evaluation of its entire (cumulative) phonetic composition. This finding was replicated in a subsequent series of studies by Frisch et al (2000).

Coleman and Pierrehumbert's (1997) grammar considers the likelihood of onset and rimes within the syllabic and prosodic positions in which these appear in words. In this grammar, a constituent's prosodic position will encompass both its location within a word (intial, medial, or final) and the stress of the syllable in which it occurs (stressed vs. unstressed). Onsets only occur in word initial position, while rimes only occur in word final position. Therefore, following Coleman and Pierrehumbert, eight probability distributions by position emerge: stressed initial onsets, stressed medial onsets, stressed medial rimes, stressed final rimes, and their unstressed counterparts.

In the present study, to compute the probability of a particular constituent in a particular prosodic position, the number of words in USFL that contained the constituent in the specified prosodic position (e.g., stressed initial onset, unstressed medial rime) was divided by the total number of words in the USFL containing constituent segments in that position. For example, in the case of the nonword **0[f<a>]1[B+<o>]**, the following formula was used to determine the probability of the unstressed initial onset (UIO), /f/:

$$\text{Probability of /f/ as UIO} = \frac{\text{\# of words containing /f/ as an UIO}}{\text{\# of words containing an UIO}}$$

After probabilities were computed for onset and rime constituents, the distribution of these subsyllabic constituents was used as a database to create nonwords by selecting constituents at random to concatenate into novel nonwords. The probabilities of onsets and rimes in each nonword were then multiplied to determine each nonword's expected phonotactic probability, following Coleman and Pierrehumbert (1997). This measure integrates the cumulative effects of nonword constituents' probabilities and is highly correlated with nonword acceptability judgments (see also Frisch et al., 2000). Consistent with other psychological scales for frequency, a logarithm of the expected (cumulative) probability of each nonword was used as the cognitive scale of nonword probability.

Examples of nonwords' constituent and log expected probabilities can be found in Table 2.3. The first column displays a transcription of two example nonwords. The columns labeled PO1, PR1, PO2, PR2, PO3, and PR3 include information about the probabilities for the specific onsets and rimes in the nonword. For example, the two-syllable nonword [faβo] includes two onset phonemes and two rime sequences. The penultimate (in this case, first) syllable is unstressed, while the ultimate syllable is stressed. According to the data in the USFL, the probability that the initial onset, /f/, occurs in initial position of words and in an unstressed syllable is .025. The probability that /o/ is a stressed final rime is .003. It is important to note that longer nonwords contain more onset and rime constituents, and as a result more probabilities that are multiplied together. Therefore, some of the longest nonwords with high-probability constituents have lower cumulative probabilities than the two syllable nonwords with low probability constituents (Frisch et al 2000).

Table 2.3

Examples of Stimulus Items and their Constituent and Expected Probabilities

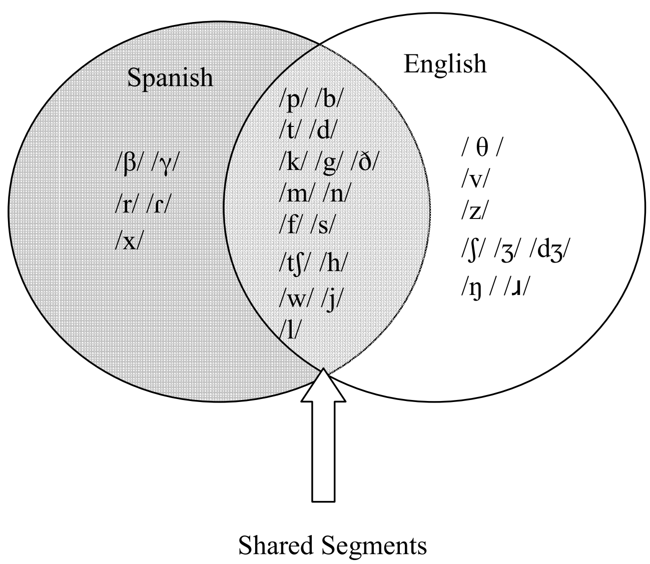
Nonword	**Constituent Probabilities**						**Log Probability**
	P(O1)	P(R1)	P(O2)	P(R2)	P(O3)	P(R3)	
0[f<a>]1[B+<o>]	0.025	0.202	0.040	0.003			-6.229
0[k<a>]1[r<o>r]0[B+<e>]	0.111	0.202	0.071	0.008	0.052	0.134	-7.024

Spanish Nonwords: Four Linguistic Factors

In addition to expected phonotactic probability, four linguistic factors were considered in the development of the nonwords. These factors have been previously manipulated by Edwards et al. (2004) in their studies of English nonword repetition; however, they have not been systematically controlled in studies of Spanish nonword repetition. The four linguistic factors include: (a) age of acquisition of phonemes in Spanish, (b) consonantal allophonic variations, (c) Spanish phonotactic rules, and (d) word length. The following discussion describes how the linguistic factors were considered in the development of the nonword stimuli:

Age of acquisition of phonemes. There are 18 phonemic consonants in Spanish: the voiced stops /b, d, g/, the voiceless stops /p, t, k/, the voiceless fricatives /f, s, h/, the affricate /tʃ/, the glides /w, j/, the nasals /m, n, η/, the lateral /l/, and the tap/trill /ɾ/r/ (Iglesias & Anderson, 1993). Spanish has five vowels (/a/, /e/, /i/, /o/, /u/). Spanish also has fricative allophones of the voiced stops (/β/, /ð/, /ɤ/). It is important to note briefly that the phonologies of Spanish and English are different. Figure 2.1 shows the segmental inventories of consonants for the two languages. While many segments are used by both languages, each language also has distinct consonant segments not found in the other. Goldstein (2004) has suggested that the unshared phonemes, in particular the Trill and flap /r/ for Spanish and the fricatives /**θ**, z, **ʃ**, **ʒ**/ and affricate /d**ʒ**/ in English, are among the latest acquired phonemes in bilingual children.

Figure 2.1. Spanish and English consonant segment inventories



Available data indicate that Spanish phonological acquisition follows a predictable universal order: Vowels appear first and are followed by nasals, plosives, glides, liquids, fricatives, and, finally, affricates. There is little agreement regarding the ages at which Spanish speaking children have mastered their phonetic repertoires.

However, approximately by the age of 4 years, typically-developing children who are monolingual Spanish-speaking, as well as those who are learning English as a second language, appear to have developed a majority of the Spanish phonemes (Acevedo, 1993; Goldstein, personal communication February 16, 2006; Goldstein & Washington, 2001). The trill /r/ (e.g., *carro* /karo/ ('car') has been identified as the latest-acquired phoneme. Previous research (Acevedo, 1993; Jimenez, 1987) concluded that between ages of 4; 7 and 5; 0, most children have mastered the production of this phoneme.

In order to control for the effect of articulatory difficulty and reduce cognitive load on the repetition task for the young participants in Study 2, the trill /r/ was excluded from the target sequences embedded in the nonwords that were used in the child study. This modification, in turn, allowed the inference that errors in the repetition task related to difficulties in recall and not production of the target sequences.

Allophonic variations. Allophonic variations of the stop consonants (i.e., /b/, /d/, /g/), which appear as spirants (i.e., /**β**, **ð**, **ɣ**/ in intervocalic position, and following consonants other than nasals, were considered in the design of the nonwords (Green, 1996). These spirant allophones appear within and across word boundaries and are produced by all Spanish dialect speakers. As a result, it was necessary to include them in the nonwords. Additionally, this consideration was developmentally appropriate, because by age 5 years, most bilingual children have mastered the production of these spirant allophones in their appropriate phonetic contexts (Brian Goldstein, personal communication August 24, 2006). Allophonic variants were used only in syllabic positions that were appropriate for their appearance.

Phonotactic patterns. Within Spanish words, sequences of identical consonants within or across syllabic boundaries, or geminates, do not occur (e.g., *mamma*, which is not a Spanish word). If one stop consonant (b, p, d, t, g, k) follows another, the second stop consonant must be a dental (e.g., /t/), as in the word *di**ct**ado*. The opposite consonant combination, dental-velar (e.g., /tk/) is not allowed. Finally, word internal nasal consonants can only be followed by consonants that share their place of articulation, or are homorganic (Hualde, 2005). An example of this syllable-contact pattern can be found in the word *cantar* ('to sing'), in which the alveolar stop /t/ follows the alveolar nasal /n/. These phonotactic, or syllable-contact, patterns were not violated in constructing the Spanish nonwords.

Word length (length in syllables). Accuracy of repetition decreases as nonword length increases. This relationship is robust (Dollaghan & Campbell, 1998; Edwards et al., 2004; Gathercole, 1995). Whereas English has a preponderance of monosyllabic words, in Spanish two- and three-syllable words are more common (Goldstein, 2004). Nonword repetition tasks in English have typically used two- and three-syllable words. Thus, to simulate the level of complexity encountered in language use and to be comparable to tasks in English, the Spanish nonword task included two-, three-, and four-syllable nonwords.

Stimulus Set

A set of 240 nonwords, 80 each of two-, three-, and four-syllables in length, was created. For each syllable length, final and penultimate stress patterns were used in developing the stimulus items. Thus, 40 nonwords in each of the two stress patterns were included in each syllable length. Syllable constituents of varying probabilities for each of the eight prosodic positions (i.e., stressed initial onset, stressed medial onsets, stressed medial rimes, stressed final rimes, and their unstressed counterparts) were randomly selected in creating nonwords. Stimulus items complied with the four linguistic factors outlined in the previous discussion and ranged in phonotactic probability. Orthographic spellings and IPA phonetic transcriptions of the 240 stimulus items were developed by the author. These orthographic transcriptions, as well as the probabilities of each stimulus item are found in Tables 1 and 2 in Appendix A.

Statistical Analyses

To ensure that stimulus items differed in expected phonotactic probability between lengths, and that the two selected stress patterns were equally distributed at each length, a 3 X 2 ANOVA was computed with length in syllables and stress patterns as repeated measures factors and log phonotactic probability as the dependent variable. Results revealed a significant main effect of syllable length, $F(2,234)=117.62$, $p<.001$, partial $\eta^2=.501$, a medium effect size. Pairwise comparisons using Tukey HSD revealed that four-syllable nonwords were significantly less probable (m_1 = -9.13) than three-syllable nonwords (m_2 = -8.51) which, in turn, were significantly less probable than two-syllable nonwords (m_3= -6.37). Finally, as can be observed in Table 2.4, neither the main effect of stress pattern, nor the length by stress pattern interaction were significant. Thus, the two stress patterns had equally probable nonwords at each length.

Table 2.4

ANOVA with Length in Syllables and Stress Pattern as Factors Across Stimuli

Source	*Type III Sum of Squares*	*df*	*Mean Square*	*F*	*Sig.*	*Partial η^2*
Stress Pattern	2.382	1	2.382	1.682	.196	
Syllable Length	333.295	2	166.647	117.622	.000	.501
Stress * Length	1.104	2	.552	.390	.678	
Error	331.533	234	1.417			
Total	16050.619	240				
Corrected Total	668.356	239				

Prompts and Recording

Prompts to elicit the rating of nonwords were prerecorded in Spanish. The 240 nonwords were spoken by an adult, male, Spanish-dominant bilingual speaker who spoke an accentless, standard dialect of Spanish. The speaker of the nonwords was not aware of the methods used to generate the stimuli. Orthographic transcriptions of the nonwords were provided for the speaker to read prior to the recording session. During the recording session, these nonwords were individually orally presented to the speaker. The speaker was required to repeat the productions. Repetitions that did not match the targets were re-recorded until a match to the target nonword was achieved. Recordings took place in a sound-treated laboratory at the University of South Florida. A sampling rate of 44.1 kHz was used for all recordings, which were conducted using a SONY Digital Audio Tape (DAT) Recorder (Model PCM-M1).

After all nonwords were recorded, the recorded stimuli were screened for accuracy and fluency. Through this screening process, two nonwords were excluded. One nonword did not match the target's stress pattern. Background noise was perceived in the recording of the second excluded nonword. Recorded files were converted to .wav files and the best production was selected from a visual representation of the sound waveform using the software program Praat version 4.3.14 (Boersma & Weenik, 2006). Five milliseconds were left silent prior to the beginning of each stimulus item.

Preliminary Study 2: Judging Spanish Wordlikeness

Purpose

Obtaining ratings of wordlikeness constitutes an essential step in the systematic development of nonword stimuli for repetition tasks because it has been identified as a factor affecting performance in such tasks (Edwards et al., 2004; Gathercole, 1995; Gathercole et al., 1991). The following research questions related to this study:

1. Is there an effect of length in syllables and stress pattern on wordlikeness ratings for Spanish nonwords?
2. Is there a relationship between expected phonotactic probability in the Coleman and Pierrehumbert (1997) stochastic grammar and adult wordlikeness ratings in Spanish?

From a practical perspective, this phase of the preliminary study sought to obtain ratings of wordlikeness for a large set of candidate Spanish nonwords in order to control the effect of wordlikeness in the Spanish nonword repetition task to be used in the child study. Ultimately, a total of 36 of the 238 rated nonwords from this study, 12 each in two-, three-, and four- syllable lengths, were selected as stimulus items for the child investigation.

Method

Materials

Spanish language use questionnaire. Spanish and English versions of an L1 use questionnaire were developed for this study (Appendix B). This questionnaire was designed to determine the participant's years of exposure to the languages spoken with regard to: the Spanish-speaking country of origin, language(s) spoken in the home, and language spoken in other settings (e.g., school, work, social events). As part of this questionnaire, participants were also required to rate the frequency with which they listened to or used Spanish with a variety of conversational partners (e.g., family, neighbors, friends). The remaining questions were used to collect demographic information and data on educational background, in particular literacy skills, in Spanish and English.

Wordlikeness judgment task. A total of 238 nonwords, ranging in expected phonotactic probability, were included in the study. Eighty two-syllable nonwords, 79 three-syllable nonwords, and 79 four-syllable nonwords were presented. Nonwords were divided into three randomized blocks containing nearly equal numbers of items.

Participants

Ten adult Spanish speakers between the ages of 22 and 31 years participated in the wordlikeness judgment experiment. This sample was considered appropriate, based on a review of relevant literature (Edwards et al., 2004; Frisch et al., 2000; Gathercole et al., 1991). These previous studies required English-speaking adults to rate their nonwords for wordlikeness. In the current study, Spanish-English bilingual participants were asked to rate Spanish nonwords for wordlikeness. Validity of the use of bilingual adults instead of monolingual adults was obtained from a recent study by Frisch et al. (submitted), in which thirty Spanish-English bilinguals rated English and Spanish nonwords for wordlikeness. During this metalinguistic well-formedness judgment task, the bilingual Spanish-English speakers appeared to have knowledge of probabilistic phonotactics in both of their languages, consulting this information on a language-specific basis.

All participants were Spanish speakers who had lived in the United States at least 5 years. Appendix C displays participant demographic information. Seven of the participants in this study reported an age of immersion (AOI) in the English-speaking environment of age 10 years or earlier. Three participants reported the AOI to be after 12 years of age. All participants confirmed the absence of previous speech, language, hearing, and cognitive disorders. Participants also completed a language use questionnaire in which they provided demographic information and indicated the length of exposure and types of exposure to Spanish and English. In addition, they rated their oral and written Spanish and English skills. Table 2.5 displays the Spanish language ratings. The rating scale used to self-evaluate Spanish frequency of use in a variety of social contexts ranged from 1 (never) to 5 (always). A similar range was utilized to rate Spanish reading and writing skills, however the descriptors were different (i.e., a rating of "1" suggested "poor skills" and rating of "5" indicated "excellent skills"). It is therefore not surprising that the mean oral language ratings were lower than the literacy ratings. These participants spoke mostly English in their everyday. As a group, these participants also had reported receiving Spanish reading instruction in their early years, thus resulting in their high literacy ratings.

Table 2.5.

Adult Spanish Language Ratings

Participant	Oral Language Mean Ratings	Literacy Mean Ratings
1	3.8	4.0
2	2.0	4.0
3	2.0	3.0
4	1.5	3.5
5	2.0	3.0
6	2.3	3.5
7	2.8	3.0
8	3.0	4.0
9	3.0	5.0
10	2.3	3.0
Mean Ratings (SD)	2.47 (0.68)	3.60 (0. 66)

Note: Oral language use scale: 1 (never) – 5 (always); Literacy skills scale: 1 (poor) – 5 (excellent).

Procedure

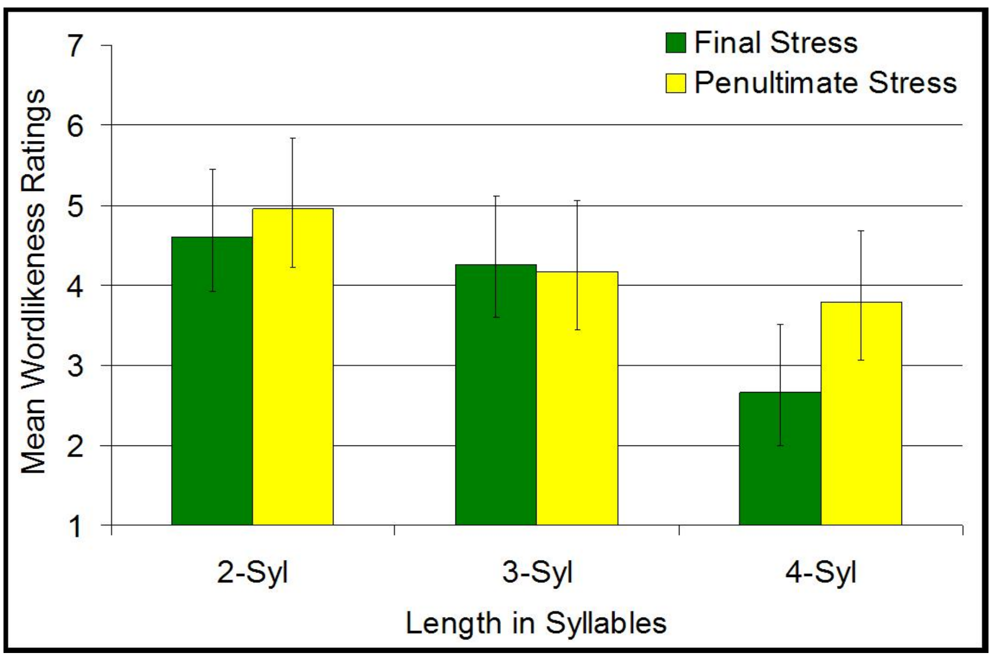
Participants were individually tested either in a laboratory at the University of South Florida or in a quiet room in the participants' homes. First, both the English and Spanish written forms of the language use questionnaire were offered. Participants were encouraged to select the language in which they preferred to complete the language use questionnaire and to answer questions thoroughly. The PI was available to answer any questions the participants may have had. All participants selected the English version of the questionnaire.

The judgment task was then administered. This task was conducted entirely in Spanish. The software program Praat version 4.3.14 (Boersma & Weenik, 2006) was used for this task. For this portion of the study, each participant was seated in front of a computer screen. Nonwords were individually presented via headphones in a computer-randomized order. The participants were asked to rate the nonwords for their wordlikeness on a seven-point scale, following the paradigm employed by Frisch et al. (2000). Specifically, a rating scale ranging from 1 to 7 appeared on the screen. A rating of 1 indicated that a nonword could never be a word in Spanish (i.e., *bajo - imposible*; low – impossible rating) and a rating of 7 was used to describe a nonword that had a high possibility of resembling a real Spanish word (i.e., *alto – posible*; high-possible rating). Thus, a "4" constituted a *neutro* (neutral) rating, while "2" and "3" and "5" and "6" represented "unlikely to be a word in Spanish" and "likely to be a word in Spanish" ratings, respectively. Participants were instructed to respond by clicking with a computer mouse on the number that best represented their response.

Results

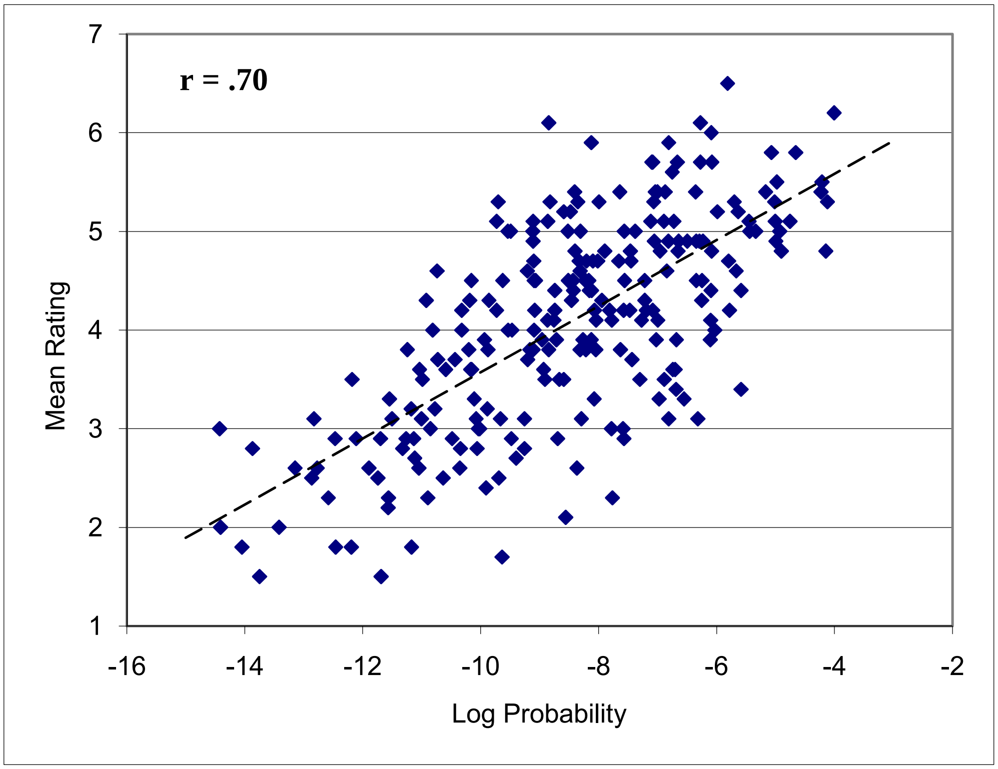
Data were collected using Praat and then transferred to a statistical software package (SPSS 11.5) for analysis. A 3x2 ANOVA was performed with length in syllables and stress patterns as within-subjects factors and wordlikeness ratings as the dependent variable. Figure 2.2 displays the mean ratings for the different types of stimuli. Significant main effects of length in syllables and stress patterns were found. Specifically, shorter stimuli were rated as more wordlike than longer stimuli, $F(2, 18) = 25.4$, $p < .001$. Nonwords containing the more frequently occurring stress pattern (i.e., penultimate stress) were rated as more wordlike than nonwords containing the less frequent stress pattern (i.e., final stress), $F(1, 9) = 22.6$, $p = .001$. These main effects were qualified by a significant length x stress pattern interaction, $F(2, 18) = 17.88$, $p<.001$. A paired-samples t-test revealed that participants rated nonwords with the most frequently occurring stress pattern more highly only for two-syllable [m_1 (2 syll, final stress) = 4.6, *SD*=.93; m_2 (2 syll, penultimate stress)= 4.9, *SD*=.92] and four-syllable nonwords [m_1 (4 syll, final stress)= 3.8, *SD*=.65; m_2 (4 syll, penultimate stress) = 2.6, *SD*=.52]. No significant differences were found between the mean ratings of the final and penultimate stress patterns in three syllable nonwords.

Figure 2.2. Mean subjective ratings for the nonword stimuli.



Mean ratings for each stimulus as a function of expected phonotactic probability (i.e., logarithm of the product of phonotactic probabilities of the onset and rime constituents) are shown in Figure 2.3. Expected phonotactic probability and average ratings were significantly correlated, $r=.70$, $p<.001$, replicating the studies of Coleman and Pierrehumbert (1997) and Frisch et al.'s (2000) of wordlikeness judgments in English.

Figure 2.3. Mean subjective ratings for each nonword as a function of the log product of constituent probabilities.



Final Stimulus Set

Table 2.6 includes the final set of 36 nonwords, 12 each at each two-, three-, and four-syllables in length, extracted from the 238 nonwords rated by the adults. Nonwords were selected when there was was a match between their expected phonotactic probability and the adults' wordlikeness ratings. For example, as seen on Table 2.6, the nonword *seixtra* had a low phonotactic probability (i.e., -8.26) and received a low wordlikeness rating (i.e., 3.9). The stimulus items were balanced for stress pattern (final, penultimate), wordlikeness (high, low), and phonotactic probability. That is, six nonwords for each stress pattern were included at each length. For each stress pattern and length, three nonwords were relatively high in phonotactic probability and received high wordlikeness ratings and three nonwords were relatively low in phonotactic probability and received low wordlikeness ratings. It should be noted that wordlikeness is inherently confounded with length in syllables and stress pattern. When nonwords were deemed to be too similar to real words or phrases in Spanish, as in the nonword *questá*, which was an exact replica of the phrase que está (that is), they were not included as items.

Table 2.6

Nonword Repetition Stimulus Set

Nonword	No. of Syllables	Degree of Wordlikeness	Stress Pattern	Expected Phonotactic Probability	Wordlikeness Rating
preno	2	High	Final	-5.99	5.2
esia	2	High	Final	-4.93	5
prise	2	High	Final	-5.34	5
prestie	2	Low	Final	-7.08	4.2
daquia	2	Low	Final	-6.03	4
seixtra	2	Low	Final	-8.26	3.9
erpa	2	High	Penultimate	-4.76	5.1
chinso	2	High	Penultimate	-5.01	5.1
sioga	2	High	Penultimate	-5.45	5.1
muabi	2	Low	Penultimate	-7.47	4.2
trueñes	2	Low	Penultimate	-8.74	4.2
luapria	2	Low	Penultimate	-7.00	4.1
fableto	3	High	Final	-8.40	4.8
quibrinto	3	High	Final	-9.10	4.7
iperco	3	High	Final	-8.21	4.7
nexdomo	3	Low	Final	-10.11	3.3
biprioco	3	Low	Final	-10.04	3
leisquebe	3	Low	Final	-11.56	2.3
jorermo	3	High	Penultimate	-7.66	4.7
pabloña	3	High	Penultimate	-8.33	4.7
fectasno	3	High	Penultimate	-8.10	4.7
biebaplio	3	Low	Penultimate	-9.48	2.9
mosbletro	3	Low	Penultimate	-9.26	2.8
mosdinsil	3	Low	Penultimate	-10.34	2.8
oquiseuno	4	High	Final	-10.99	3.5
matrodenda	4	High	Final	-11.54	3.3
anquergine	4	High	Final	-11.18	3.2
traurespago	4	Low	Final	-13.15	2.6
nanquerbago	4	Low	Final	-12.77	2.6
duguiclera	4	Low	Final	-11.89	2.6
ismaretia	4	High	Penultimate	-8.46	4.3
ilirdera	4	High	Penultimate	-8.87	4.1
pineguesta	4	High	Penultimate	-9.17	3.8
maicatabo	4	Low	Penultimate	-9.40	2.7
pasneisodo	4	Low	Penultimate	-11.05	2.6
sifatrasbo	4	Low	Penultimate	-9.91	2.4

Study 3: Spanish-specific Patterns and Nonword Repetition Performance in Preschool English Language Learners

Purpose

The rationale for this study originated from a significant need for the systematic design of a Spanish nonword repetition measure that is equivalent to currently-available English measures. To accomplish this task, a subset of the rated nonwords from Preliminary Study 2 were extracted and presented for repetition to a sample of Spanish-speaking preschool and early school-age English language learners (ELLs). The current study had several specific aims:

(a) to examine the effect of age, gender, and vocabulary breadth on nonword repetition performance;

(b) to investigate the effects of word length, wordlikeness, and stress pattern frequency on nonword repetition performance; and

(c) to obtain normative data on nonword repetition performance by Spanish-English learning children.

Participants

Sample characteristics. A total of 68 children, four to six years of age were recruited for the sample. There were 21 four-year-olds, 25 five-year-olds, and 22 six-year-olds in the sample. Forty-seven children of the total sample were girls and 21 were boys. The Spanish-English speaking children were recruited from pre-kindergarten, kindergarten, and first grade classrooms in two urban private and two public schools, three Head Start sites, and one non-profit childcare center sponsored by the Redlands Christian Migrant Association (RCMA) in West Central Florida. Table 2.7 provides a distribution of these 68 participants by ethnicity, age, gender, and school site from which they were recruited. Table 2.8 displays the mean ages of the children in each group. .

Table 2.7

Total Number of Participants Distributed by Ethnicity, Age, Gender, and Participating Site

	Private Schools	Public Schools	Head Start Preschools	RCMA Preschoo l	Totals
Ethnicity					
Mexican	0	3	24	8	35
Cuban	4	13	1	0	18
Puerto Rican	1	8	2	0	11
Colombian	0	3	0	0	3
Honduran	0	1	0	0	1

Table 2.8

Mean Age per Group

Mean Age (SD, in months)	Males	Females
4;6 (4)	6	15
5;5 (3)	7	18
6;5 (4)	8	14

Inclusion criteria. To become a participant in this study, three inclusion critera had to be met. The first was parental consent. Only participants who returned signed consent forms were included. Consent forms were distributed to the identified sites. Parents were encouraged to review the information provided, sign the consent form if interested in participating, and return the form to their child's preschool or school site. Consent forms were collected by teachers. The collected consent forms were reviewed and participants' eligibility (e.g., child age and ethnicity) was confirmed. Of the potential pool of 127 participants, parents or caregivers did not give consent for 7 children. were .

Second, participants had to: (a) be identified by their English as a Second Language or regular classroom teachers as Spanish-speaking and demonstrate the ability to pass evaluation tasks from the *Woodcock-Muñoz Spanish Language Survey - Revised* (WMLS-R, Woodcock, Muñoz-Sandoval, Ruef, & Alvarado, 2005) and (b) demonstrate typical speech and hearing skills by passing Spanish articulation and hearing screenings.

Third, participants who were receiving speech, language, and/or learning supplementary services were excluded from the study. Five participants were eliminated because they were identified as non-Spanish speakers. Although these participants had been identified as Spanish-speaking by their teachers, they were unable to complete the first five items in the picture vocabulary sub-test of the WMLS-R. Four of these children spoke only English and one spoke the Southern Mexican indigenous dialect Mexteco, which is phonologically, semantically, and syntactically different from Spanish.

Hearing and speech screenings were essential methodological steps of the inclusion process. Because nonword repetition entails the perception and repetition of novel words, it was critical that potential variability in performance as a result of a hearing loss and errors in nonword articulation due to underdeveloped phonological systems be eliminated. Interestingly, this criterion resulted in a sizeable part of the sample pool being disqualified. In fact, 32 potential participants failed the articulation portion of the screening. All of these children had difficulty producing the tap /r/ in word-initial, medial, and final position, as well as in consonant blends. Other participants demonstrated difficulty producing fricatives (particularly /s/) and the affricate (i.e., /tʃ/).

In order to participate in the study, participants were required to demonstrate hearing thresholds of 25dB HL (American National Standards Institute, ANSI, 1996) for all audiometric test frequencies (500 Hz to 4000 Hz), bilaterally. Hearing was screened twice for participants who failed; six potential participants were eliminated as a result of not passing the screening. The children's teachers were advised of the failed screenings and short announcements were sent to the parents, requesting that they follow up with the children's pediatricians.

Due to the cross-sectional design of this study, attrition was not initially considered as a factor that could impact the sample size. However, a great number of the potential participants were children of migrant workers, who relocated several times within a school year. Two children were not assessed because they had emigrated from Florida in the span of time between obtaining the signed permissions and subsequent scheduling of their assessments. Parents did not inform the school or the teacher that their children would discontinue school attendance. Additionally, during transcription and analyses, three participant recordings had poor quality and could not be utilized for this study. Thus, out of the potential sample of 127 children, 68 provided usable data for this study. Females were more successful in passing the articulation measure and as a result, more female participants constituted the sample.

Materials

Demographic information. In all settings, teachers provided birthdate and countries of origin information, and indicated whether any of their students were receiving supplementary speech, language, and learning services. School procedures prohibit the identification of socioeconomic status of individual children, but general records from the two participating public schools indicated that all public school students (n=28) were enrolled in the free/reduced lunch program.

Oral language use. A Spanish language use questionnaire was modified from the one developed by Gutierrez-Clellen and Kreiter (2003). It was employed to obtain parents' estimate of the amount of participants' native language use in nonacademic situations (Appendix D). In this questionnaire, parents were asked to identify the percentage of time their children listened to and spoke Spanish in three social activities (e.g., watching television or playing games, participating in shared reading, and during meal routines). Fifty-eight participants of the total sample returned these questionnaires. Of these, 52 provided the estimates of frequency for all of the situations. Spanish was most frequently used (between 75-100%) during meal times. Frequency of use of Spanish in the other two contexts ranged from 0-60%. Some caregivers indicated on the questionnaires that the only time they shared as a family was during meal routines. And as a result, other situations resulted in more variability in the ratings. Table 2.9 summarizes the mean percentage of Spanish use for each nonacademic setting.

Table 2.9

Mean Native Language Percentage of Use in Nonacademic Settings

	Listen TV	Listen Book-Sharing	Listen Meals	Speak Games	Speak Book-Sharing	Speak Meals
Mean (in percentage)	54	58	94	69	56	92
SD	28	31	10	32	35	20

Articulation/ phonological skill. Currently, there are no standardized measures available to assess the phonological skills of Spanish-English bilingual children. Some limited normative data were used to construct the Spanish version of the *Phonological Measure of Bilingual Latino/a Children* (Goldstein & Washington, 2001). This measure was administered to assess the participants' productive phonology in Spanish. It is composed of 28 Spanish words familiar to most Spanish-speaking children. These words include singleton consonants (e.g., b, d, g), indivisible syllable initial clusters (e.g., bl, pl, br, bl, cr, cl, gr, fr, fl), and divisible abutting intersyllabic consonant clusters (e.g. -mp- in /ka*mp*o/ -- country). In this task, children were asked to orally name pictures of familiar objects. Testing photographs and drawings were collected by the author. The complete set of photographic items is included in Appendix E, and the administrator's instructions and response materials follow. Responses were phonetically transcribed and scored during the administration. Any errors in production that were not a result of dialect differences resulted in exclusion from the study.

Spanish vocabulary. The *Woodcock-Muñoz Spanish Language Survey - Revised* (WMLS-R, Woodcock et al., 2005) provides "a sampling of proficiency in oral language, language comprehension, reading, and writing" (p. 1). For the purposes of this study, only the cluster of subtests that yielded the oral language total score was administered.

Those subtests include: picture vocabulary, verbal analogies, understanding directions, and story recall. Standard Scores for sub-tests are based on a mean of 100 and a standard deviation of $\pm$15. Therefore, any standard score falling below 85 is considered below average.

For the purposes of this dissertation, the Picture Vocabulary standard score was of particular interest. Because the items in this nonword repetition measure were randomly selected from constituents in real Spanish words, it could be hypothesized that the more words a participant knew, the more specific knowledge of the form of these words she or he would have accumulated. The Picture Vocabulary subtest measures the ability to identify and retrieve the names of familiar and unfamiliar pictured objects and people. Although a few identification items are administered at the beginning of the test, this is primarily a retrieval vocabulary task. The task elicits single-word productions that represent a progression of familiar to unfamiliar vocabulary (Woodcock et al., 2005). The child receives one point for each correct answer, and the test is discontinued when the child answers six consecutive items incorrectly.

Sample item A was the starting item for the four-year-olds. Item 7 was used as the starting item for the five- and six-year-olds. Participants' performance on the four sub-tests was scored during the assessment using the Microsoft Windows Journal program (Microsoft, 2001) on a tablet PC.

Normative data for the Spanish form of the WMLS-R were obtained from a sample of over 1,000 Spanish-speaking participants inside and outside of the United States (Woodcock et al., 2005). Native Spanish-speakers represented a variety of countries, including Mexico, Argentina, Panama, Costa Rica, United States, Colombia, and Puerto Rico. Median test-retest reliabilities reportedly range from .88 to .98 for the clusters.

Nonword repetition. A total of 36 nonwords (see Table 2.2), 12 each in two-, three-, and four- syllable lengths were administered. Two stress patterns were equally represented across all lengths. In each set, half were highly wordlike nonwords and half were less wordlike nonwords, similar to procedures employed by Gathercole (1995). All disyllabic nonwords preceded tri-syllabic nonwords, which were presented before tetra-syllabic nonwords. Highly wordlike nonwords were presented before their low-wordlike counterparts. The participants were instructed to repeat each nonword presented. Wordlikeness ratings from Preliminary Study 2 were used to categorize the nonwords. The instructions and scoring form can be found in Appendix F.

Procedure

Parents were asked to complete the language use questionnaire and return it with the signed consent. All participants were tested individually in a quiet room in their school. Testing took place in one session. Before beginning a testing session, the author introduced herself and established rapport with the children in Spanish. Children were required to provide oral assent in order to participate in the study (Appendix G). Participants took part in the hearing screening, the articulation/phonological measure, the WMLS-R, and the nonword repetition measure, in that order. Instructions were presented in Spanish using vocabulary and syntax that is intelligible for children in the selected age-range. This session took approximately 30 minutes. The following discussion provides detailed procedures for the testing session:

Hearing screening. Hearing was individually tested with a portable GSI-17 audiometer calibrated to ANSI standards (ANSI, 1996). Manipulatives in the form of small, plastic colored teddy bears were used to condition the participants to respond to the typical frequencies assessed. The participants were instructed to place a teddy bear in a bucket every time they heard the tone.

Articulation/phonological skill. To elicit the target words, photographs representing the objects were shown to the participants. If the participant was unresponsive, the examiner provided two levels of prompting (Washington & Goldstein, 2001). Level 1 involved the description of the item's function "se usa para…" (It is used for…), while level 2 involves the presentation of cloze, fill-in-the blank sentences to obtain the target word, as in "En la mañana me cepillo los ____" to elicit *dientes* (i.e., In the morning, I brush my ____ --"teeth"). No responses in level 2 resulted in the PI producing the target word and requiring its imitation. Correct and incorrect responses were phonetically transcribed by hand and scored as correct or incorrect in tandem with test administration.

Spanish vocabulary. The WMLS-R (Woodcock et al., 2005) is an individually administered measure. Children were presented with drawings of depicting objects and concepts that range in frequency of occurrence in the American school classroom (Guerrero & Del Vecchio, 1996; Solórzano, 2008). Children were either asked to point to the drawing depicting the named object/concept or they were asked to provide the label for a drawing.

Nonword repetition. All stimuli were presented via Cyber Acoustics stereo headphones (Model AC-401). Recorded files of the nonwords used for the adult wordlikeness judgment study were used. The software program Praat version 4.3.14 (Boersma & Weenik, 2006) was used to present the nonword stimulus items. The participants were instructed to repeat each nonword presented. Individual nonwords were re-administered if the child's production was completely unintelligible, low in volume, or when no responses were provided. Children's repetitions were audio recorded for later transcription and coding. The headset contained a direct noise cancelling microphone (Model DNCT4) used to amplify the children's productions. An Olympus Digital Voice Recorder (Model WS-100) with USB adapter was utilized for recordings. The sound files in .wav format were transferred to a computer for transcription and coding.

Data Reduction

Phonology/articulation. Results from the phonological measure were only utilized to determine whether children had mastered the Spanish phonemes prior to administration of the Nonword Repetition Measure. A coarse-grained scoring method was used. Children's productions received a "1" if they matched the target and a "0" if they failed to produce the phoneme being assessed. Only children who had mastery of all of the Spanish phonemes were allowed to remain in the study. Articulation/phonological errors were not expected for the four- to six-year-olds in the sample because, by the age of four years, bilingual children have mastered almost all of the phonemes in their repertoire (Goldstein, 2004).

Data reduction took into account dialectal patterns in children's phonological productions, or particular sound substitutions and deletions like those listed on Table 2.10. It is important to note that not every speaker of a particular dialect will make use of every feature included in the examples provided on this table. When these occurred, which was uncommon (*n* = 1 high Cuban dialect user), they were not considered articulation errors, following Goldstein and Iglesias (1996). On the other hand, when stop consonants /b, d, g/ were substituted for their intervocalic allophones, these productions were awarded “0” points. These allophones are common to all Spanish dialects and were expected to be mastered by children in this study.

Table 2.10

Dialect Features and Examples

Spanish Dialect	**Feature**	**Example (English Gloss)**
Argentinian, Chile, Castillian	• /j/ & /dʒ/ → [ʃ] • /s/ & /z/ → [θ]	• /vaje/ → [vaʃe] (‘valley’) • /efisjente/ → [efiθjente] (‘efficient’)
Colombian, Cuban, Dominican, Mexican, Puerto Rican, & Venezuelan	• /s / → [Ø] at the end of syllables and words (plural and 3rd person markings) • Omission, aspiration, or assimilation of /s/ in medial word positions • Glottal or uvular /r/ • Lateralization of /r/ • Deletion of intervocallic / ð / • Deletion of /k/ before alveolar voiced stop /t/	• /castijo/ → [caØtijo] (‘castle’) • /este/ → [e^{h}te] (‘this one’) • /karo/ → [kaxo] (‘car’) • /karta/ → [kalta] (‘letter’) • /kandaðo/ → [candao] (‘lock’) • /diktaðo/ → [ditaðo] (‘dictation’)

Note: “→” indicates “X substituted by Y.” “Ø” suggests omission. “^{h}” suggests aspiration.

Spanish vocabulary. The raw scores from the picture vocabulary sub-test of the WMLS-R were converted to standard scores using the computerized Scoring and Reporting Program for Windows Operating system (Version 1.0). This software facilitates the scoring process by generating a variety of reports using the raw data. The program automatically scores the data and produces participant reports in the same format as is done manually using the test record and norms tables.

Nonword repetition. All of the children's repetitions of nonwords were narrowly transcribed by a bilingual/biliterate speech-language pathologist, the author, using the International Phonetic Alphabet (IPA). After transcription was completed, nonwords were scored using two levels of scoring. Using a binary, coarse-grained scoring system, it was determined whether the repetitions matched the targets in terms of length in syllables and stress pattern. During this level of analysis, each repetition produced by the participants was scored in its entirety (i.e., without subdivisions into constituents). The nonword stimuli included the production of allophonic variations of the stop consonants (i.e., /**β**, **ð**, **ɣ**/ in their appropriate phonetic contexts. A score of either "0" or a "1" was awarded depending on whether the repeated nonword matched the target in its number of syllables or stress pattern. Table 2.11 provides a sample of this scoring system.

Table 2.11

Stress and Nonword Length: Coarse-Grained Scoring System

Nonwords			**Transcription of Participant's Production**	**Stress Score**	**Syllableness Score**
Target	**No. of syll**	**Stress pattern**			
preno	2	final	preól	1	1
fektasno	3	penultimate	pékstasno	0	1
okiseuno	4	final	okinó	1	0

Note: Stress assignment for the child's production is denoted with an orthographic accent mark on the vowel nucleus of the stressed syllable.

The second scoring level entailed a fine-grained analysis of the nonword repetitions. Specifically, the onsets and rimes within each syllable of the nonwords were identified. Then, each constituent was given a score of "1," correct, or "0," incorrect, depending on whether they matched the target nonwords' constituents. Table 2.12 includes a sample of this level of scoring.

Table 2.12

Constituent Error Analysis: Fine-Grained Scoring Level

Nonwords			Transcription of Participant's Production	Segmental Score							
Target	Length	Stress pattern		O1	R1	O2	R2	O3	R3	O4	R4
preno	2	final	preól	1 pr	1 e	0	0 ol				
lejskeβe	3	final	lejskeβéj	1 l	1 ejs	1 k	1 e	0 b[2]	0 ej		
okiseuno	4	final	okiseno	1	1 o	1 k	1 i	1 s	0 e	1 n	1 o

Notes:

[1] Stress assignment for the child's production is denoted with an orthographic accent mark on the vowel nucleus of the stressed syllable.

[2] Substitution of stop consonants /b, d, g/ for their intervocalic allophones was awarded "0" points.

In order to determine the reliability of these scoring systems, nine transcripts were randomly selected and given to an independent coder. The second coder was a Spanish-English, bilingual/biliterate speech-language pathologist, trained by the author. This second coder was required to: (1) Assign the overall, coarse-grained stress and syllableness score and (2) segment the nonwords into onsets and rimes to apply the fine-grained constituent error analysis. Only one disagreement in the application of the coarse-grained method, an error in stress scoring, occurred out of 648 instances.

In terms of the fine-grained scoring level, total numbers of instances in which agreements and disagreements in scoring onsets and rimes occurred in all of the nonwords were tabulated. Cohen's kappa (Bakeman & Gottman, 1997) agreement statistics were calculated per constituent at each word length. For example, for each constituent within each syllable length, four categories of decisions between the coders were possible: (a) they both agreed that the production of a specific constituent matched the target or received a “1;” (b) they both disagreed that the constituent production did not match the target, or received a “0;” (c) coder 1 scored the constituent as a “1,” while coder 2 assigned a “0;” and (d) coder 1 scored the constituent as a “0,” while coder 2 assigned a score of “1.” The probabilities of observed and expected responses were calculated and then, the kappa coefficient was computed using the following formula:

$$\mathbf{K} = \frac{\mathbf{P_{observed} - P_{expected}}}{\mathbf{1 - P_{expected}}}$$

These kappas ranged from a low of .83 to a high of .98 for constituents in the two-syllable nonwords, from .88 to a high of .99 for constituents in the three-syllable nonwords, and from a low of .73 to a high of .97 for constituents in the four-syllable nonwords. Bakeman and Gottman (1997) suggest that Kappas above .60 are good and above .75 are excellent.

Though few in number, more disagreements occurred when the coders scored rimes, regardless of length. The latter seemed to be due primarily to differences in syllabifying word-internal consonant sequences. As seen in the example in Table 2.13, the difference in scoring resulted in a “0” being awarded by the independent coder for the first unstressed medial rime (i.e., /ej/). Additionally, in this case, the medial onset (i.e., onset of the second syllable, sk-) received a “0” from the independent coder as well. Unlike English, in Spanish, syllables do not start with the sk- cluster (Hualde, 2005). That is, when dividing Spanish words into syllables, each syllable must “have the structure of a well-formed, free-standing, Spanish word" (Hualde, 2005, pp. 73-74). Then, in the case of medial clusters, it appeared that the independent coder was applying the syllabification principles of English. These disagreements were discussed and agreement was reached. The author's codes were used in the analyses.

Table 2.13

Sample of Disagreement in Segmentation Patterns

Nonword	Transcribed production	Coder 1 (PI)	Independent Coder
lejs-ke-βe	lejskebej	l-**ejs-k**-e-b-ej[1]	l-**ej-sk**-e-b-ej[2]

Note :

[1] Followed Spanish syllabification pattern and resulted in "1s" awarded for medial unstressed rime and medial unstressed onset.

[2] Followed English syllabification pattern and resulted in "0s" awarded for medial unstressed rime and medial unstressed onset.

Data Analyses and Scoring

Prior to the statistical analyses, error rates were calculated for each constituent by dividing the number of correct productions per constituent (e.g., O1, R1, O2…) and dividing it by the total possible productions of the constituent across all participants using the following formula, where the number of productions is basically the number of participants, since each participant produced each item once (and so each constituent within each item once).

$$\textbf{Constituent Error Rate} = 1 - \frac{\textbf{(total \# of correct productions of that constituent)}}{\textbf{(total \#of productions of that constituent)}}$$

Constituent average error rates were then calculated per item by summing the average error rates of all the constituents and dividing by the total number of constituents in the nonword. The denominator increased as length in syllables increased. A similar process was done with errors per participants. That is, an error rate per each syllable length was calculated for each participant.

$$\textbf{Average Participant Error Rate} = 1 - \frac{\textbf{(Total \# correct productions of constituent)}}{\textbf{(Total participants producing particular constituent)}}$$

CHAPTER 3

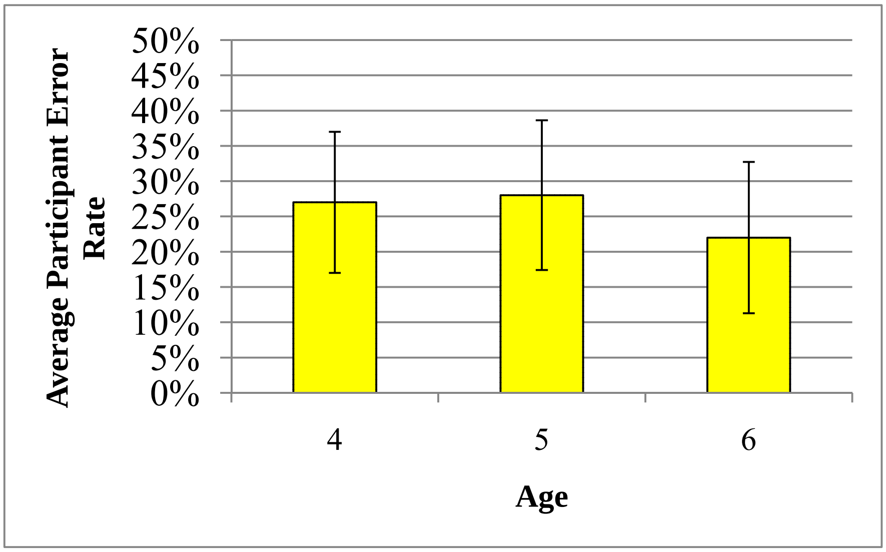
Results

The current study explored the effects of participant (age, gender, and vocabulary breadth) and item (length and wordlikeness) factors on nonword repetition. Data were tabulated into Microsoft Excel (Windows, Version 2007) and then transferred to a statistical software package (SPSS 16.0) for analysis. Nonword repetition performance data included the proportions of incorrect constituent productions obtained from both the fine- and the coarse-grained scoring system.

Hypothesis 1: Nonword repetition performance, as measured by the average proportion of incorrect constituent (onset and rime) productions, will be affected by participant age and vocabulary breadth, but not gender.

Age and gender. A 3 x 2 analysis of variance (ANOVA) was performed with age (4, 5, and 6 years) and gender (male and female) as between-subjects factors and average participant error rate (proportion of errors per word length per participant) as the dependent variable. There was a significant main effect of age on nonword repetition performance, $F(2, 62) = 3.59$, MS=.066, $p<.05$, and partial $\eta^2 = .104$, a small effect size, which suggests that only a small percent of the variance is explained by age. The six-year-old participants had lower average error rates in their repetitions ($M = .221$) than their four-year-old ($M = .270$) and five-year-old ($M = .283$) counterparts (See Figure 3.2). There was no significant difference between the error rates of the 4year-old and the 5 year-old participants. Additionally, as predicted by the hypothesis, there was no significant difference in repetition accuracy between males (M = .257, SD = .017) and females (M = .259, SD = .011). Furthermore, there were no significant interactions among the variables of interest. See Appendix H for the ANOVA results.

Figure 3.1. Effect of Age on Nonword Repetition Performance



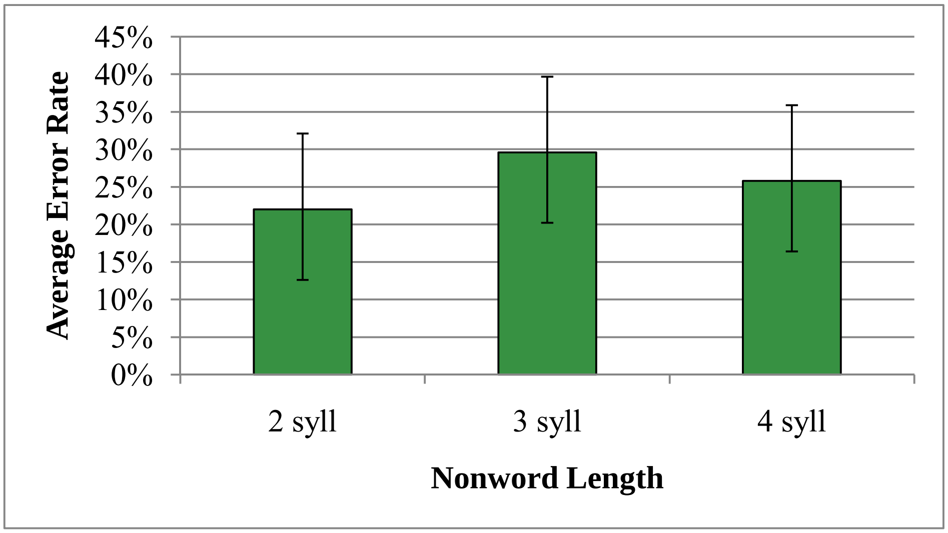
Vocabulary breadth. Vocabulary group membership was determined based on standard scores on the picture vocabulary sub-test of the Woodcock-Muñoz Spanish Language Survey – Revised (WMLS-R; Woodcock et al., 2005), a mixed measure of conceptual retrieval and picture recognition in Spanish. Participants who obtained standard scores (SS) of 84 or below on the Picture Vocabulary sub-test of the WMLS-R were assigned to the low-vocabulary group. On the other hand, participants whose SS fell in the average range, according to the mean of the standardization sample of the measure (SS = 85-115), were assigned to the group with average vocabulary. Using this criterion, two groups containing 34 children each were identified. The average vocabulary group had a mean vocabulary standard score of 92.53 (SD = 5.74) and the low vocabulary group had a mean vocabulary score of 70.06 (SD = 13.58). In other words, the average group displayed significantly more extensive vocabulary breadth than the low vocabulary group, $F(1, 62)= 68.41$, MS=7575.75, $p<.001$.

A one-way ANOVA was conducted to determine whether nonword repetition error rates differed for the two vocabulary groups. Vocabulary group membership did not affect nonword repetition performance, $F(1,66)=.085$, MS=.001, $p>.05$. That is, no significant difference was found between the groups' error rates ($M = .257$, for the low vocabulary group, and $M = .264$, for the average vocabulary group). Additionally, a one-tailed bivariate correlation was conducted to explore whether vocabulary group membership predicted nonword repetition performance. This correlation was not significant, $r = .188$, $p>.05$.

Hypothesis 2: Repetition performance, as measured by the average proportion of incorrect constituent (onset and rime) productions, will be affected by word length and wordlikeness (i.e., stress pattern and wordlikeness ratings).

Nonword length. As predicted, there was a significant main effect of nonword length, $F(2, 124)= 24.75$, MS= .084, $p<.001$, and partial $\eta^2 = .285$, a medium effect size. Pairwise comparisons using Bonferroni adjustments revealed that performance differed significantly ($p \leq .001$) at all three of the nonword lengths. Specifically, repetition of the two-syllable nonwords resulted in fewer errors per constituent ($M = .220$, CI = .194-.245) than did repetition of three- and four-syllable nonwords. Although significantly different from each other, a reversal in the expected pattern of results was found for the latter two error rates. That is, the three-syllable nonwords elicited significantly more errors per constituent (M = .296, CI = .273-.319) than did the longer four-syllable, stimulus items (M = .258, CI = .235-.282).

Figure 3.2. Mean Error Rates by Nonword Length



Wordlikeness and stress pattern. Wordlikeness ratings were obtained during the preliminary study by asking adult Spanish-speakers to rate the nonwords. High and low wordlike nonwords were included in the stimuli. Also, two patterns of stress assignment, which differed in frequency of occurrence in the Spanish language corpus of words from which the nonwords were constructed, were balanced in the stimulus items.

A paired, two-tailed t-test revealed significant differences in accuracy of repetition for nonwords that were rated high in wordlikeness as contrasted with low wordlikeness, $t(67) = -2.996$, $p < .01$. Specifically, the highly wordlike nonwords elicited lower error rates (M= .255, SD = .089) than the less wordlike nonwords (M= .276, SD = .093), as predicted.

The second variable of interest in the third hypothesis was stress pattern. It was predicted that participants' repetitions of nonwords with final stress, the less frequent phonotactic pattern in Spanish, would result in higher error rates than would repetitions of nonwords with penultimate stress. This prediction was not supported, $t(67)=-1.005$, $p>.05$. The mean error rates for both stress patterns were nearly equivalent, as can be observed in Table 3.1.

Table 3.1.

Error Rates and Stress Pattern

Stress Pattern	Mean Error Rate (*SD*)
Final	.255 *(.012)*
Penultimate	.262 *(.009)*

Hypothesis 4a: Errors affecting syllable length will be more common than errors affecting stress pattern.

Using the coarse-grained analysis, the numbers of errors that resulted in modifications to the length (addition or deletion of syllables) and stress pattern of the nonwords were determined. To do this, each repetition produced by the participants was scored in its entirety (i.e., without subdivisions into constituents). Therefore, for this level of analysis, in every nonword item there was the possibility of making one error in stress pattern and one error in syllable length.

In general, these error types were not frequent in the sample (i.e., they only occurred in 4% of all of the repetitions, 112 errors total). As predicted, errors resulting in changes to the length of the nonword were more frequent (i.e., 87% of total errors) than errors that affected the stress pattern (i.e., 13% of total errors). It must be noted, however, that within each nonword, any participant could have made errors of both types. Additionally, a participant could have produced several repetitions which violated syllabification and stress patterns. Thus the errors themselves are not independent of each other and some children may have contributed to the results more than others. Table 3.2 includes the raw frequencies of these errors per nonword, as well as the total proportions per type.

Table 3.2

Syllable Length and Stress Pattern Errors per Nonword

Nonword (alphabetical per length)	Syllabification Errors	Stress Errors
daquia	0	0
erpa	1	0
esia	4	3
luapria	4	1
muabi	0	0
preno	0	0
prestie	0	0
prise	1	0
seixtra	2	2
sioga	0	0
trueñes	1	0
chinso	0	0
biebaplio	1	0
biprioco	0	0
fableto	1	0
fectasno	1	0
horermo	1	0
iperko	2	0
kibrinto	2	1
leiskebe	1	0
mosbletro	1	0
mosdinsil	11	2
neksdomo	0	0
pablonia	0	0
ankerhine	4	2
duguiclera	10	0
ilirdera	7	0
ismaretia	2	0
maicatabo	3	0
matrodenda	4	0
nankerbago	1	0

Nonword (alphabetical per length)	Syllabification Errors	Stress Errors
okiseuno	4	0
pasneisodo	1	0
pineguesta	10	1
sifatrasbo	7	1
traurespago	2	0
Totals Numbers of Errors	89 (87%)	13 (13%)

Hypothesis 4b: Consonant substitution errors will be more frequent than consonant deletion errors, which will be more frequent than consonant additions.

The numbers of consonant substitutions, deletions, and additions were determined using the fine-grained error analysis. To do this, the onsets and rimes within each syllable of the nonwords were identified. Then, each constituent was given a score of "1," correct, or "0," incorrect, depending on whether they matched the target nonwords' constituents. Segment substitutions, deletions, and additions were noted and their frequencies of occurrence are herein described. Analysis of the proportions per error category supported the hypothesis. That is, as can be observed in Table 3.3, errors that resulted in consonants being substituted were more frequent (64%) than errors due to consonant deletions (23%) and errors due to consonant additions (13%).

Table 3.3

Proportions and Frequency of Error Types per Nonword

Nonword	Proportions of Errors			Raw Error Counts/Frequencies			
2- Syllables	Substitutions	Deletions	Additions	Substitutions	Deletions	Additions	Total Raw Errors per Nonword
preno	0.65	0.02	0.33	28	1	14	43
esia	0.09	0.02	0.89	4	1	42	47
prise	0.47	0.03	0.50	16	1	17	34
prestie	0.44	0.20	0.37	18	8	15	41
dakia	0.55	0.02	0.43	27	1	21	49
seixtra	0.56	0.16	0.27	35	10	17	62
erpa	0.21	0.26	0.53	16	20	40	76
chinso	0.86	0.10	0.05	18	2	1	21
sioga	0.71	0.18	0.12	12	3	2	17
muabi	0.31	0.63	0.06	11	22	2	35
trueñes	0.65	0.26	0.09	15	6	2	23
luapria	0.76	0.18	0.06	50	12	4	66
3-Syllables	Substitutions	Deletions	Additions	Substitutions	Deletions	Additions	Total Raw Errors per Nonword
fableto	0.76	0.05	0.19	67	4	17	88
quibrinto	0.81	0.10	0.10	83	10	10	103
iperco	0.60	0.15	0.25	51	13	21	85
nexdomo	0.77	0.20	0.03	53	14	2	69
biprioco	0.81	0.10	0.10	59	7	7	73
leisquebe	0.84	0.11	0.05	31	4	2	37
jorermo	0.80	0.18	0.03	96	21	3	120
pablonia	0.80	0.17	0.03	52	11	2	65
fectasno	0.65	0.26	0.08	62	25	8	95
biebaplio	0.91	0.05	0.04	92	5	4	101
mosbletro	0.84	0.09	0.07	86	9	7	102
mosdinsil	0.35	0.64	0.01	34	63	1	98

4-Syllable	Substitutions	Deletions	Additions	Substitutions	Deletions	Additions	Total Raw Errors per Nonword
oquiseuno	0.33	0.15	0.51	13	6	20	39
matrodenda	0.58	0.36	0.06	69	43	7	119
anquergine	0.44	0.49	0.07	47	52	7	106
traurespago	0.66	0.22	0.12	49	16	9	74
duguiclera	0.84	0.12	0.04	96	14	4	114
nanquerbago	0.53	0.44	0.03	68	56	4	128
ismaretia	0.62	0.34	0.03	18	10	1	29
ilirdera	0.42	0.52	0.06	38	47	5	90
pineguesta	0.50	0.46	0.04	45	41	4	90
maicatabo	0.76	0.15	0.10	31	6	4	41
pasneisodo	0.68	0.22	0.10	62	20	9	91
sifatrasbo	0.75	0.16	0.08	107	23	12	142
Category Totals Across All Stimuli	64% (*SD* = .20)	23% (*SD* = .17	13% (*SD* = .20)	1659	607	347	2613

Summary of Effects by Hypothesis:

Hypothesis 1: Participant variables and nonword repetition

- *Age* affected nonword repetition accuracy: The 6-year-old participants exhibited significantly lower error rates than the 4- and 5-year old participants. There were no statistically significant differences between the two younger groups.
- *Gender* did not affect nonword repetition accuracy. Males and females did not differ in their average repetition error rates.
- *Vocabulary breadth* did not affect nonword repetition accuracy. There was no significant difference in the repetition error rates for the low and average vocabulary groups. There was no significant correlation between vocabulary knowledge and repetition performance.

Hypothesis 2: Item variables and nonword repetition

- *Stress pattern* did not influence performance. Participants did not differ in their repetitions of nonwords with final and penultimate stress.
- *Wordlikeness* affected nonword repetition accuracy. Participants repeated the nonwords rated high in wordlikeness more accurately than the nonwords rated low in wordlikeness.

Hypothesis 3: Error patterns in Spanish nonword repetition

- Errors affecting the *length of nonwords* were more frequent than errors affecting the *stress pattern* of the nonwords. There errors were infrequent in the data.
- Errors resulting from consonants being *substituted* were more frequent than errors that resulted from consonants being *deleted*, which in turn, were more frequent than errors from consonant *additions*.

CHAPTER 4

Discussion

The present study investigated the contributions of participant factors (age, gender, and vocabulary knowledge) and item factors (stress pattern and wordlikeness) on Spanish repetition performance in a group of Spanish speaking, English language learning children. From a theoretical perspective, this investigation allowed a first observation of how experience with listening to and producing Spanish words during language acquisition may explain the acquisition of Spanish-specific phonological patterns. The following discussion focuses on the hypotheses of the study and their relation to previous literature. The findings are discussed in the context of models of language acquisition that stress the importance of working memory, and on models of language acquisition that stress the importance of long-term memory acquired through language use. Clinical and educational implications related to this study follow. Finally, the current study's potential limitations and directions for future research are addressed.

Participant Characteristics: Chronological Age, Gender, and Vocabulary Breadth

One purpose of this study was to investigate the extent to which participant characteristics, such as age and gender, affect the average proportion of incorrect constituent (onset-rime) repetitions in a measure of Spanish nonword repetition. In general, patterns within the results appear to echo previous studies of English nonword repetition. However, in some important ways, findings from this study diverge from previous investigations.

Chronological Age

Previous studies with monolingual English-speaking samples have demonstrated a stable developmental progression in nonword repetition accuracy between the ages of 4 and 6 years (Gathercole & Baddeley, 1989; Gathercole et al., 1991). Additionally, the age effect was replicated in a recent study on Spanish nonword repetition with preschool-aged Spanish-speaking, English language learners (Danahy et al., 2008). Consistent with these previous findings, the younger children (4 and 5 years of age) in the present study were the least accurate in their repetitions of nonwords, and the oldest, 6-year-old, children performed better than the younger participants.

Increased efficiency of working memory with age. One possibility accounting for these developmental findings resides in a developmental progression in the efficiency of the phonological loop (Baddeley, 2000; Baddeley & Hitch, 1974). Nonword repetition tasks were originally developed to assess the efficiency of the phonological loop component of working memory, distinct from the influences of long term language knowledge (e.g., Alloway et al., 2004; Gathercole & Baddeley, 1989; 1990; Gathercole et al., 1991). The fact that even the youngest participants in this experiment could repeat novel forms with considerable accuracy suggests that some cognitive mechanism is in place to allow the active maintenance of novel phonological memory traces and accessibility to their corresponding phonological representations. The phonological loop component of working memory has been hypothesized to become active between the ages of 4r and 6 years in English-speaking monolinguals (Alloway et al., 2004).

In explaining differences in performance as a result of age, it is possible that the 6-year-olds performed better than the younger participants because they had developed more precise articulatory abilities, which resulted in better subvocal rehearsal of the nonword phonological constituents. Children develop precision and sophistication in their articulations with age (Gathercole et al., 1991). However, this explanation of improved articulation of novel stimuli relies at least in part on a detailed and structured set of phonological representations in long-term memory. In turn, it may be that being able to articulate with more precision leads to more efficient subvocal rehearsal processes (Gathercole & Baddeley 1991). Subvocal rehearsal is the mechanism by which the loop actively maintains the to-be-repeated ‘skeleton’ of sub-lexical components (e.g., syllables, onsets-rimes). Through improvements in articulatory skill and increased efficiency in subvocal rehearsal, it may become easier to accrue knowledge about more complex word-forms in a language, allowing the development of more elaborate lexical-phonological structures (Gathercole, 1995; Gathercole & Baddeley, 1989).

Schemas through articulatory practice. Both experiences listening to and repeatedly producing a frequently occurring language-specific phonological pattern may allow the pattern to be easily generalized to similar forms and to become strongly represented mentally (Bybee, 2001). Therefore, practice mapping the acoustic structure of words with their respective motor plans may help to create auditory-motor-word form schemas. In the case of this study, evidence for the effect of auditory and productive practice with the sound structures of Spanish could be substantiated by the sample’s overall low repetition error rates (i.e., approximately 30% by constituents). It could be said that all of the participants, regardless of age, had repeatedly listened to and produced Spanish words which varied in phonological complexity and frequency of occurrence, as substantiated by their reported high percentages of use of Spanish and their passing scores on the phonological screening task administered in order to qualify for the study.

Similarly, increases in repetition accuracy with age could be explained under a usage-based phonological learning account. With practice listening to and articulating word-forms comes increased automaticity in motor plans. Thus, an outcome of more prolonged exposure to oral Spanish was repeated auditory experience and practice producing word constituents in that language for the older children, in contrast to their younger counterparts. As a result, the 6-year-old participants in the current study might have had more detailed auditory encodings of Spanish phonological structures to rely on during the repetition task than did the younger 4- and 5-year-old participants. The influence of wordlikeness on repetition accuracy also supports the relevance of familiarity through usage to an account of nonword repetition, as discussed below.

Gender

As predicted, gender did not exert an effect on repetition performance. Gender is often considered in the sample selection process, but it is seldom investigated as a potential predictive variable. Only one study has investigated the potential effects of this variable on repetition performance (Radeborg, Barthelom, Sjöberg, & Sahlén, 2006). The findings from the current study are consistent with those from the Radeborg et al. (2006) study. Therefore, it appears that both boys and girls are equally able to repeat novel phonological structures. The results suggest that children from 4 to 6 years, regardless of gender, are successful at mapping acoustic-perceptual information and articulatory representations about phonological structure.

Effect of Vocabulary Breadth on Spanish Nonword Repetition

To the extent that practice with hearing and articulating phonological sequences supports the integration of a motor plan for their repetition, it is likely that frequent experiences with learning words would support nonword repetition. In fact, studies with English-speaking monolinguals have noted a modest, but robust, relationship between vocabulary recognition breadth and nonword repetition performance in children of different ages with typical language ability (e.g., Edwards et al., 2004; Gathercole & Baddeley, 1989, 1990; Gathercole et al., 1991).

The participants in the present study were administered the picture vocabulary sub-test of the *Woodcock-Muñoz Spanish Language Survey - Revised* (WMLS-R, Woodcock et al., 2005), a measure of concept identification and word recall. From this, two distinct groups of children were formed, one that performed below average expectations and another group whose scores fell within the average range in the vocabulary task. Although the two groups were significantly different from each other in vocabulary scores, no effect of vocabulary recognition was found on their nonword repetitions. That is, in contrast with the aforementioned studies, vocabulary breadth did not appear to support repetition accuracy. Two previous studies with Spanish-speaking children had similar results. Girbau and Schwartz (2007) failed to find correlations between scores on a measure of lexical fluency and nonword repetition. Similarly, Danahy et al. (2008) found nonsignificant correlations between their participants' repetitions and their scores on Spanish and English Expressive Language tasks from the Preschool Language Scales-4 (Zimmerman, Steiner, & Pond, 2002a, 2002b).

There are a variety of explanations for the lack of a relationship between vocabulary breadth and repetition performance. First, the type of vocabulary knowledge assessed may not be related to repetition performance. The WMSLS manual states that it provides "a sampling of proficiency in oral language, language comprehension, reading, and writing" (Woodcock et al., 2005, p. 1). Recent test reviews suggest that its items are more representative of the type of language encountered in academic settings, rather than the kind of language used in everyday social conversations (Pray, 2005; Vechio & Guerrero, 1995).

It thus may not be surprising that there was no correlation between the vocabulary scores and the nonword repetition error rates. In the present study, the WMLS-R in Spanish assessed recall and recognition of literate vocabulary (i.e., words encountered within Spanish academic contexts) which provides a limited view of word knowledge in these English language learners. Perhaps analyzing the breadth of knowledge about 'social' words versus the extent of knowledge about 'academic' words would yield different indices of vocabulary size. In the case of the participants in this study, Spanish vocabulary for social exchanges may have been better developed than their knowledge of Spanish academic meanings. In fact, it could be that the children in this study were more focused on accruing vocabulary in English in the environment in which the study was conducted, because that was the language of instruction in the academic settings from which the samples were selected.

Secondly, it may be that yet other aspects of vocabulary learning, namely depth of knowledge, are more predictive of nonword repetition performance. For example, a task in which the syntagmatic (syntactic) and paradigmatic (hierarchical) relations between words are identified might provide information about how English language learners are organizing their lexical networks in two languages. The organization of representations might necessitate further specificity at the phonological level, because some words may have similar sound structures in the two languages. The vocabulary sub-test of the WMLS-R does not include items assessing more complex word relations.

On the other hand, it is possible that vocabulary breadth did not affect repetition performance in this study because the standardized measure was insufficient at capturing the relevant variance of this sample. As one illustration, it is possible that there was not enough spread in the range of vocabulary scores of these children. The participants exhibited either average or low vocabulary. Perhaps if the two vocabulary groups were assigned *a priori* and a group of children with above-average vocabulary would have been included, there would have been performance differences observed in the nonword repetition task.

There is a final and more important explanation for the lack of a relationship between vocabulary breadth and nonword repetition performance. There are differences between the process of learning meanings of new words and the process of repeating novel word forms. When learning a real word, children have the opportunity to experience its form and its semantic content in multiple contexts over time. When perceiving and repeating a nonword, there is limited time. Meanings can be partially mapped, instead of familiar. The traditional breadth measures do not provide information about the different levels of knowledge about words that children may have established based on their errored responses. What is known in terms of recognition breadth is that the phonological form and the semantic content might be familiar, or has been experienced prior to the task. Additionally, in studying the relationship between vocabulary knowledge and nonword repetition performance, it may be advantageous to manipulate other variables related to the phonological constitution of a nonword, such as its length in syllables, its prosodic contour, and its phonological similarity to other real words in the lexicon (i.e., its wordlikeness).

Item Characteristics and Language-Specific Variables: Effect of Nonword Length, Stress Pattern, and Wordlikeness on Repetition Performance

It has been suggested that limitations in repeating nonwords are related to limitations in working memory (Gathercole & Baddeley, 1990). In addition, the prosodic characteristics of the items may influence repetition, especially since "nonwords are not simple linear sequences of sound segments that can be divorced from the prosodic structures in which they occur" (Snowling, Chiat, & Hulme, 1991, p. 371). Moreover, the English nonword repetition research literature (e.g., Gathercole, 1995; Gathercole & Adams, 1994; Gathercole et al., 1999) has reported that the more wordlike the item, the more accurate its repetition. The following discussion relates findings from the current study to previous studies with English-speaking children and suggests a theoretical explanation beyond working memory limitations for the documented effects of stimulus length, stress pattern, and wordlikeness on repetition accuracy.

Nonword Length

The effect of word length in the present study replicated findings with monolingual English-speaking children (e.g., Gathercole & Adams, 1994; Gathercole & Baddeley, 1989), monolingual Spanish-speaking children (Girbau & Schwartz, 2007, 2008), and bilingual Spanish-English language users (Calderón & Gutierrez-Clellen, 2003). Similar to those studies, more accurate repetitions were found for the shorter items (two-syllable nonwords) than for nonwords of any other length. The accuracy advantage for short over long stimuli suggests the dependence on a "time- or capacity-limited phonological memory system" (Gathercole et al., 1991, p. 357), comparable to the phonological loop, in repetition tasks.) In effect, the longer the stimulus item, the greater are the demands on the storage and rehearsal functions of the loop (Baddeley & Hitch, 1974; Baddeley, 2002). When the storage and rehearsal functions of the loop are taxed, there are less complete and precise short-term representations and less accurate repetitions of novel phonological forms.

On the other hand, decay in the memory traces of the three- and four-syllable nonwords may have been more specifically related to the simultaneous processes of retrieving and sequentially ordering the nonword constituents. According to Gupta (2005), demands on an individual's short term memory to *serially* repeat long lists of sublexical chunks (i.e., onsets and rimes) results in more repetition errors. In this case, a nonword may be operationalized as a list of syllables, onsets and rimes, or phonemes that are ordered according to the phonotactic constraints of a language.

Interestingly, the increase in errors for the longer nonwords that Gupta suggested may also exemplify the effect of practice using language units. For instance, short words tend to be more prevalent in early vocabulary learning contexts. Gupta hypothesized that similar processes are utilized in the repetition of real words and nonwords. It is possible that the children in the present study more accurately repeated short nonwords because they more frequently encountered lexical forms that resembled these nonwords in length. Similarly, long nonwords could have elicited more errors due to unfamiliarity or insufficient practice with long words.

It is relevant to mention that the effect of length on performance has not been found in all English studies of nonword repetition. For example, in Gathercole and Baddeley (1989), the repetition of stimulus items that were one-syllable in length elicited more errors than did the repetition of two-syllable nonwords. The authors suggested that the lower repetition accuracy for one-syllable items may have been a result of the "intrinsic acoustic characteristics [and specifically, the frequency of constituent phonemes] of the stimuli constructed at this length" (Gathercole & Baddeley, 1989, p. 209). No additional justifications were provided for the absence of the expected pattern in their results. Additional evidence of inconsistency in length effects is seen in a recent investigation of nonword repetition in a group of Spanish-English bilingual children. Danahy et al. (2008) obtained a length effect on repetition performance only when the repetitions of four- and five-syllable nonwords were compared to those of the shorter stimulus items.

Although the general repetition pattern previously identified in the literature was replicated, the results are also somewhat at odds with prior research in that a systematic decline in repetition performance with increases in nonword length was not observed in this study. In fact, the three-syllable nonwords elicited higher error rates on constituents than did the four-syllable nonwords (however, the total number of errors produced on four syllable nonwords was larger than for three syllable nonwords). Findings from the current study suggest that repetition accuracy might not be a simple function of memory capacity as measured by word-length; rather, it may be influenced by other factors (Gathercole, 1995). The task of repeating nonwords, in effect, may involve the processing of linguistic stimuli using a variety of component processes (e.g., phonological encoding, phonological storage, motor planning, and articulation skills) and two levels of encoding of a novel form (i.e., articulatory and auditory) all of which to an extent are based on repetitive encounters with germane language-specific units. One method by which investigators can assess whether children are having difficulty with specific component processes is through the use of an item analysis.

Types of Errors in Spanish Nonword Repetition: Making Sense of the Patterns

Previous studies involving monolingual, English-speaking children with typical language ability have not conducted error analyses (Gathercole & Baddeley, 1989; Gathercole et al., 1991). Error pattern analysis has frequently been utilized to determine the locus of the breakdown in the nonword repetition abilities of children with language impairment. These analyses allow for the identification of simplifications that children may make that are influenced by the level of phonological complexity and the frequency of phonetic constituents of the nonwords. Interestingly, the error patterns found in the present study parallel the types of errors encountered in previous studies involving children with atypical language and phonological development.

In contrast with Danahy et al. (2008), syllable structure errors and stress-pattern errors occurred in less than 5% of all of the repetitions. Of this small number of occurrences, syllable structure errors were more prevalent than stress pattern errors. Syllable structure errors could be interpreted as evidence that these children had difficulty forming representations of syllable units, while stress pattern errors could be indicative of difficulties encoding the prosodic structure of the nonwords. On the other hand, the fact that syllable structures of some nonwords were less accurately repeated than their stress patterns may be due to greater variability in the syllables than in the stress patterns sampled for this study. The following discussion about the absence of a coarse-grained frequency effect of stress on repetition performance provides some theoretical support for the low incidence of these error types.

In terms of consonantal errors, phoneme substitutions were the most frequently encountered error pattern in the children's repetitions. Most of these substitutions were assimilation errors (i.e., the production of one segment of the nonword is influenced by place of articulation or manner of another segment in the nonword). Substitutions are the most commonly identified error pattern in nonword repetition studies with young English-speaking children with typical and atypical language development (e.g., Dollaghan et al., 1998; Edwards & Lahey, 1998; Edwards et al., 2004) and phonological disorders (Munson, Edwards, & Beckman, 2005). Similarly, in Girbau and Schwartz's (1997, 1998) studies, phoneme substitutions were the most prevalent error patterns in the repetitions of Spanish-speaking children with typical language development and children with language impairment. According to Edwards and Lahey (1998), phoneme substitutions suggest that there is a slot for every phonetic segment to be produced in the phonetic representation of working memory, but that errors can occur in the association links between these slots and the segmental information that is to be produced. In other words, substitution errors also suggest that the target articulatory pattern is not yet robustly encoded.

The participants deleted consonants with less frequency than they substituted them. These deletions appeared to become more prevalent as length in syllables increased. It could be that, as the length of the nonword increased, the participants experienced difficulty with forming or holding detailed phonological representations in working memory (Edwards & Lahey, 1998). It is important to note, however, that the longer nonwords also have lower expected phonotactic probability than the shorter nonwords.

Prior studies of English nonword repetition have not considered additions of consonantal segments as errors because their occurrence suggests that there was no phonetic information missing (Dollaghan & Campbell, 1998). Girbau and Schwartz (2007) analyzed the incidence of this error type in the nonword repetitions of Castilian speakers. Consonant additions occurred in approximately 2% of the repetitions in their study. Thus, they are fairly infrequent. In the present study, additions were the least frequent of all errors. The particular stimulus items which resulted in the highest raw counts of segment additions had syllables with empty onsets. For instance, the first syllable in “esia” and “erpa” typically were produced with a plosive consonant by the participants. This finding may be important methodologically, as it suggests that these nonwords are phonotactically improved with the inclusion of those phonemes. This possibility could be addressed with an analysis of the frequency of empty onset syllables relative to those that have initial consonants. Alternatively, the inclusion of such segments may be due to the influence of English phonotactic patterns on Spanish articulation in the participants.

In summary, the findings from this fine-grained error analysis support the patterns of performance previously indentified in the literature. The error patterns reveal the complex processes involved in nonword repetition and of the influences of coarse-grained frequency effects present in phonological learning.

Effect of Stress Pattern on Nonword Repetition Performance

The error analysis revealed that stress pattern errors were infrequent in the repetitions. The effect of stress pattern on nonword repetition performance is seldom analyzed. The final corpus included nonwords at different syllable lengths that were balanced for stress pattern (final, penultimate) and wordlikeness (high, low). However, in the lexicon of Spanish, the stress patterns themselves do not occur with equal frequency. Quantitative analyses of nonword repetition performance supported the qualitative findings. That is, no effect of stress pattern was found. Two potential explanations may be advanced for the lack of this expected effect.

First, it is important to note that the participants in this study were moderately accurate in repeating the nonwords' prosodic contour. The current results appear to contradict the findings of Dollaghan et al. (1995) that stress plays a role in English repetition accuracy. However, it is important to note some key methodological differences between the Dollaghan et al. study and the current investigation. Their nonwords included real words as syllables, because the purpose of that investigation was to search for the contributions of lexical knowledge to nonword repetition accuracy. These authors suggested that both stress and the lexical status of the syllable jointly influence repetition, with nonwords that contain stressed lexical items as syllables repeated more accurately. Dollaghan et al. (1995) did not explain whether their items followed the English metrical stress pattern. Therefore, their outcomes may not be easily related to the results from this investigation.

One potential explanation for accurate prosodic reproduction by children in the present study involves the early acquisition of suprasegmental patterns in the Spanish language. As previously indicated, Hochberg (1988) found in her study of 3- to 6-year-old Mexican-Spanish speakers that even the youngest participants had mastered the stress rules of Spanish. Specifically, the 3-year-old participants in her study were influenced by whether the nonword presented contained regular stress, irregular stress, or prohibited stress. The nonwords containing regular stress were repeated with more accuracy (only 20% of phonological errors) than the novel words with irregular stress (69% of phonological errors) and prohibited stress (90% of phonological errors). She also found that children's production improved only slightly with age. Specifically, Hochberg observed that, regardless of age, children's skill at replicating stress assignment in nonwords with the frequent stress pattern 'extended' to repeating correct stress patterns in nonwords that contained infrequent stress patterns (Hochberg, 1988).

Secondly, the absence of stress pattern effects may be due to children's ability to make generalizations about linguistic exemplars based on their everyday language experiences. The nonwords in the current study were constructed with stress patterns that were common, but varied in frequency within the Spanish language. Therefore, participants would have been exposed to many real Spanish words with the two stress patterns sampled, and this familiarity probably contributed to accurate repetitions at a prosodic level. A similar hypothesis about the influence of linguistic familiarity on articulation of phonological sequences was recently advanced by Woodward, Macken, and Jones (2008). They argued that the frequency of occurrence of a sound pattern influences repetition. Specifically, Woodward et al. (2008) argued that practice producing the more frequent phoneme sequences enables the articulatory plan to become more fluent. In summary, although the two stress patterns differed in terms of frequency in the lexicon, they are both frequent enough in the Spanish language that they might not have yielded different accuracy rates.

Effect of Wordlikeness on Nonword Repetition Performance

In monolingual, English-speaking children, repetition accuracy depends on the intrinsic characteristics of the nonword items (e.g., phonotactic probability and wordlikeness, see Edwards, Beckman, & Munson, 2004; Gathercole, 1995). Like children with typical and atypical language skills in English (e.g., Gathercole, 1995; Gathercole & Adams, 1994; Gathercole et al., 1991), the participants in this study more accurately repeated nonwords that were wordlike than nonwords that were rated as low in wordlikeness. This particular finding constitutes a considerable contribution to the literature, since it had not been previously replicated with bilingual Spanish-English learners. Prior to the current investigation, no study of Spanish nonword repetition had involved items that ranged in wordlikeness. In fact, previous Spanish studies of nonword repetition did not include the acquisition of wordlikeness ratings as a methodological step in their stimulus development. The wordlikeness effect on nonword repetition performance has important methodological as well as theoretical implications.

There are at least three methodological implications. First, the wordlikeness effect suggests that "language experience" may be defined in different ways. The adults in the preliminary study varied in the length and types of exposure they had to both their first and second languages. However, a significant correlation between the probabilities of the onset-rime constituent probabilities in the nonwords and their subjective ratings of wordlikeness was still observed. The finding of a positive relationship between the frequency distributions for these constituents and the participants' perceptions of what could constitute a word in Spanish indicates that language experience may (1) be defined as involving lexical knowledge as well as sublexical knowledge of the phonological structures of words and (2) not be solely dependent on the age during which initial language exposure occurred.

Second, the corpus from which the constituents were drawn to create the nonwords was based on adult conversational data. Previous investigations have criticized the use of adult corpora in developing stimuli for use with children (Coady & Anslin, 1993; Dollaghan, 1994). In the case of this study, however, it appears that the statistical distribution of onsets and rimes derived from the adult corpus, which presumably represented the patterns of a fully developed lexicon, reliably approximated the properties of the Spanish-speaking children's developing lexicon.

Third, based on their age of immersion, the adults had the opportunity to experience the Spanish language for a prolonged period of time in contrast to the children. There could be concern about using adult ratings in classifying the nonwords that the children were to repeat. However, the adult wordlikeness ratings appeared to provide an appropriate estimate of the types of phonological patterns with which children are familiar.

Theoretically speaking, the wordlikeness effect found in this study provides evidence of the influence of linguistic frequency and familiarity on the acquisition of the structural properties of the lexicon. The fact that children were sensitive to the nonwords' similarity to other words in Spanish suggests the relationship between the frequency of occurrence of specific phonological patterns and their established representations in long-term memory (Thorn & Gathercole, 1999). Wordlike nonwords were constituted of onsets and rimes with higher phonotactic probability. Phonological patterns that occur frequently in a language have been described as potentially more 'readily supported' within a network of phonological units (Gupta & MacWhinney, 1997). According to Thorn and Gathercole (1999), the more knowledge that children accumulate about the phonological and phonotactic patterns in a specific language, the more successful they can become at "reconstructing the original sound pattern from its incomplete record in the phonological loop" (p. 321).

It may be that there is more to nonword repetition than the assessment by a modular short-term memory phonological processor. As children practice perceiving and producing the phonological patterns of their native language, the representations of phoneme combinations may transition from more holistic to becoming more segmental in nature. The representation of phonological structure may reorganize itself based on similarity and frequency of occurrence in the language.

Because repetition accuracy depends on how much phonological overlap exists between a nonword and other known words, nonword repetition performance may index the process of reorganizing the phonological structure of words in Spanish (Metsala, 1999). If this is the case, then nonword repetition tasks do not measure variability in independent phonological storage or rehearsal abilities; rather, these tasks index variability in language experience (MacDonald & Christiansen, 2002). Thus, it could be that those nonwords that were rated as less wordlike in this study were also repeated less accurately because the children had less practice with articulating similarly structured real words. It is important to note, however, that phonological knowledge is not categorical in nature. Rather, children may gradually accrue information about phonological patterns, and these patterns might become represented at coarse- and fine-grained levels based on their frequency of occurrence in the language and their frequency of use in everyday conversations. It may be, then, that the clinical value of nonword repetition lies not in determining the efficiency of working memory storage and retrieval; rather, the task may be useful in analyzing the levels of phonological knowledge children acquire and represent. Similar levels of phonological representation may be observed in learning to accurately produce and perceive real words.

What Nonword Repetition Performance May Reveal About the Acquisition of Words: Study Limitations and Future Directions

Lexical learning is a complex process which involves multiple levels of encoding and integration of several sources of information. For example, a child who has heard the word ‘curious’ in a variety of contexts may more easily access it for use in a sentence if she has had experience with other word exemplars similar to it in phonological structure (e.g. 'cure' and 'serious'). This initial, coarse-grained, articulatory level of encoding of a word-form, then, results from the input. That is to say, experiences with the frequent and less frequent patterns of a grammar provide a language user with the linguistic types that can be cognitively represented based on what is available in that language. In addition, there must be sufficient practice with the articulatory (or motor) production of the word in order for it to be correctly produced. Fluidity in a word's execution, or motor plan, results from generalizations across fine-grained (phonetic) representations, or schemas of the phonological structures within the word. It is possible to have rich experiences with the auditory encoding of the word 'curious' without ever experiencing its articulatory production as a complete unit.

The Future of Spanish Nonword Repetition

This study provided an initial analysis of how language experience can influence the production of Spanish-specific phonological patterns. Additionally, it extended the current literature to Spanish on the influence of coarse-grained type frequency effects on repetition performance. The following section is organized into three major themes. First, limitations of and improvements on the current study are suggested. Next, additional interesting empirical and theoretical directions are proposed. Finally, clinical/educational issues linked to the use of nonword repetition are addressed.

Limitations of the Current Study

The current study had several limitations. First, although the data revealed an age effect on performance, there was no significant difference between the two younger age-groups in the study, a result that is in contradiction with English and Spanish studies of nonword repetition. Limited information about the literacy practices in the children's classrooms limits generalizations about age-related acquisition of phonological knowledge. Also, the fact that children in the study were only assessed in Spanish makes it difficult to determine whether performance patterns in the three age groups could be the result of: (a) inequalities in phonological acquisition in two languages, (b) differences in phonological patterns between the two languages, or (c) difficulties inhibiting phonological/phonotactic patterns of English during the task.

Two aspects of the study relate to this limitation. The lack of consistent completion and return of the parent questionnaires precludes an accurate estimate of language exposure. Future studies might improve on this limitation, by incorporating ethnographic interviews with caregivers and teachers or by conducting naturalistic observations of the participants in their home or educational environments. Also, the WMLS-R, the language proficiency measure, assessed only academic language and not oral components of communication, which may have been a different construct than that measured by nonword repetition. Perhaps a comprehensive oral Spanish language measure would have been more appropriate for this study.

Second, the three syllable items did not yield the expected length effect. A more careful analysis of these repetitions must be undertaken that considers other aspects of metrical structure, such as the onsets and feet of syllables. Also, it is important to return to the adult corpus from which the constituents for the stimulus items were drawn. As can be recalled, there was no effect of stress pattern frequency on the wordlikeness ratings at this length. It may be that the two stress patterns are equally frequent at that length in the corpus.

Further Research Directions

Further analyses could be conducted on the data collected from the child experiment. For example, repetition of the first, second, and third constituent syllables of the tri-syllabic nonwords could be analyzed for: (a) primacy and recency serial memory effects at the level of the syllable and (b) processing differences at the level of sub-syllabic constituents (onsets, rimes) or supra-syllabic constituents (feet, stressed vs. unstressed syllables). In addition, substitution errors could be analyzed further to uncover the occurrence of phonological assimilation, one of the most common phonological errors made by children. In this process, the production of a consonant segment is modified to match a previous or subsequent consonant in manner or place of production (Bybee, 2001; Hoff, 2009). There may be a tendency of the participants to simplify or temporally reduce the number of oral-motor gestures that must be sequenced in the production of a particular nonword. More importantly, perhaps these errors can be correlated with the phonotactic probability of the target constituent in order to identify the influence of type frequency for phonological constituents at the level of production (such as the substitution of more frequency constituents for less frequent constituents in errors).

Another potential strand of research involves a replication of the adult wordlikeness rating study using Spanish-English bilingual children in late elementary, middle-, and high-school settings who differ in their L1 and L2 language use. The adult ratings of wordlikeness seemed to be compatible with the children's accumulated phonological knowledge in this study. However, conducting a study with younger raters might provide insights about developmental trajectories in the abstraction of language-specific phonological knowledge and metalinguistic awareness for phonological patterns.

Yet another study might focus on the amount of knowledge necessary for a researcher to conduct reliable fine-grained error analysis in Spanish. In the computation of the Cohen's Kappa reliability coefficient for the transcriptions and error analyses for the child study, disagreements occurred when the second coder applied syllabification patterns of English in the scoring process. This methodological study would also resonate clinically, as it may enumerate the required competencies of speech-language pathologists and educators seeking to evaluate phonological knowledge in Spanish-English emerging bilingual children.

An additional direction in this line of research would involve expanding the child study to include analyses of the variables in both languages. First, the development of a comparable English nonword repetition task is necessary. Additional attention at the stimulus development phase might be necessary in order to avoid exact replications of phonetic constituents across the tasks. A larger sample size, a more reliable estimate of first and second language use, more description and better control over pre-literacy and literacy practices in participating classrooms, and a wider range of ages than those assessed in this current study are also possible future modifications.

A different but related study might investigate bilingual fast-mapping using stimuli varying in frequency of occurrence in the two languages. Using onset and rime constituents varying in phonotactic probability from two parallel corpora, nonwords in Spanish and in English could be constructed. These nonwords could be used in a fast-mapping study as labels to be acquired by two groups of 24-30-month-old Spanish-speaking children. The children in the two groups could be pre-selected to differ in their frequency of exposure to Spanish and English. Articulation of age-appropriate Spanish and English phonemes would be a precondition to be selected for the study. Parents could provide completed MacArthur-Bates Communicative Inventories as a measure of lexical development.

A more theoretically oriented future study could involve an examination of what constitutes "sufficient language experience" in adult judgment studies. That is, it could examine how much exposure to and practice with the patterns of a language a bilingual adult must have in order to be sensitive to coarse-grained type frequency effects. Estimates of vocabulary breadth and depth might be necessary in such a study, which could also incorporate a nonword judgment task. Individuals with varying levels of phonological proficiency in Spanish and English might be required. A longitudinal design would prove useful in determining the effect of duration of language exposure on the representation of phonological structure.

Clinical Implications

Because nonword repetition requires the perception and articulation of novel phonological constructions, the task may be valuable in assessing phonological acquisition. Nonword repetition has several advantages over available articulation and phonological assessments. These standardized tests allow the speech-language pathologist to sample one target production of each consonant in word-initial, medial, and final position, as well as most initial clusters. These tasks, therefore, tend to focus on assessing the existence of fine-grained articulatory representations for these segments, assuming of course that the phoneme is the principal structure of representation in an individual's lexicon. On the other hand, nonword repetition may be utilized to assess coarse- and fine-grained mappings of phonological knowledge. That is, when nonwords include high and low probability constituents (e.g., syllables, onsets-rimes, and diphones), an analysis of the effect of frequency on accuracy can be conducted. The size of the frequency effect might denote the integration of coarse-grained auditory experience with the assessed targets with their fine-grained articulatory productions.

Moreover, nonword repetition may reveal the effect of Spanish type frequency on the gradual infusion of sounds, or lexical diffusion that takes place on a word-by-word basis in a group of preschool-age children with phonological disorders. Such a retrospective study was conducted by Gierut and Dale (2007) utilizing data from two children with phonological disorders who participated in a clinical outcomes study (Morrisette, 1999). The analysis of sub-lexical frequency effects may suggest which phonotactic patterns might successfully induce generalization and which might be the recipients of phonological change. Gierut and Dale (2007) identified more lexical diffusion for the low-frequency words than the high frequency words. On the other hand, previous research has found that more generalization takes place when high frequency word probes are utilized as targets in phonological tasks. Knowing what probes lead to more generalization and diffusion is important in determining the appropriate remediation targets to select when treating Spanish-speaking children with phonological disorders.

Summary

In summary, the study of nonword repetition has the ability to shed light upon the representation and use of phonological knowledge in language learners at both segmental and suprasegmental levels. As children acquire language through exposure to words, frequently repeated sub-syllabic, syllabic, or prosodic patterns become instantiated as phonological generalizations that emerge through language use (Bybee, 2001). In the repetition of nonwords, children must access and manipulate this abstract long term phonological knowledge directly, as they do not have holistic phonological representations or semantic associations that might provide a shortcut in the processing of real words.

While the concept of a working memory system is useful in explaining how children can manipulate phonological information in novel words, the fact that nonword repetition is sensitive to phonotactic probability shows that nonword repetition makes use of long term phonological representations. In turn, this work demonstrates that working memory itself is more of an organizational system than a memory store (e.g. Gupta, 2005) that makes serial associations between a sequencing frame for the nonword and long term phonological representations, providing more general insight into the nature of linguistic cognition.

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Appendices

Appendix A

Table 1.

Expected Probabilities of Nonword Stimulus Set

Stim No.	Strpat	Stimulus	Probability	Rnd Prob
1	01	0[k<e>]1[pr<ya>]	-7.29693	-7
2	01	0[k<o>s]1[tr<ye>n]	-8.01376	-8
3	01	0[fr<e>]1[B+<o>]	-7.05569	-7
4	01	0[k<e>]1[tr<o>]	-6.09755	-6
5	01	0[b<e>r]1[h<wa>]	-7.78308	-7
6	01	0[m<e>]1[B+l<a>]	-7.06737	-7
7	01	0[f<e>s]1[D+<o>]	-6.70318	-6
8	01	0[Empty<e>]1[tr<yo>]	-6.74123	-6
9	01	0[m<e>r]1[D+<e>]	-6.34289	-6
10	01	0[k<i>]1[B+<o>]	-5.66883	-5
11	01	0[d<i>n]1[t<o>]	-6.08246	-6
12	01	0[f<a>]1[B+<o>]	-6.22924	-6
13	01	0[b<i>s]1[D+<o>]	-6.88718	-6
14	01	0[pr<e>s]1[t<ye>]	-7.08182	-7
15	01	0[pr<e>]1[n<o>]	-5.98681	-5
16	01	0[Empty<a>r]1[m<e>r]	-4.99607	-4
17	01	0[m<a>]1[s<e>]	-4.97959	-4
18	01	0[b<o>s]1[tr<ya>]	-8.43377	-8
19	01	0[s<ey>ks]1[tr<a>]	-8.26358	-8
20	01	0[kl<a>s]1[t<ya>]	-8.71275	-8
21	01	0[d<i>]1[tr<ya>]	-6.65457	-6
22	01	0[br<o>]1[l<ya>n]	-8.21923	-8
23	01	0[pr<i>]1[s<e>]	-5.3365	-5
24	01	0[Empty<e>]1[s<a>s]	-4.15017	-4
25	01	0[Empty<e>]1[s<ya>]	-4.92832	-4
26	01	0[C<e>]1[G+<a>]	-7.09993	-7
27	01	0[h<e>]1[r<yo>]	-7.45383	-7
28	01	0[m<e>]1[p<ye>n]	-6.49917	-6
29	01	0[fl<i>]1[r<o>]	-7.11293	-7
30	01	0[pr<u>]1[D+<a>]	-6.27519	-6
31	01	0[pr<a>]1[G+<a>]	-6.346	-6
32	01	0[Empty<i>]1[r<wa>]	-5.58649	-5
33	01	0[d<a>]1[k<ya>]	-6.0309	-6
34	01	0[g<a>]1[r<o>]	-6.35667	-6
35	01	0[Empty<i>n]1[s<a>]	-5.17041	-5
36	01	0[d<a>]1[C<ya>]	-6.81176	-6
37	01	0[d<i>]1[B+<o>]	-5.79577	-5
38	01	0[s<aw>]1[D+<e>]	-6.75301	-6

39	01	0[Empty<e>r]1[m<a>]	-5.78002	-5
40	01	0[k<e>s]1[t<a>]	-5.63265	-5
41	10	1[pr<e>]0[l<e>r]	-6.686	-6
42	10	1[dr<a>]0[s<o>]	-5.017	-5
43	10	1[b<e>]0[r<yo>]	-4.2301	-4
44	10	1[d<e>ks]0[tr<o>s]	-8.82143	-8
45	10	1[Empty<i>]0[G+<o>r]	-7.03978	-7
46	10	1[m<wa>]0[B+<i>]	-7.4718	-7
47	10	1[tr<we>]0[N+<e>s]	-8.7403	-8
48	10	1[k<a>ks]0[t<a>r]	-7.573	-7
49	10	1[pr<i>]0[n<yo>]	-4.90005	-4
50	10	1[f<o>s]0[tr<ya>]	-6.81341	-6
51	10	1[m<i>]0[tr<o>]	-4.00873	-4
52	10	1[s<a>]0[gr<ye>]	-6.86983	-6
53	10	1[s<a>n]0[s<ya>]	-4.6573	-4
54	10	1[k<o>]0[r<u>r]	-6.97222	-6
55	10	1[b<o>]0[tr<o>]	-4.12293	-4
56	10	1[pl<i>m]0[b<a>]	-7.43259	-7
57	10	1[m<e>ks]0[tr<o>]	-6.29089	-6
58	10	1[n<i>n]0[f<e>]	-6.27699	-6
59	10	1[pr<e>]0[G+<ya>s]	-8.31051	-8
60	10	1[k<o>ns]0[tr<a>]	-7.08277	-7
61	10	1[p<a>m]0[b<yo>]	-6.95897	-6
62	10	1[m<u>]0[N+<o>]	-5.06929	-5
63	10	1[s<aw>]0[br<o>s]	-8.84377	-8
64	10	1[f<o>s]0[tr<a>]	-6.0811	-6
65	10	1[l<wa>]0[pr<ya>]	-6.99856	-6
66	10	1[h<a>l]0[d<a>]	-6.25022	-6
67	10	1[b<e>r]0[B+l<o>]	-5.43674	-5
68	10	1[d<oy>]0[B+<o>]	-6.10128	-6
69	10	1[Empty<e>r]0[p<a>]	-4.75593	-4
70	10	1[tr<i>]0[b<yo>]	-5.81475	-5
71	10	1[kl<e>]0[t<ye>]	-6.55259	-6
72	10	1[fr<i>n]0[t<ya>]	-6.24597	-6
73	10	1[C<e>r]0[h<o>]	-5.58352	-5
74	10	1[dr<e>]0[Empty<a>]	-5.702	-5
75	10	1[C<i>n]0[s<o>]	-5.00543	-5
76	10	1[s<yo>]0[G+<a>]	-5.44903	-5
77	10	1[g<e>]0[D+<a>s]	-6.66245	-6
78	10	1[s<u>]0[r<i>l]	-6.09152	-6
79	10	1[k<a>B+s]0[D+<a>]	-6.68239	-6
80	10	1[d<i>]0[t<yo>]	-4.21326	-4
81	001	0[d<i>]0[n<a>]1[B+<o>]	-7.64229	-7
82	001	0[k<i>]0[p<o>]1[l<a>]	-7.63085	-7
83	001	0[t<a>]0[G+r<i>]1[B+<o>]	-8.8625	-8
84	001	0[Empty<i>]0[m<a>]1[l<ye>]	-7.58541	-7
85	001	0[s<e>s]0[p<o>]1[t<o>]	-8.40456	-8

86	001	0[s<a>]0[D+<a>]1[G+<o>]	-8.15533	-8
87	001	0[Empty<o>]0[r<i>]1[D+<a>]	-6.72331	-6
88	001	0[k<i>]0[B+r<i>n]1[t<o>]	-9.10095	-9
89	001	0[m<e>]0[n<u>]1[B+r<e>]	-9.11072	-9
90	001	0[s<a>]0[r<e>]1[k<o>]	-7.57657	-7
91	001	0[m<e>]0[l<o>]1[B+l<e>]	-9.20645	-9
92	001	0[Empty<i>]0[p<a>]1[D+<e>]	-6.6449	-6
93	001	0[s<u>]0[D+<a>]1[B+<e>]	-8.16582	-8
94	001	0[p<a>]0[l<u>r]1[t<o>]	-9.20354	-9
95	001	0[m<a>]0[B+<o>]1[k<e>]	-7.81684	-7
96	001	0[b<i>]0[pr<yo>]1[k<o>]	-10.0373	-10
97	001	0[p<yo>]0[B+r<a>]1[k<a>]	-9.93635	-9
98	001	0[h<a>]0[t<u>]1[D+<o>]	-8.29396	-8
99	001	0[Empty<o>]0[B+<o>r]1[C<e>]	-8.93447	-8
100	001	0[l<i>]0[D+<u>]1[s<o>]	-8.35376	-8
101	001	0[tr<a>]0[G+<e>]1[s<o>]	-8.47831	-8
102	001	0[Empty<a>]0[t<e>r]1[f<o>]	-8.04394	-8
103	001	0[p<aw>]0[C<o>]1[h<ya>]	-11.2453	-11
104	001	0[n<e>ks]0[D+<o>]1[m<o>]	-10.111	-10
105	001	0[k<i>]0[h<i>]1[r<e>]	-7.56137	-7
106	001	0[Empty<i>]0[p<e>r]1[k<o>]	-8.20548	-8
107	001	0[Empty<e>]0[B+l<i>]1[N+<a>]	-8.55792	-8
108	001	0[f<a>]0[B+l<e>]1[t<o>]	-8.39924	-8
109	001	0[d<a>]0[r<i>]1[m<a>]	-7.21931	-7
110	001	0[dr<u>l]0[m<e>]1[D+<o>]	-10.9211	-10
111	001	0[s<a>]0[k<o>r]1[D+<i>]	-8.12191	-8
112	001	0[t<a>]0[kr<i>]1[m<a>]	-8.96098	-8
113	001	0[Empty<e>]0[D+<i>s]1[m<o>]	-8.31451	-8
114	001	0[l<ey>s]0[k<e>]1[B+<e>]	-11.5627	-11
115	001	0[d<a>]0[s<a>]1[n<ya>]	-7.46182	-7
116	001	0[dr<e>s]0[k<o>]1[r<o>]	-10.3187	-10
117	001	0[k<e>]0[n<u>r]1[D+<o>]	-9.11464	-9
118	001	0[p<a>]0[B+<a>r]1[B+<o>]	-9.10913	-9
119	001	0[h<o>]0[m<o>r]1[t<a>]	-9.09334	-9
120	001	0[Empty<o>]0[kr<a>n]1[t<e>]	-8.66906	-8
121	010	0[Empty<i>]1[r<ay>]0[B+<o>]	-6.89187	-6
122	010	0[b<ye>]1[B+<a>]0[pl<yo>]	-9.48238	-9
123	010	0[d<a>n]1[l<i>]0[kr<e>]	-8.07622	-8
124	010	0[Empty<ya>]1[h<i>n]0[tr<o>]	-8.52218	-8
125	010	0[k<a>]1[r<o>r]0[B+<e>]	-7.0238	-7
126	010	0[f<a>]1[r<a>s]0[n<ya>]	-7.94406	-7
127	010	0[n<e>s]1[t<o>n]0[C<a>]	-9.09639	-9
128	010	0[s<u>]1[f<u>]0[G+r<yo>]	-8.74324	-8
129	010	0[d<o>]1[l<e>k]0[tr<a>]	-7.77826	-7
130	010	0[p<o>r]1[G+<e>]0[n<ya>]	-8.12642	-8
131	010	0[t<i>n]1[d<o>]0[B+r<a>]	-8.84659	-8
132	010	0[m<o>s]1[B+l<e>]0[tr<o>]	-9.25568	-9

133	010	0[h<o>]1[r<e>r]0[m<o>]	-7.65625	-7
134	010	0[g<aw>n]1[t<e>]0[G+r<o>]	-10.1998	-10
135	010	0[g<o>]1[kl<i>]0[D+<o>]	-8.04842	-8
136	010	0[g<o>]1[r<ay>n]0[t<yo>]	-8.90968	-8
137	010	0[s<e>]1[kr<a>]0[D+<o>]	-7.00287	-7
138	010	0[Empty<u>]1[fl<o>]0[pr<o>]	-8.37004	-8
139	010	0[Empty<aw>]1[t<e>]0[B+<o>]	-6.10466	-6
140	010	0[pl<o>]1[r<e>]0[pr<e>]	-8.51569	-8
141	010	0[b<e>]1[N+<o>s]0[D+<a>]	-8.593	-8
142	010	0[tr<a>]1[r<u>]0[l<e>]	-7.21701	-7
143	010	0[p<a>]1[B+l<o>]0[N+<a>]	-8.32883	-8
144	010	0[h<i>r]1[n<u>s]0[t<a>]	-9.62763	-9
145	010	0[t<o>]1[r<i>s]0[D+<o>]	-6.84429	-6
146	010	0[m<e>]1[B+l<e>r]0[t<a>]	-8.06984	-8
147	010	0[l<o>]1[pl<u>]0[r<o>]	-7.99594	-7
148	010	0[Empty<ye>m]1[pl<e>]0[k<o>]	-8.75784	-8
149	010	0[fl<e>]1[B+<e>]0[l<o>]	-7.27416	-7
150	010	0[s<e>m]1[br<o>s]0[k<a>]	-9.541	-9
151	010	0[bl<e>]1[r<u>]0[p<ya>]	-9.11105	-9
152	010	0[m<o>s]1[D+<i>n]0[s<i>l]	-10.3401	-10
153	010	0[p<e>]1[N+<a>r]0[t<o>]	-7.379	-7
154	010	0[f<a>n]1[tr<a>s]0[n<ya>]	-9.72897	-9
155	010	0[m<ay>]1[n<i>]0[B+<o>]	-7.89493	-7
156	010	0[m<wa>r]1[t<a>]0[B+r<yo>]	-9.53502	-9
157	010	0[l<e>r]1[p<e>]0[B+<a>r]	-10.3911	-10
158	010	0[f<e>k]1[t<a>s]0[n<o>]	-8.0983	-8
159	010	0[h<i>]1[l<o>n]0[d<o>]	-8.31218	-8
160	010	0[k<yo>]1[l<e>]0[s<o>]	-6.31872	-6
161	0010	0[k<e>]0[D+<o>n]1[d<u>]0[B+l<o>]	-9.77247	-9
162	0010	0[h<wa>n]0[t<e>]1[D+<i>]0[p<o>]	-10.4744	-10
163	0010	0[Empty<o>]0[n<u>]1[r<i>]0[s<o>]	-6.81105	-6
164	0010	0[t<e>n]0[d<o>n]1[t<o>]0[G+<o>]	-10.3564	-10
165	0010	0[k<o>]0[B+r<i>]1[m<a>]0[n<o>]	-8.20933	-8
166	0010	0[k<e>ks]0[tr<i>]1[B+<a>]0[D+<o>]	-9.11189	-9
167	0010	0[p<i>]0[n<e>]1[G+<e>s]0[t<a>]	-8.65107	-8
168	0010	0[pr<e>]0[D+<a>]1[l<o>]0[N+<o>]	-8.70258	-8
169	0010	0[s<a>l]0[t<o>m]1[pl<e>]0[t<o>]	-10.4361	-10
170	0010	0[s<i>]0[f<a>]1[tr<a>s]0[B+<o>]	-9.5255	-9
171	0010	0[l<i>]0[r<o>]1[kl<a>]0[r<e>]	-9.01638	-9
172	0010	0[b<a>]0[k<e>]1[k<ya>]0[f<o>]	-8.61215	-8
173	0010	0[p<o>]0[k<i>]1[D+<yo>]0[B+<a>]	-8.55449	-8
174	0010	0[tr<e>]0[D+<o>n]1[t<a>r]0[C<o>]	-10.6582	-10
175	0010	0[k<a>]0[B+l<o>n]1[f<yo>]0[s<a>]	-10.0788	-10
176	0010	0[b<ye>]0[N<o>]1[B+l<e>n]0[d<i>l]	-11.8472	-11
177	0010	0[kr<u>s]0[D+<a>]1[N+<e>]0[G+<o>]	-11.8006	-11
178	0010	0[Empty<yo>]0[m<o>]1[Empty<i>]0[t<a>]	-7.70152	-7
179	0010	0[k<o>ns]0[t<a>]1[D+<u>]0[f<a>]	-9.36022	-9

180	0010	0[k<e>]0[r<wa>]1[Empty<e>]0[t<o>]	-8.31558	-8
181	0010	0[k<o>]0[tr<a>]1[p<a>]0[G+<yo>]	-8.48329	-8
182	0010	0[Empty<e>]0[B+l<i>]1[l<a>]0[B+<a>]	-7.25213	-7
183	0010	0[f<e>n]0[tr<a>]1[r<a>s]0[t<e>]	-9.56241	-9
184	0010	0[br<o>]0[D+<i>]1[k<o>]0[B+<e>]	-9.29724	-9
185	0010	0[p<a>s]0[n<ey>]1[s<o>]0[D+<o>]	-10.6645	-10
186	0010	0[h<o>]0[n<e>m]1[b<a>]0[m<o>]	-10.6212	-10
187	0010	0[k<e>]0[D+<e>]1[n<a>]0[t<o>]	-6.43422	-6
188	0010	0[tr<a>]0[G+<i>]1[D+<e>]0[N+<o>]	-9.31958	-9
189	0010	0[Empty<a>]0[D+<e>r]1[B+<i>]0[t<o>]	-7.18344	-7
190	0010	0[pl<o>n]0[s<u>]1[D+<e>]0[s<o>]	-9.2817	-9
191	0010	0[Empty<i>]0[l<i>r]1[D+<e>]0[r<a>]	-8.35312	-8
192	0010	0[Empty<a>l]0[t<ey>]1[k<a>]0[r<o>]	-9.48041	-9
193	0010	0[Empty<e>m]0[B+l<e>]1[f<i>]0[r<a>]	-9.21626	-9
194	0010	0[Empty<i>s]0[m<a>]1[r<e>]0[t<ya>]	-7.21119	-7
195	0010	0[s<o>]0[f<u>n]1[t<i>]0[G+<a>]	-9.66929	-9
196	0010	0[br<i>]0[G+<e>]1[tr<e>n]0[k<o>]	-10.3471	-10
197	0010	0[kr<a>]0[t<a>]1[m<a>]0[n<a>]	-7.60503	-7
198	0010	0[p<o>m]0[b<o>]1[k<e>]0[l<o>]	-9.9381	-9
199	0010	0[Empty<e>r]0[s<e>n]1[s<u>]0[kr<o>]	-9.09011	-9
200	0010	0[m<ay>]0[k<a>]1[t<a>]0[B+<o>]	-9.0166	-9
201	0001	0[Empty<e>]0[l<e>]0[n<i>]1[s<o>]	-5.89395	-5
202	0001	0[b<i>]0[D+<i>]0[t<e>]1[m<a>]	-6.92988	-6
203	0001	0[tr<aw>]0[r<e>s]0[p<a>]1[G+<o>]	-10.6132	-10
204	0001	0[Empty<yo>]0[l<e>]0[t<e>k]1[t<o>]	-8.10015	-8
205	0001	0[k<ye>]0[t<o>]0[l<a>]1[f<o>]	-9.03239	-9
206	0001	0[n<a>n]0[k<e>r]0[B+<a>]1[G+<o>]	-10.2369	-10
207	0001	0[Empty<o>]0[k<i>]0[s<ew>]1[n<o>]	-8.45381	-8
208	0001	0[d<e>]0[D+<a>]0[B+<i>]1[m<ya>]	-7.12817	-7
209	0001	0[m<o>r]0[l<a>]0[m<a>]1[s<a>]	-7.68688	-7
210	0001	0[Empty<e>n]0[tr<a>]0[r<e>s]1[n<a>]	-8.15715	-8
211	0001	0[Empty<u>]0[D+<yo>]0[t<i>]1[h<o>]	-8.2404	-8
212	0001	0[Empty<e>]0[t<a>]0[n<o>r]1[f<o>]	-7.52451	-7
213	0001	0[pl<e>]0[fl<u>]0[B+<a>]1[t<o>]	-10.3262	-10
214	0001	0[k<u>]0[fl<e>]0[n<e>]1[s<o>]	-8.60112	-8
215	0001	0[Empty<a>n]0[k<e>r]0[G+<i>]1[n<e>]	-8.90704	-8
216	0001	0[b<i>]0[s<e>]0[s<i>s]1[B+l<a>]	-9.36011	-9
217	0001	0[Empty<a>]0[G+<i>n]0[h<o>s]1[k<o>]	-9.93033	-9
218	0001	0[t<e>]0[N+<yo>]0[n<e>]1[tr<o>]	-10.2916	-10
219	0001	0[m<i>]0[n<ye>]0[kr<i>]1[l<a>]	-10.1329	-10
220	0001	0[t<e>]0[p<o>]0[D+<i>]1[t<o>]	-7.6243	-7
221	0001	0[m<a>]0[r<yo>r]0[s<e>r]1[C<a>]	-11.4189	-11
222	0001	0[Empty<o>m]0[p<e>]0[l<a>]1[N+<o>]	-8.96719	-8
223	0001	0[Empty<i>s]0[k<e>]0[C<u>]1[t<a>]	-8.79226	-8
224	0001	0[m<e>]0[B+<i>]0[D+<ya>]1[B+l<e>]	-10.3145	-10
225	0001	0[g<a>r]0[m<ey>]0[B+<e>]1[l<o>]	-11.333	-11
226	0001	0[Empty<i>]0[m<o>s]0[k<a>]1[B+l<a>]	-9.37022	-9

227	0001	0[Empty<i>]0[h<ye>]0[n<a>]1[B+<o>]	-8.72881	-8
228	0001	0[d<u>]0[G+<i>]0[kl<e>]1[r<a>]	-9.56528	-9
229	0001	0[s<o>]0[G+<o>]0[t<a>s]1[n<o>]	-9.20418	-9
230	0001	0[m<e>r]0[n<a>]0[f<o>]1[n<e>]	-8.62571	-8
231	0001	0[m<ye>]0[k<o>]0[m<e>]1[G+<yo>]	-9.76698	-9
232	0001	0[f<a>n]0[tr<i>]0[m<e>s]1[D+<o>]	-9.6544	-9
233	0001	0[C<e>]0[D+<e>]0[t<i>]1[B+<a>]	-8.02636	-8
234	0001	0[m<a>]0[tr<o>]0[D+<e>n]1[d<a>]	-9.21646	-9
235	0001	0[m<a>]0[t<i>]0[G+<o>]1[B+l<e>]	-9.05633	-9
236	0001	0[p<wa>]0[B+r<u>]0[m<u>]1[h<o>]	-11.5108	-11
237	0001	0[f<i>s]0[kr<e>n]0[t<o>]1[kr<o>]	-11.8725	-11
238	0001	0[b<wo>]0[r<i>]0[n<a>]1[s<o>]	-9.57534	-9
239	0001	0[f<e>]0[r<i>]0[n<i>]1[n<a>]	-7.30822	-7
240	0001	0[p<u>]0[t<o>r]0[h<e>]1[m<a>]	-8.84669	-8

Table 2.

Orthographic Spellings of Nonwords

	Strpat	Stimulus	Spellings
1	01	0[k<e>]1[pr<ya>]	quepriá
2	01	0[k<o>s]1[tr<ye>n]	costrién
3	01	0[fr<e>]1[B+<o>]	frebó
4	01	0[k<e>]1[tr<o>]	quetró
5	01	0[b<e>r]1[h<wa>]	berjuá
6	01	0[m<e>]1[B+l<a>]	meblá
7	01	0[f<e>s]1[D+<o>]	fesdó
8	01	0[Empty<e>]1[tr<yo>]	etrió
9	01	0[m<e>r]1[D+<e>]	merdé
10	01	0[k<i>]1[B+<o>]	quibó
11	01	0[d<i>n]1[t<o>]	dintó
12	01	0[f<a>]1[B+<o>]	fabó
13	01	0[b<i>s]1[D+<o>]	bisdó
14	01	0[pr<e>s]1[t<ye>]	prestié
15	01	0[pr<e>]1[n<o>]	prenó
16	01	0[Empty<a>r]1[m<e>r]	armér
17	01	0[m<a>]1[s<e>]	masé
18	01	0[b<o>s]1[tr<ya>]	bostriá
19	01	0[s<ey>ks]1[tr<a>]	seixtrá
20	01	0[kl<a>s]1[t<ya>]	clastiá
21	01	0[d<i>]1[tr<ya>]	ditriá
22	01	0[br<o>]1[l<ya>n]	brolián
23	01	0[pr<i>]1[s<e>]	prisé
24	01	0[Empty<e>]1[s<a>s]	esás
25	01	0[Empty<e>]1[s<ya>]	esiá
26	01	0[C<e>]1[G+<a>]	chegá
27	01	0[h<e>]1[r<yo>]	gerió
28	01	0[m<e>]1[p<ye>n]	mepién
29	01	0[fl<i>]1[r<o>]	fliró
30	01	0[pr<u>]1[D+<a>]	prudá
31	01	0[pr<a>]1[G+<a>]	pragá
32	01	0[Empty<i>]1[r<wa>]	iruá
33	01	0[d<a>]1[k<ya>]	daquiá
34	01	0[g<a>]1[r<o>]	garó
35	01	0[Empty<i>n]1[s<a>]	insá
36	01	0[d<a>]1[C<ya>]	dachiá
37	01	0[d<i>]1[B+<o>]	dibó
38	01	0[s<aw>]1[D+<e>]	saudé
39	01	0[Empty<e>r]1[m<a>]	ermá
40	01	0[k<e>s]1[t<a>]	questá
41	10	1[pr<e>]0[l<e>r]	préler
42	10	1[dr<a>]0[s<o>]	dráso

43	10	1[b<e>]0[r<yo>]	bério
44	10	1[d<e>ks]0[tr<o>s]	déxtros
45	10	1[Empty<i>]0[G+<o>r]	ígor
46	10	1[m<wa>]0[B+<i>]	muábi
47	10	1[tr<we>]0[N+<e>s]	truéñes
48	10	1[k<a>ks]0[t<a>r]	cáxtar
49	10	1[pr<i>]0[n<yo>]	prínio
50	10	1[f<o>s]0[tr<ya>]	fóstria
51	10	1[m<i>]0[tr<o>]	mítro
52	10	1[s<a>]0[gr<ye>]	ságrie
53	10	1[s<a>n]0[s<ya>]	sánsia
54	10	1[k<o>]0[r<u>r]	córur
55	10	1[b<o>]0[tr<o>]	bótro
56	10	1[pl<i>m]0[b<a>]	plímba
57	10	1[m<e>ks]0[tr<o>]	méxtro
58	10	1[n<i>n]0[f<e>]	nínfe
59	10	1[pr<e>]0[G+<ya>s]	préguias
60	10	1[k<o>ns]0[tr<a>]	cónstra
61	10	1[p<a>m]0[b<yo>]	pámbio
62	10	1[m<u>]0[N+<o>]	múño
63	10	1[s<aw>]0[br<o>s]	sáubros
64	10	1[f<o>s]0[tr<a>]	fóstra
65	10	1[l<wa>]0[pr<ya>]	luápria
66	10	1[h<a>l]0[d<a>]	jálda
67	10	1[b<e>r]0[B+l<o>]	bérblo
68	10	1[d<oy>]0[B+<o>]	dóibo
69	10	1[Empty<e>r]0[p<a>]	érpa
70	10	1[tr<i>]0[b<yo>]	tríbio
71	10	1[kl<e>]0[t<ye>]	clétie
72	10	1[fr<i>n]0[t<ya>]	fríntia
73	10	1[C<e>r]0[h<o>]	chérjo
74	10	1[dr<e>]0[Empty<a>]	dréa
75	10	1[C<i>n]0[s<o>]	chínso
76	10	1[s<yo>]0[G+<a>]	sióga
77	10	1[g<e>]0[D+<a>s]	guédas
78	10	1[s<u>]0[r<i>l]	súril
79	10	1[k<a>B+s]0[D+<a>]	cábsda
80	10	1[d<i>]0[t<yo>]	dítio
81	001	0[d<i>]0[n<a>]1[B+<o>]	dinabó
82	001	0[k<i>]0[p<o>]1[l<a>]	quipolá
83	001	0[t<a>]0[G+r<i>]1[B+<o>]	tagribó
84	001	0[Empty<i>]0[m<a>]1[l<ye>]	imalié
85	001	0[s<e>s]0[p<o>]1[t<o>]	sespotó
86	001	0[s<a>]0[D+<a>]1[G+<o>]	sadagó
87	001	0[Empty<o>]0[r<i>]1[D+<a>]	oridá
88	001	0[k<i>]0[B+r<i>n]1[t<o>]	quibrintó
89	001	0[m<e>]0[n<u>]1[B+r<e>]	menubré

90	001	0[s<a>]0[r<e>]1[k<o>]	sarecó
91	001	0[m<e>]0[l<o>]1[B+l<e>]	meloblé
92	001	0[Empty<i>]0[p<a>]1[D+<e>]	ipadé
93	001	0[s<u>]0[D+<a>]1[B+<e>]	sudabé
94	001	0[p<a>]0[l<u>r]1[t<o>]	palurtó
95	001	0[m<a>]0[B+<o>]1[k<e>]	maboqué
96	001	0[b<i>]0[pr<yo>]1[k<o>]	bipriocó
97	001	0[p<yo>]0[B+r<a>]1[k<a>]	piobracá
98	001	0[h<a>]0[t<u>]1[D+<o>]	jatudó
99	001	0[Empty<o>]0[B+<o>r]1[C<e>]	oborché
100	001	0[l<i>]0[D+<u>]1[s<o>]	lidusó
101	001	0[tr<a>]0[G+<e>]1[s<o>]	traguesó
102	001	0[Empty<a>]0[t<e>r]1[f<o>]	aterfó
103	001	0[p<aw>]0[C<o>]1[h<ya>]	pauchogiá
104	001	0[n<e>ks]0[D+<o>]1[m<o>]	nexdomó
105	001	0[k<i>]0[h<i>]1[r<e>]	quigiré
106	001	0[Empty<i>]0[p<e>r]1[k<o>]	ipercó
107	001	0[Empty<e>]0[B+l<i>]1[N+<a>]	ebliñá
108	001	0[f<a>]0[B+l<e>]1[t<o>]	fabletó
109	001	0[d<a>]0[r<i>]1[m<a>]	darimá
110	001	0[dr<u>l]0[m<e>]1[D+<o>]	drulmedó
111	001	0[s<a>]0[k<o>r]1[D+<i>]	sacordí
112	001	0[t<a>]0[kr<i>]1[m<a>]	tacrimá
113	001	0[Empty<e>]0[D+<i>s]1[m<o>]	edismó
114	001	0[l<ey>s]0[k<e>]1[B+<e>]	leisquebé
115	001	0[d<a>]0[s<a>]1[n<ya>]	dasaniá
116	001	0[dr<e>s]0[k<o>]1[r<o>]	drescoró
117	001	0[k<e>]0[n<u>r]1[D+<o>]	quenurdó
118	001	0[p<a>]0[B+<a>r]1[B+<o>]	pabarbó
119	001	0[h<o>]0[m<o>r]1[t<a>]	jomortá
120	001	0[Empty<o>]0[kr<a>n]1[t<e>]	ocranté
121	010	0[Empty<i>]1[r<ay>]0[B+<o>]	iráibo
122	010	0[b<ye>]1[B+<a>]0[pl<yo>]	biebáplio
123	010	0[d<a>n]1[l<i>]0[kr<e>]	danlícre
124	010	0[Empty<ya>]1[h<i>n]0[tr<o>]	yagíntro
125	010	0[k<a>]1[r<o>r]0[B+<e>]	carórbe
126	010	0[f<a>]1[r<a>s]0[n<ya>]	farásnia
127	010	0[n<e>s]1[t<o>n]0[C<a>]	nestóncha
128	010	0[s<u>]1[f<u>]0[G+r<yo>]	sufúgrio
129	010	0[d<o>]1[l<e>k]0[tr<a>]	doléctra
130	010	0[p<o>r]1[G+<e>]0[n<ya>]	porguénia
131	010	0[t<i>n]1[d<o>]0[B+r<a>]	tindóbra
132	010	0[m<o>s]1[B+l<e>]0[tr<o>]	mosblétro
133	010	0[h<o>]1[r<e>r]0[m<o>]	jorérmo
134	010	0[g<aw>n]1[t<e>]0[G+r<o>]	gauntégro
135	010	0[g<o>]1[kl<i>]0[D+<o>]	goclído
136	010	0[g<o>]1[r<ay>n]0[t<yo>]	goráintio

137	010	0[s<e>]1[kr<a>]0[D+<o>]	secrádo
138	010	0[Empty<u>]1[fl<o>]0[pr<o>]	uflópro
139	010	0[Empty<aw>]1[t<e>]0[B+<o>]	autébo
140	010	0[pl<o>]1[r<e>]0[pr<e>]	plorépre
141	010	0[b<e>]1[N+<o>s]0[D+<a>]	beñósda
142	010	0[tr<a>]1[r<u>]0[l<e>]	trarúle
143	010	0[p<a>]1[B+l<o>]0[N+<a>]	pablóña
144	010	0[h<i>r]1[n<u>s]0[t<a>]	girnústa
145	010	0[t<o>]1[r<i>s]0[D+<o>]	torísdo
146	010	0[m<e>]1[B+l<e>r]0[t<a>]	meblérta
147	010	0[l<o>]1[pl<u>]0[r<o>]	loplúro
148	010	0[Empty<ye>m]1[pl<e>]0[k<o>]	yempléco
149	010	0[fl<e>]1[B+<e>]0[l<o>]	flebélo
150	010	0[s<e>m]1[br<o>s]0[k<a>]	sembrósca
151	010	0[bl<e>]1[r<u>]0[p<ya>]	blerúpia
152	010	0[m<o>s]1[D+<i>n]0[s<i>l]	mosdínsil
153	010	0[p<e>]1[N+<a>r]0[t<o>]	peñarto
154	010	0[f<a>n]1[tr<a>s]0[n<ya>]	fantrásnia
155	010	0[m<ay>]1[n<i>]0[B+<o>]	mainíbo
156	010	0[m<wa>r]1[t<a>]0[B+r<yo>]	muartábrio
157	010	0[l<e>r]1[p<e>]0[B+<a>r]	lerpébar
158	010	0[f<e>k]1[t<a>s]0[n<o>]	fectásno
159	010	0[h<i>]1[l<o>n]0[d<o>]	gilóndo
160	010	0[k<yo>]1[l<e>]0[s<o>]	quioléso
161	0010	0[k<e>]0[D+<o>n]1[d<u>]0[B+l<o>]	quedondúblo
162	0010	0[h<wa>n]0[t<e>]1[D+<i>]0[p<o>]	juantedípo
163	0010	0[Empty<o>]0[n<u>]1[r<i>]0[s<o>]	onuríso
164	0010	0[t<e>n]0[d<o>n]1[t<o>]0[G+<o>]	tendontógo
165	0010	0[k<o>]0[B+r<i>]1[m<a>]0[n<o>]	cobrimáno
166	0010	0[k<e>ks]0[tr<i>]1[B+<a>]0[D+<o>]	quextribádo
167	0010	0[p<i>]0[n<e>]1[G+<e>s]0[t<a>]	pineguésta
168	0010	0[pr<e>]0[D+<a>]1[l<o>]0[N+<o>]	predalóño
169	0010	0[s<a>l]0[t<o>m]1[pl<e>]0[t<o>]	saltompléto
170	0010	0[s<i>]0[f<a>]1[tr<a>s]0[B+<o>]	sifatrásbo
171	0010	0[l<i>]0[r<o>]1[kl<a>]0[r<e>]	lirocláre
172	0010	0[b<a>]0[k<e>]1[k<ya>]0[f<o>]	baquequiáfo
173	0010	0[p<o>]0[k<i>]1[D+<yo>]0[B+<a>]	poquidióba
174	0010	0[tr<e>]0[D+<o>n]1[t<a>r]0[C<o>]	tredontárcho
175	0010	0[k<a>]0[B+l<o>n]1[f<yo>]0[s<a>]	cablonfiósa
176	0010	0[b<ye>]0[N<o>]1[B+l<e>n]0[d<i>l]	bieñobléndil
177	0010	0[kr<u>s]0[D+<a>]1[N+<e>]0[G+<o>]	crusdañégo
178	0010	0[Empty<yo>]0[m<o>]1[Empty<i>]0[t<a>]	yomoíta
179	0010	0[k<o>ns]0[t<a>]1[D+<u>]0[f<a>]	constadúfa
180	0010	0[k<e>]0[r<wa>]1[Empty<e>]0[t<o>]	queruaéto
181	0010	0[k<o>]0[tr<a>]1[p<a>]0[G+<yo>]	cotrapáguio
182	0010	0[Empty<e>]0[B+l<i>]1[l<a>]0[B+<a>]	eblilába
183	0010	0[f<e>n]0[tr<a>]1[r<a>s]0[t<e>]	fentraráste

184	0010	0[br<o>]0[D+<i>]1[k<o>]0[B+<e>]	brodicóbe
185	0010	0[p<a>s]0[n<ey>]1[s<o>]0[D+<o>]	pasneisódo
186	0010	0[h<o>]0[n<e>m]1[b<a>]0[m<o>]	jonembámo
187	0010	0[k<e>]0[D+<e>]1[n<a>]0[t<o>]	quedenáto
188	0010	0[tr<a>]0[G+<i>]1[D+<e>]0[N+<o>]	traguidéño
189	0010	0[Empty<a>]0[D+<e>r]1[B+<i>]0[t<o>]	aderbíto
190	0010	0[pl<o>n]0[s<u>]1[D+<e>]0[s<o>]	plonsudéso
191	0010	0[Empty<i>]0[l<i>r]1[D+<e>]0[r<a>]	ilirdéra
192	0010	0[Empty<a>l]0[t<ey>]1[k<a>]0[r<o>]	alteicáro
193	0010	0[Empty<e>m]0[B+l<e>]1[f<i>]0[r<a>]	emblefíra
194	0010	0[Empty<i>s]0[m<a>]1[r<e>]0[t<ya>]	ismarétia
195	0010	0[s<o>]0[f<u>n]1[t<i>]0[G+<a>]	sofuntíga
196	0010	0[br<i>]0[G+<e>]1[tr<e>n]0[k<o>]	briguetrénco
197	0010	0[kr<a>]0[t<a>]1[m<a>]0[n<a>]	cratamána
198	0010	0[p<o>m]0[b<o>]1[k<e>]0[l<o>]	pomboquélo
199	0010	0[Empty<e>r]0[s<e>n]1[s<u>]0[kr<o>]	ersensúcro
200	0010	0[m<ay>]0[k<a>]1[t<a>]0[B+<o>]	maicatábo
201	0001	0[Empty<e>]0[l<e>]0[n<i>]1[s<o>]	elenisó
202	0001	0[b<i>]0[D+<i>]0[t<e>]1[m<a>]	biditemá
203	0001	0[tr<aw>]0[r<e>s]0[p<a>]1[G+<o>]	traurespagó
204	0001	0[Empty<yo>]0[l<e>]0[t<e>k]1[t<o>]	yoletectó
205	0001	0[k<ye>]0[t<o>]0[l<a>]1[f<o>]	quietolafó
206	0001	0[n<a>n]0[k<e>r]0[B+<a>]1[G+<o>]	nanquerbagó
207	0001	0[Empty<o>]0[k<i>]0[s<ew>]1[n<o>]	oquiseunó
208	0001	0[d<e>]0[D+<a>]0[B+<i>]1[m<ya>]	dedabimiá
209	0001	0[m<o>r]0[l<a>]0[m<a>]1[s<a>]	morlamasá
210	0001	0[Empty<e>n]0[tr<a>]0[r<e>s]1[n<a>]	entraresná
211	0001	0[Empty<u>]0[D+<yo>]0[t<i>]1[h<o>]	udiotijó
212	0001	0[Empty<e>]0[t<a>]0[n<o>r]1[f<o>]	etanorfó
213	0001	0[pl<e>]0[fl<u>]0[B+<a>]1[t<o>]	pleflubató
214	0001	0[k<u>]0[fl<e>]0[n<e>]1[s<o>]	cuflenesó
215	0001	0[Empty<a>n]0[k<e>r]0[G+<i>]1[n<e>]	anquerginé
216	0001	0[b<i>]0[s<e>]0[s<i>s]1[B+l<a>]	bisesisblá
217	0001	0[Empty<a>]0[G+<i>n]0[h<o>s]1[k<o>]	aguinjoscó
218	0001	0[t<e>]0[N+<yo>]0[n<e>]1[tr<o>]	teñionetró
219	0001	0[m<i>]0[n<ye>]0[kr<i>]1[l<a>]	miniecrilá
220	0001	0[t<e>]0[p<o>]0[D+<i>]1[t<o>]	tepoditó
221	0001	0[m<a>]0[r<yo>r]0[s<e>r]1[C<a>]	mariorserchá
222	0001	0[Empty<o>m]0[p<e>]0[l<a>]1[N+<o>]	ompelañó
223	0001	0[Empty<i>s]0[k<e>]0[C<u>]1[t<a>]	isquechutá
224	0001	0[m<e>]0[B+<i>]0[D+<ya>]1[B+l<e>]	mebidiablé
225	0001	0[g<a>r]0[m<ey>]0[B+<e>]1[l<o>]	garmeibeló
226	0001	0[Empty<i>]0[m<o>s]0[k<a>]1[B+l<a>]	imoscablá
227	0001	0[Empty<i>]0[h<ye>]0[n<a>]1[B+<o>]	igienabó
228	0001	0[d<u>]0[G+<i>]0[kl<e>]1[r<a>]	duguiclerá
229	0001	0[s<o>]0[G+<o>]0[t<a>s]1[n<o>]	sogotasnó
230	0001	0[m<e>r]0[n<a>]0[f<o>]1[n<e>]	mernafoné

231	0001	0[m<ye>]0[k<o>]0[m<e>]1[G+<yo>]	miecomeguió
232	0001	0[f<a>n]0[tr<i>]0[m<e>s]1[D+<o>]	fantrimesdó
233	0001	0[C<e>]0[D+<e>]0[t<i>]1[B+<a>]	chedetibá
234	0001	0[m<a>]0[tr<o>]0[D+<e>n]1[d<a>]	matrodendá
235	0001	0[m<a>]0[t<i>]0[G+<o>]1[B+l<e>]	matigoblé
236	0001	0[p<wa>]0[B+r<u>]0[m<u>]1[h<o>]	puabrumujó
237	0001	0[f<i>s]0[kr<e>n]0[t<o>]1[kr<o>]	fiscrentocró
238	0001	0[b<wo>]0[r<i>]0[n<a>]1[s<o>]	buorinasó
239	0001	0[f<e>]0[r<i>]0[n<i>]1[n<a>]	ferininá
240	0001	0[p<u>]0[t<o>r]0[h<e>]1[m<a>]	putorgemá

Appendix B

Spanish and English Language Use Questionnaire

Demographic information

Date of birth (month /year):
Gender: M or F
Country of Origin:
Month/year of arrival in the US:
In addition to English and Spanish, do you speak, read, or write any other language?

Ever been diagnosed with a speech, language, or hearing disorder? Yes No
Please explain:

When did you first begin to learn English?

When did you first begin to learn Spanish?

Academic language use

1.

Years of schooling	Spanish-speaking Country	United States
High school	1 2 3 4	1 2 3 4
University	1 2 3 4	1 2 3 4
Post-graduate work (write in number of years)		

2. Please answer the following question and if applicable, complete the table below:

Did you study in a bilingual program? Yes No

Country	Courses taken in English	Courses taken in Spanish

3. The following questions refer to your reading and writing skills:

a. How are your reading skills in Spanish?

1 2 3 4 5
Poor Excellent

b. How are your writing skills in Spanish?

1 2 3 4 5
Poor Excellent

c. How are your reading skills in English?

1 2 3 4 5
Poor Excellent

d. How are your writing skills in English?

1 2 3 4 5
Poor Excellent

<u>Social Language Use</u>

4. Indicate how often you use Spanish in the following situations:

	Ratings	1 Never	2	3	4	5 Always
Situation	Home					
	School					
	Work					
	Social Events					

5. Indicate how often you use English in the following situations:

	Ratings	1 Never	2	3	4	5 Always
Situation	Home					
	School					
	Work					
	Social Events					

6. Proficiency Rating Scale – Please respond by selecting the number that best represents your opinion.

a. Most of my family members speak Spanish.

0	**1**	**2**	**3**	**4**	**5**
Never	**Rarely**	**Sometimes**	**Often**	**Mostly**	**Always**

b. I speak to most of my family members in Spanish.

0	**1**	**2**	**3**	**4**	**5**
Never	**Rarely**	**Sometimes**	**Often**	**Mostly**	**Always**

c. My neighbors speak Spanish.

0	**1**	**2**	**3**	**4**	**5**
Never	**Rarely**	**Sometimes**	**Often**	**Mostly**	**Always**

d. I speak to my neighbors in Spanish.

0	**1**	**2**	**3**	**4**	**5**
Never	**Rarely**	**Sometimes**	**Often**	**Mostly**	**Always**

e. My friends speak Spanish to me outside of school or on the phone.

0	**1**	**2**	**3**	**4**	**5**
Never	**Rarely**	**Sometimes**	**Often**	**Mostly**	**Always**

f. I speak to my friends in Spanish outside of school or on the phone.

0	**1**	**2**	**3**	**4**	**5**
Never	**Rarely**	**Sometimes**	**Often**	**Mostly**	**Always**

g. I watch television in Spanish.

0	1	2	3	4	5
Never	**Rarely**	**Sometimes**	**Often**	**Mostly**	**Always**

h. My family watches television in Spanish.

0	1	2	3	4	5
Never	**Rarely**	**Sometimes**	**Often**	**Mostly**	**Always**

7. Do you feel that you speak Spanish better than English? Yes No
Please explain.

8. Indicate with an "X" your strong points in each language:

Areas	Spanish	English
Vocabulary		
Grammar		
Reading Comprehension		
Fluency of Expression		

Cuestionario de uso del español y el inglés

Información demográfica

Fecha de nacimiento (mes / año):
Sexo: M o F
País de origen:
Mes y año de llegada a los Estados Unidos:
Además de inglés y español, habla, lee, o escribe algún otro idioma?

Alguna vez ha sido diagnosticado con desórdenes de audición, del habla o del lenguaje?
Sí o No.
Explique por favor:

Cuando aprendio a hablar en ingles?

Cuando aprendio a hablar en español?

Uso académico de los idiomas

1.

Años de estudio	País de habla hispana	Estados Unidos
Bachillerato o escuela secundaria	1 2 3 4	1 2 3 4
Universidad	1 2 3 4	1 2 3 4
Estudio Postgrado (indicar numero de años)		

2. Favor de contestar la pregunta debajo y si le aplica, complete la tabla adjunta:

Estudió en un programa bilingue? Sí No

País	Cursos de studio en inglés	Cursos de estudio en español

3. Las siguientes preguntas le pediran que dé información sobre sus habilidades lectoescritoras:

a. Que tan bien lee en español?

1 2 3 4 5
pobremente excelentemente

b. Que tan bien escribe en español?

1 2 3 4 5
pobremente excelentemente

c. Que tan bien lee en inglés?

1 2 3 4 5
pobremente excelentemente

d. Que tan bien escribe en inglés?

1 2 3 4 5
pobremente excelentemente

<u>Uso social de los idiomas</u>

4. Por favor, indique cuan frequentemente utiliza usted el español en las siguientes situaciones:

Situación		1 Nunca	2	3	4	5 Siempre
	Casa					
	Escuela					
	Trabajo					
	Eventos Sociales					

5. Por favor, indique cuan frequentemente utiliza usted el inglés en las siguientes situaciones:

Situación		1 Nunca	2	3	4	5 Siempre
	Casa					
	Escuela					
	Trabajo					
	Eventos Sociales					

6. Fluidez de expression – Por favor escoja el número que representa mejor su opinión.

a. Mi familia, en general, habla en español

0	1	2	3	4	5
Nunca			**A menudo**		**Siempre**

b. Yo hablo en español con miembros de mi familia.

0	1	2	3	4	5
Nunca			**A menudo**		**Siempre**

c. Mis vecinos hablan en español.

0	1	2	3	4	5
Nunca			**A menudo**		**Siempre**

d. Hablo con mis vecinos en español.

0	1	2	3	4	5
Nunca			**A menudo**		**Siempre**

e. Mis amigos me hablan en español en persona o por teléfono.

0	1	2	3	4	5
Nunca			**A menudo**		**Siempre**

f. Hablo con mis amigos en español en persona o por teléfono.

0	1	2	3	4	5
Nunca			**A menudo**		**Siempre**

g. Veo television en español.

0 1 2 3 4 5

Nunca A menudo Siempre

h. Mi familia ve television en español.

0 1 2 3 4 5

Nunca A menudo Siempre

8. Siente usted que habla mejor el español que el inglés? Sí No
Por favor explique su respuesta.

9. Por favor, indique con una "X" en cual de los dos idiomas siente usted que tiene mejores habilidades en las siguientes areas :

Areas	Español	Inglés
Vocabulario		
Gramática		
Comprensión lectora		
Fluidez de expresión		

Appendix C

Adult Participant Demographic Information

Participant	Gender	Age	Country of Origin	Age of Immersion (in years)
1	F	29	United States	Birth
2	M	28	Dominican Republic	14
3	M	22	Dominican Republic	7
4	F	23	United States	Birth
5	F	31	United States	Birth
6	F	28	Cuba	2
7	M	25	Mexico	8
8	F	28	Colombia	21
9	F	23	Colombia	17
10	F	29	United States	Birth

Appendix D

Teacher Questionnaire: Spanish Language Use

ID Code:________________________ Date:________________________________

Teacher:______________________________

1. Mark with an "x" the number that best describes how often the child ***hears*** Spanish in the following situations.

	Ratings	1 Never	2	3	4	5 Always
Situation	Recess					
	Lunch					
	Other school social situations					

2. Mark with an "x" the number that best describes how often the child ***speaks*** Spanish in the following situations.

	Ratings	1 Never	2	3	4	5 Always
Situation	Recess					
	Lunch					
	Other school social situations					

3. Mark with an "x" the number that best describes how often the child ***hears*** Spanish in the following situations.

	Ratings	1 Never	2	3	4	5 Always
Situation	Center Time					
	Other academic situations					

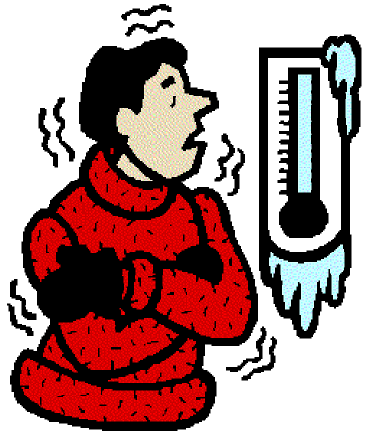
4. Mark with an "x" the number that best describes how often the child ***speaks*** Spanish in the following situations.

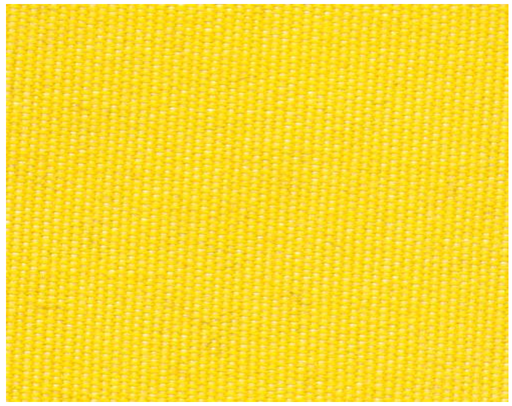
	Ratings	1 Never	2	3	4	5 Always
Situation	Center Time					
	Other academic situations					

Modified from: Gutierrez-Clellen, V., & Kreiter, J. (2003). Understanding child bilingual acquisition using parent and teacher reports. *Applied Psycholinguistics, 24*, 267-288.

Appendix E

Photos for Articulation Task





Appendix F

Nonword Repetition Spanish Instructions

Instrucciones generales

Vamos a ponernos nuestros super oidos! Vamos a escuchar unas palabras inventadas que suenan raras. Después de cada palabra quiero que la repitas en voz alta. Primero vamos a intentar algunas…Estas listo/a con tus super oídos? ('Let's put on our super listening ears! Let's listen some made-up words that sound funny. After each word, I want you to repeat it aloud. First we are going to try a couple. Are you ready with your super ears?')

Present the first trial (press "play")

Feedback (only for trial items)

Response Matching Target: *Muy bien! Escuchaste con tus super oidos y repetiste la palabra!* ('Very good! You listened with your super ears and repeated the word!')

Response in Error: *Bien hecho, estas cerca! La respuesta correcta era: Vamos a escuchar con cuidado otra palabra. Listo/a?* ('Good try, you're close! The correct response was…. Let's listen carefully to another word. Are you ready?').

Present the second trial…. (press *play*)

Repeat the same feedback after the second trial…

After the two trials, say:

"Vamos a seguir escuchando palabras. Pero ahora, por favor, presta atención porque no puedo repetir las palabras. Estas listo/a para ponerte los super oidos para escuchar?" ('Let's keep listening to words. But, now please, pay attention because I cannot repeat the words. Are you ready to put on your super listening ears?')

Participant code ___________
Gender _______

Nonwords	**Segmental Error?**								**Stress Error?**
Target	**O1**	**R1**	**O2**	**R2**	**O3**	**R3**	**O4**	**R4**	
preno									
esja									
prise									
prestje									
dakja									
sejkstra									
erpa									
tʃinso									
sjoɣa									
muaβi									
truenjes									
luaprja									
3 syllables									
fableto									
kibrinto									
Iperko									
neksðomo									
Biprjoko									
Lejskebe									
Horermo									
Pablonja									
Fektasno									
bieβapljo									
Mosbletro									
Mosðinsil									
4 syllables									
okiseuno									
matroðenda									
ankerhine									
trawrespaɣo									
duɣiklera									
nankerbaɣo									
ismaretja									
Ilirðera									
pinegesta									
majcataBo									
pasnejsoðo									
sifatrasβo									

Child Assent Statement

Hi, my name is Maria. I can speak in Spanish like you! Today, I need your help learning about words in Spanish. I have a few word games we can play. In some games I will need you to listen carefully, in others will need you to talk with me. Your mommy and daddy gave you permission to play in these games with me. But, if you do not want to play the games or if you get tired when we are playing, it's OK. You can tell me that you don't want to play by saying "stop, please." So, what are we going to do? Yes! Play some games.

Do you want to play?

And if you get tired of playing, what do you say? OK!

Are you ready to play?

Spanish Child Assent Statement

Hola, me llamo María y como tu se hablar en español! Hoy necesito tu ayuda aprendiendo sobre las palabras en espanol. Tengo unos juegos de palabras que podemos jugar. En algunos juegos tienes que oír con atención, en otros tienes que hablar. Tu mami y tu papi dieron su permiso para que jugaras conmigo, pero si no quieres jugar o te cansas cuando estemos jugando, esta bien. Solo me dices que no quieres jugar. Puedes decirme "para por favor!"

Sabes lo que vamos a hacer entonces? Sí, a jugar unos juegos.

Quieres jugar?

Y si te cansas que me dices? Muy bien!

Listo/a para empezar?

Appendix H

Table H1

Effects of Age, Gender, and Word Length on NWR

Source	*Sum of Squares*	*df*	*Mean Square*	*F*	*Sig.*	*Partial* η^2
Age	.131	(2,62)	.066	3.59	<.05	.104
Gender	8.852	(1, 62)	8.852	.005	.945	.000
Age x Gender	.106	(2, 62)	.053	2.893	.063	.085
Error	1.133	62	.018			

About the Author

Maria Brea-Spahn received a Master's Degree in Communication Sciences and Disorders from the University of South Florida (USF). After she graduated, she collaborated in an internally-funded, faculty-directed project at USF that aimed at developing a test of phonological processing for Spanish-speakers. Due to her interest in this area of research, she returned to the University of South Florida in December of 2000 to pursue a Ph.D. While in the Interdisciplinary Ph.D. in Cognitive and Neural Sciences, Ms. Brea-Spahn became interested in the role of experience on the development of phonological structure in bilingual children, an interest she pursued in depth in her dissertation. While in the Ph.D., she also co-authored two book chapters, taught graduate and undergraduate courses, supervised clinical graduate students in the Speech-Language-Hearing Center, and presented her work in a variety of professional conferences.