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Research Article

Relationships Between Vocabulary Size, Working Memory, and Phonological Awareness in Spanish-Speaking English Language Learners

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Purpose: The goals of this study were to evaluate the impact of short-term phonological awareness (PA) instruction presented in children's first language (L1; Spanish) on gains in their L1 and second language (L2; English) and to determine whether relationships exist between vocabulary size, verbal working memory, and PA in Spanish-speaking English language learners (ELLs).
Method: Participants included 25 kindergartners who received PA instruction and 10 controls. A 2-way within-subjects repeated measures multivariate analysis of variance (MANOVA) was conducted to evaluate gains. Relationships between PA gains, Spanish and English vocabulary, and memory, as measured using nonword repetition and experimental working memory tasks, were analyzed using correlation and regression analyses.
Results: Results indicated significant and equivalent gains in both languages of children in the experimental group and no gains in the control group. Spanish vocabulary size was significantly related to PA gains in both languages and was more strongly related to English gains than was English vocabulary size. The memory tasks predicted gains in each language in distinct ways.
Conclusion: Results support the conclusion that PA instruction and strong vocabulary skills in an individual's L1 benefit PA development in both the L1 and L2. Results also indicate that dynamic relationships exist between vocabulary size, storage and processing components of working memory, and PA development in both languages of ELLs.

Key Words: phonological awareness, vocabulary, working memory, English language learners, Spanish

There is a critical need for increased insight into the reading development and difficulties of English language learners (ELLs). ELLs represent ~10.8% (>5.3 million) of school-age children in the United States (National Clearinghouse for English Language Acquisition, 2011), 71% of whom are reading below the basic proficiency level by fourth grade (National Center for Education Statistics, 2009). Spanish-speaking children, in particular, are the largest and fastest growing group of ELLs and are a particularly high priority for research (García & Jensen, 2009).

Phonological awareness (PA) is a phonological processing skill that has been shown to be a stronger predictor of reading development than IQ, language proficiency, and other conventional tests of reading readiness (e.g., Goswami & Bryant, 1990; Vellutino & Scanlon, 1987; Wagner, Torgesen, & Rashotte, 1994). Although there is extensive documentation of the role of PA in literacy acquisition, the basis for individual differences in, and mechanisms underlying, PA development are poorly understood. Several potential contributors to PA development have been explored, including vocabulary, verbal working memory (WM), letter knowledge, literacy experience, and speech perception (e.g., Gathercole, Willis, & Baddeley, 1991; Gibbs, 2004; Gillam & van Kleeck, 1996; McBride-Chang, 1995; Metsala & Walley, 1998; Oakhill & Kyle, 2000; Rvachew, 2006; Rvachew & Grawburg, 2006). However, relatively little is known about PA development in ELLs (Anthony et al., 2009). In the current study, the potential contributions of vocabulary size and WM to PA development in ELLs were explored.

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Effect of Vocabulary Size on PA

Vocabulary is one variable that is considered to have a significant role in PA development. Certain evidence suggests that young children store newly acquired words as holistic phonological units (e.g., Ferguson, 1986; Vihman & Croft, 2007; Walley, 1993), and that gradually, expansion in vocabulary size stimulates phonological segmentation and restructuring of their lexicon (Fowler, 1991; Metsala & Walley, 1998). In other words, as children add more words to their repertoire, their phonological systems become more sensitive to the sound differences between words. In turn, this process may drive further segmentation and refinement of the phonological representation of words, thereby promoting PA development. These representations may then gradually become organized categorically based on sublexical characteristics such as word structures and phonemes (Edwards, Beckman, & Munson, 2004; Mayo, Scobbie, Hewlett, & Waters, 2003; Munson, Edwards, & Beckman, 2005; Pierrehumbert, 2003; Vihman & Croft, 2007). Metsala and Walley (1998) proposed that this gradual whole- to part-word processing occurs on a word-by-word basis and is influenced by a child's vocabulary size, age of acquisition, word familiarity, and sound similarities among words in the child's lexicon. According to this view, more familiar and early acquired words should be stored in segmented form before, and therefore easier to analyze during PA tasks than, less familiar or later acquired words.

Numerous studies with English speakers have indicated that a significant relationship exists between PA and vocabulary size, as measured by receptive vocabulary tests, in both typically developing children (DeCara & Goswami, 2003; Metsala, 1999) and children with speech sound disorders (Rvachew, 2006; Rvachew & Grawburg, 2006). Although vocabulary is generally accepted as a contributor to PA development, it should be noted that not all research has shown a correlation (Garlock, Walley, & Metsala, 2001; Gathercole et al., 1991), indicating that the relationship between PA and vocabulary size warrants further examination.

Effect of WM on Phonological Representation and PA

In addition to vocabulary, the role of WM in PA development has also been explored. Several investigations have indicated that WM and PA are significantly correlated and are important contributors to reading acquisition (e.g., Mann & Liberman, 1984; Siegel & Linder, 1984; Wagner & Torgesen, 1987). WM has also been shown to play a role in PA development, with its contribution often attributed to the phonological loop component of the well-known WM model proposed by Baddeley and Hitch (1974). A recent review by Montgomery, Magimairaj, and Finney (2010) provides an excellent, thorough review of perspectives and research on WM. To summarize, PA may be dependent on WM skills because the ability to reflect on sounds in words first requires activation of phonological representations, and these representations must then remain active long enough for a child to successfully analyze and manipulate the sounds (Gillam & van Kleeck, 1996; Mann & Liberman, 1984). Gathercole and Baddeley (1993) proposed that the short-term storage function of the phonological loop is critical to coding stable phonological representations. Consequently, limitations in WM capacity "may make it more difficult to discover and master metaphonological skills" (Brady, 1991, pp. 130–131).

As with the role of vocabulary, not all research findings support the role of WM in PA development. Gillam and van Kleeck (1996) did not find that WM, as measured by nonword repetition (NWR), predicted the PA gains of preschoolers with language impairment following an intervention that was provided throughout the academic year. Two possible explanations for this unexpected finding include the particular task that was used to measure WM and the duration of the intervention. WM has often been measured using NWR, word span, and digit span tasks that measure simple storage capacity. NWR appears to reliably evaluate phonological WM (Gathercole & Baddeley, 1993). However, several researchers have pointed out that simultaneous storage and complex processing demands are inherent in most PA tasks (Daneman & Carpenter, 1980; Leather & Henry, 1994; Yopp, 1988). Consequently, Oakhill and Kyle (2000) advised that memory should be tapped by tasks that involve both storage and processing components of verbal WM, which is a recommendation that was followed in the current study. Furthermore, the relationships between PA and its contributors are complex and may change rather than become clearer over time (Gathercole, Willis, Emslie, & Baddeley, 1992). In the current study, therefore, children's PA gains were examined following a focused, short-term intervention.

Interactions Between Vocabulary Size, WM, and PA

Research investigating the unique roles of vocabulary size and WM in PA development is confounded by the natural entanglement of these domains. On the one hand, short-term memory has been shown to play a causal role in word learning in a native, or first, language (L1; Gathercole et al., 1991; Michas & Henry, 1994) and in a second language (L2; Cheung, 1996; Service, 1992). This may be because the ability to maintain the phonological information of a new word in an activated state will increase the probability that its phonological trace will become permanently encoded and mapped with its semantic referent (Gathercole et al., 1992). On the other hand, vocabulary skills may influence phonological memory, as measured by NWR, if phonological templates of real words serve as analogies that support recall of new words (Metsala, 1999; Snowling, Chiat, & Hulme, 1991). Interestingly, Gathercole et al. (1991) did not find a link between vocabulary and PA using a rhyming task in 4- and 5-year-old children. Instead, they found that phonological memory contributed significantly to vocabulary, with NWR and digit span accounting for 16.7% and 7.7%, respectively, of the variance in the children's vocabulary scores. When analyzing the direction of the association between vocabulary and NWR, Gathercole et al. (1991) found that phonological memory appeared to be the pacemaker in 4- and 5-year-old children, but vocabulary emerged as the pacemaker in 5- and 6-year-old children. Thus, there is a bidirectional relationship between cognitive and linguistic resources in the process of word learning, with potential variations in the effect of one skill on the other during different stages in children's development.

Moreover, there may be individual differences in how vocabulary size and WM impact children's PA development. Gibbs (2004), for example, examined the interaction between vocabulary and memory and their roles in PA development.

Fifty-five children ages 5 to 7 years completed vocabulary, alphabet span, rhyming, and initial phoneme matching tasks. After 6 months, the children with low memory spans and high vocabulary had achieved greater PA gains than the children with low memory and low vocabulary. For children with high memory spans, vocabulary size did not appear to have an effect. Gibbs suggested that the interaction between constrained memory and lexical skills was most critical for children with smaller memory spans. Overall, the results appeared to support Gathercole, Hitch, Service, and Martin's (1997) view that both short-term memory and vocabulary size contribute to learning about the phonological structure of new words—a view that has since received further support through computational modeling (Gupta & Tisdale, 2009).

PA Development in ELLs

Several studies have examined the roles of vocabulary and WM in monolinguals' PA development. In contrast, the majority of research with ELLs has focused on the relationship between PA skills in the L1 and literacy achievement in English, the L2. There has been some disagreement as to whether or not PA development is specific to a particular language (Caravolas & Bruck, 1993; Stuart-Smith & Martin, 1999). Branum-Martin et al. (2006) examined Spanish–English bilingual children's skills at both student and classroom levels and found a high degree of overlap between Spanish and English PA constructs, although statistically, the two constructs were distinct. However, despite variation between the languages in terms of phonemes, phonotactic constraints, syllable structure, and word length, investigators have found consistent evidence of skill transfer from Spanish to English (e.g., August, Calderon, & Carlo, 2002; Branum-Martin et al., 2006; Cisero & Royer, 1995; Dickinson, McCabe, Clark-Chiarelli, & Wolf, 2004; Durgunoglu, Nagy, & Hancin-Bhatt, 1993; Swanson, Saez, Gerber, & Leafstedt, 2004). This research has important educational implications for instructing ELL students. Based on such evidence, Durgunoglu et al. (1993) suggested that enhancing children's PA skills in the native language may also enhance their English literacy acquisition.

Purpose

Thus far, most evidence of ELLs' skill transfer has come from correlational data between their PA skills in L1 and later literacy achievement in English, such as from fall to spring, or from one year to another. Manis, Lindsey, and Bailey (2004) identified a methodological concern with such longitudinal research; specifically, such correlations may be mediated by children's increasing English language and literacy development over time. As a result, the first purpose of this study was to examine change in children's PA skills in Spanish and English after a short period of PA instruction presented in Spanish. In this way, PA gains in both languages could be examined while limiting the confounds of English vocabulary gains and literacy exposure during the study, thereby addressing the methodological issue noted by Manis et al. A finding of immediate gains in English PA as a direct result of PA instruction in Spanish would provide further compelling support for Durgunoglu et al.'s (1993) proposal that enhancing skills in a person's L1 may benefit literacy acquisition in both languages.

Apart from evidence of transfer, the mechanisms underlying PA development in ELLs remain poorly understood (Anthony et al., 2009). As discussed earlier, some evidence with English monolinguals suggests that an increasing vocabulary size drives phonological segmentation and restructuring of words, possibly on a word-by-word basis, thereby contributing to PA development. However, ELLs differ from monolinguals in numerous ways. For instance, some ELLs are able to complete PA tasks in English despite having a small and emerging lexical repertoire in English. Therefore, the relationship between Spanish vocabulary size and English PA merits consideration. In addition, Pearson, Fernández, and Oller (1993) underscored the importance of looking comprehensively at bilingual children's vocabulary knowledge in both languages, as single language scores will likely underestimate the children's total vocabulary knowledge. Along with variance in L1 and L2 vocabulary size, it would seem likely that storage and processing components of WM are taxed differently when performing tasks in the L1 and L2. Consequently, the second purpose of this study was to examine the relationships between total vocabulary size, storage and processing components of verbal WM, and PA in both languages of ELLs. Such an investigation would have theoretical implications for understanding various mechanisms underlying PA development in two languages, which may in turn have clinical implications for assessment, enhanced instruction, and prevention of literacy difficulties in ELLs.

Method

Participants

Sixty typically developing kindergartners who were Spanish-speaking ELLs were recruited from transitional bilingual education classrooms in central Texas and the Midwest. Initial eligibility information was obtained from parent and teacher questionnaires (Gutiérrez-Clellen & Kreiter, 2003; Restrepo, 1998), which provided converging evidence of Spanish dominance, ELL status, and overall typical development. Language proficiency ratings were based on a scale of 1 (*low*) to 5 (*high*). Criteria for selection included (a) no reported speech, language, learning, physical, or health concerns; (b) Spanish was the primary language spoken in the home; (c) English was acquired after the age of 3 years; (d) both parent and teacher ratings of the child's ability to understand and speak Spanish as 4 or 5; and (e) both parent and teacher ratings of the child's ability to understand and speak English as 1 or 2.

To investigate the impact of vocabulary on PA development in each language, it was necessary that participants demonstrate greater vocabulary skills in Spanish than English. To determine this, a modified version of the Receptive One-Word Picture Vocabulary Test: Spanish—Bilingual Edition (ROWPVT–SBE; Brownell, 2001) was administered in Spanish and English on separate days to estimate the children's vocabulary size in each language. Due to the fact that the item difficulty sequence for this test was based on English lexical development, an extended ceiling of 10 items was used (Peña & Kester, 2004) for each language. With this in mind, and due to the lack of data indicating what would constitute a significant discrepancy between Spanish and English scores, a minimum 18-month difference was arbitrarily selected based on the ROWPVT–SBE age-equivalence data. Standard scores were not reported due to modifications of standardized administration and scoring procedures. Raw scores were used for subsequent analyses.

Finally, normal speech and language development in the L1 was required for eligibility. To verify this, each participant was required to generate a Spanish narrative based on the wordless picture book, *Frog, Where Are You?* (Mayer, 1969), which was recorded using a Marantz PMD222 audio recorder. Narratives were transcribed verbatim, including phoneme omissions and substitutions, using the Systematic Analysis of Language Transcripts (SALT; Miller & Iglesias, 2006) software. A second examiner reviewed the recordings and transcripts to verify transcription accuracy and to segment utterances into communication units (C-units; Loban, 1976), which consist of an independent clause and its modifier. Any disagreements were resolved by a third examiner.

Following procedures employed by Fiestas and Peña (2004), each C-unit was coded as grammatically correct or incorrect, and the percentage of grammatical utterances was calculated. Grammaticality ≥ 82% (Restrepo, 1998) was required to indicate normal language skills. In addition, evaluators coded any errors (i.e., omissions or substitutions) in phoneme production. The percentage of correct production (Shriberg & Kwiatkowski, 1982) was calculated based on the production accuracy of the first 10 required occurrences of each phoneme in error. To indicate normal speech development, mastery of 18 Spanish consonants (90% correct production; Acevedo, 1993) or mastery of 17 Spanish consonants and substitution of a tap for a trilled /r/ was required.

Of the participant pool, 35 children between the ages of 60 and 72 months (M = 66 months; 16 boys, 19 girls) met all eligibility requirements. An a priori power analysis of pilot data using G Power software (Erdfelder, Faul, & Buchner, 1996) indicated that a minimum of seven participants was required to detect statistically significant PA gains. To maximize the number of children who received the PA instruction, 25 students from three classrooms participated in the experimental group, and 10 children from two classrooms served as the control group. All of the participants were in transitional bilingual education classrooms in which ~90% of the instructional time was in Spanish, and all were from Latino backgrounds (28 Mexican, 5 Puerto Rican, 1 Honduran, and 1 Colombian). Eighty-six percent received free or reduced lunch at their school, and 74% had attended bilingual Head Start preschools. Group assignment was not randomized; however, pretest equivalence between the experimental and control groups was evaluated across chronological age, letter knowledge, Spanish vocabulary, English vocabulary, Spanish PA, and English PA. Means and standard deviations for the pretest variables are presented in Table 1. A one-way multivariate analysis of variance (MANOVA) indicated group equivalence on all pretest variables, Hotelling's Trace = .14, $F(6, 28) = .64$, $p = .698$, $\eta_p^2 = .12$.

TABLE 1. Means and standard deviations for the pretest variables by group.

	Experimental group (n = 25)		Control group (n = 10)	
	M	*SD*	*M*	*SD*
Chronological age (in months)	67.40	3.97	65.50	3.44
Letter knowledge	19.60	8.72	21.20	7.80
ROWPVT–Spanish	52.44	9.05	54.50	10.41
ROWPVT–English	31.96	7.89	30.30	6.77
Total PA–Spanish	16.40	12.86	15.30	8.34
Total PA–English	13.88	12.00	11.70	5.81

Note. ROWPVT = as measured by the Receptive One-Word Picture Vocabulary Test: Spanish—Bilingual Edition (Brownell, 2001); PA = phonological awareness as measured by the Test of Phonological Processing in Spanish (Francis et al., 2001) and the Comprehensive Test of Phonological Processing (Wagner, Torgesen, & Rashotte, 1999).

Measures

To evaluate children's phonological awareness skills, four subtests each of the Test of Phonological Processing in Spanish (TOPPS; Francis et al., 2001) and the Comprehensive Test of Phonological Processing (C–TOPP; Wagner, Torgesen, & Rashotte, 1999) were administered. These subtests were Initial Sound Matching, Final Sound Matching, Syllable and Phoneme Blending, and Syllable and Phoneme Segmenting. The highest possible raw scores were 10, 10, 20, and 20, respectively. The subtests were selected based on a thorough literature review providing evidence for their developmental appropriateness and their correlation with Spanish speakers' literacy outcomes (Gorman & Gillam, 2003). The TOPPS was designed by prominent researchers through the Center for Applied Linguistics. At the time of this study, it was the most thoroughly researched Spanish phonological processing test (e.g., Branum-Martin et al., 2006; Mathes, Pollard-Durodola, Cárdenas-Hagan, Linan-Thompson, & Vaughn, 2007; Vaughn et al., 2006) and the only one with an equivalent English version (i.e., the C–TOPP, generally considered the gold standard) with published reliability data. Alpha coefficients range from .70 to .93 for the C–TOPP, and based on a sample of ~1,500 Spanish-speaking students, from .93 to .97 for the TOPPS (Vaughn et al., 2006). To ensure task comprehension, directions were presented in Spanish. For each subtest, items were presented in one language, then the other, with counterbalanced order of presentation.

As reported in the eligibility criteria, vocabulary size in each language was measured using the ROWPVT–SBE. To evaluate WM, children in the experimental group completed two measures. NWR was evaluated to tap the children's underlying phonological representations and the short-term storage component of WM (Gathercole & Baddeley, 1993).

Research examining NWR tasks for Spanish speakers is limited (Gutiérrez-Clellen & Simón-Cerejido, 2010). Most has focused on the effects of children's age and nonword length (Ebert, Kalanek, Cordero, & Kohnert, 2008), the effects of wordlikeness (Summers, Bohman, Gillam, Peña, & Bedore, 2010), and the contribution of NWR to the differentiation of Spanish speakers with and without language impairment (Girbau & Schwartz, 2007; Gutiérrez-Clellen & Simón-Cerejido, 2010).

In addition to PA subtests, the TOPPS includes an NWR subtest. This subtest was selected based on the large sample size on which it has been tested and its reliability data. It was designed to match the linguistic complexity in the C–TOPP, but items include phonemes and syllable structures appropriate to Spanish (Vaughn et al., 2006). The items include all Spanish vowels (a, e, i, o, u) and consonants (including the tap and trill /r/) except ñ, which represents an infrequent 0.4% of consonants produced in Spanish (Guirao & García Jurado, 1990). Stimuli also adhere to the phonotactic constraints of Spanish. As a result, the stimuli are relatively "wordlike," which facilitates recall and repetition (Gathercole et al., 1991). Items range from one to eight syllables. The predominant syllable shape is CV (consonant–vowel; 67%), followed by CVC (28%), CCV (2%), and CCVC (3%).

Research with typically developing Spanish speakers has indicated high correlations among various NWR scoring methods (i.e., percentage of phonemes correct, percentage of syllables correct, percentage of whole words correct), with a correlation of .843 between percentage of phonemes correct and dichotomous whole-word scoring (MacMillan, Marchman, Fernald, Frank, & Hurtado, 2010). Scoring on the TOPPS is dichotomous, with a score of 1 awarded for correct repetition of the entire nonword and 0 for an incorrect response. In line with the eligibility requirements for articulation, substitution of a tap for a trilled /r/ was not scored as an error. The highest possible raw score on the TOPPS is 18.

To the author's knowledge, despite recommendations to incorporate processing-based measures into assessments (Gutiérrez-Clellen, Calderón, & Ellis Weismer, 2004; Kohnert, 2004), there was no published measure of verbal WM for Spanish-speaking prereaders when this study was conducted. Consequently, I designed the Complex Span Task—Early Spanish (COST–Early Spanish; see Appendix) to measure both storage and processing components of WM. I modeled the measure after the Competing Language Processing Test (CLPT; Gaulin & Campbell, 1994), which was designed for English speakers ages 6 through 12. The CLPT taps processing skills by having children listen to simple sentences and indicate the truthfulness of each sentence. To tap storage, children then recall the last word in each sentence of the series. Examples of sentences from the CLPT are "Giants are *small*. Apples are *square*. Roses have *thorns*."

Pilot work for the present study revealed that many young Spanish speakers had difficulty responding correctly to questions in Spanish involving linguistic concepts including size, color, shape, and sequence (e.g., What was the *last* word of each sentence?), such as those used in the CLPT. These findings are consistent with those of Peña, Bedore, and Rappazo (2003), who observed that 4- to 7-year-old Latino children displayed moderate difficulty on receptive linguistic concept tasks and a high level of difficulty on expressive linguistic concept tasks in both Spanish and English. According to Kester and Peña (2002), academic topics are typically highlighted in school environments, whereas topics about family and food are often highlighted in Latino children's home environments. Consequently, in order to tap verbal WM skills to a greater extent than prior knowledge of linguistic concepts, the content of the COST–Early Spanish consists of common two-syllable food items selected from the MacArthur-Bates Inventarios del Desarrollo de Habilidades Comunicativas (Jackson-Maldonado et al., 2003).

For the COST–Early Spanish, the examiner instructed the child, "Voy a leer unas frases. Pon atención a las comidas que digo. Primero, quiero que me digas si cada frase es verdad, contestando *sí* o *no*. Después, vas a repetir las comidas que se pueden comer" (I am going to read some sentences. Pay attention to the foods that I say. First, I want you to tell me if each sentence is true, answering *yes* or *no*. Then, you will repeat the foods that can be eaten). The examiner presented two practice sets, providing repetition and corrective feedback as necessary to ensure that each child understood the task. No participant had difficulty indicating the truthfulness of the practice items, but some children needed corrective feedback for the recall portion of the task. An example of a set as translated into English was "People eat *potatoes* (yes). People eat *grapes* (yes). People eat *keys* (no). What did I say that people can eat? (*Potatoes* and *grapes*). Children were asked to recall an increasing number of items in each subsequent series. They received one point for each food recalled correctly in that series, with a highest possible raw score of 20.

Finally, to partial out the effects of letter knowledge on PA, children were asked to name written letters. Responses in either language were accepted, with a highest possible raw score of 30.

Interrater Reliability

Twenty percent of the NWR recordings were randomly selected to calculate interrater reliability of scoring. Word-by-word agreement for NWR scoring was 93%. Another 20% of narratives were randomly selected for transcription and coding reliability checks. Point-by-point reliability was 97% for C-unit segmentation, 94% for grammaticality, and 95% for phoneme production.

Procedure

This study was designed to evaluate the direct impact of PA instruction presented in the L1 on ELLs' gains in L1 and L2 and the relationships between vocabulary size, verbal WM, and PA in two languages. To minimize the potential confounds of English vocabulary gains and literacy experience during the study, PA gains were observed over a limited period of time. Therefore, PA gains were evaluated by examining children's performance on the TOPPS and C–TOPP both before (Time 1) and after (Time 2) participants in the experimental group received short-term PA instruction. Children in the control group did not receive supplemental instruction. All sessions were conducted individually within 1 week in August, September, or October in quiet locations within the children's schools.

Description of PA Instruction

After the pretesting phase, each child received two, 25-min sessions of PA instruction in Spanish targeting initial phoneme identification, syllable and phoneme blending, and syllable and phoneme segmentation, which are all skills that have been proven to be developmentally appropriate for Spanish speakers and are related to Spanish literacy outcomes (Carrillo, 1994; Cisero & Royer, 1995; Durgunoglu et al., 1993; Jiménez, 1997; Jiménez & García, 1995; Manrique & Signorini, 1998). The examiner presented a series of activities that gradually increased in difficulty, with most instructional time targeting blending and segmentation skills, which are most closely related to reading and spelling (Ayres, 1995).

Word stimuli were selected based on research examining Spanish speakers' PA development and consideration of Spanish linguistic features (see Gorman & Gillam, 2003, for a review). The complete list of training items presented to each child during the instructional sessions is provided in the online supplemental material (PA training word lists). For example, a variety of words were selected to include all of the consonantal and vocalic phonemes in Spanish, with one exception (i.e., /w/). Because the most prevalent syllable shape in Spanish is CV, stimuli contained primarily CV syllables, with fewer V, CVC, and CCV syllable shapes. Whereas English contains a high frequency of monosyllabic words, Spanish contains predominently polysyllabic words; due to its salience, the syllable appears to be a significant unit of processing for Spanish speakers (Jiménez & García, 1995). Therefore, the majority of training items consisted of two syllables, with some three- and four-syllable words. The order of item presentation increased in difficulty. In the attention through alliteration activity, for instance, words gradually increased in syllable length. In addition, words beginning with continuants (i.e., /m/, /s/) were presented first, as some research indicates that Spanish-speaking children isolate word-initial continuants more easily than stops (Jiménez & García, 1995).

Instructional strategies were based on several principles of effective PA training. The examiner provided explicit instruction to increase children's awareness of sounds in spoken language and of links between spoken and written language (Fuchs et al., 2001). Instruction incorporated oral stimuli, pictures with their corresponding written words, and physical manipulatives (i.e., picture puzzle pieces representing targeted syllables/sounds and pennies representing phonemes) to help children focus and reflect on the tasks (DeFior & Tudela, 1994; Fowler, 1990).

Memory is inherently involved in learning. Given that children must retain sounds and words long enough for task completion, memory is also involved in matching, blending, and segmentation tasks; however, these tasks' memory load is less than other tasks that require more operations, such as phoneme deletion or reversal (Yopp, 1988). Although some evidence shows that memory storage demands are not an important determinant of children's performance on PA tasks (Snowling, Hulme, Smith, & Thomas, 1994), picture stimuli were used during portions of the training to reduce the memory load (Bryant, MacLean, Bradley, & Crossland, 1990).

Due to the nature of the study, contextualization of the tasks was minimal in that training did not include a strand targeting application of PA skills during reading or writing tasks, as would be recommended in a comprehensive intervention (e.g., Vaughn et al., 2006). Rather, orthographic stimuli were incorporated to illustrate the links between sounds and letters, provide visual cues to support children's comprehension of the tasks, and provide feedback. For example, the initial sound matching activity involved having children identify which two words from a set of four contained the same first sound. Picture stimuli were included to support children's ability to direct more of their attention to phonological analysis than to word recall.

Following the phonological analysis of each set, the clinician prompted orthographic analysis, in which the child examined the written words accompanying each picture. They discussed how, in most cases, the two target words sharing the same initial sound also shared the same corresponding first letter. During the beginning portion of word blending training, the clinician modeled the relationship between PA and word reading by moving her finger over each written letter while connecting the sounds to read the complete word. She then requested that the child follow her model for the next word. Similarly, during the beginning portion of segmentation training, the clinician and child pointed to each letter in written words as they pronounced each individual sound. Gradually, the clinician reduced written cues and ceded more responsibility to the child to complete the PA tasks independently.

Each instructional session consisted of the following format: initial sound matching (5 min), blending (10 min), and segmentation (10 min), with the same sequence of activities increasing in difficulty level each day of instruction. A training template was designed and followed to ensure consistency of instruction (see the online supplemental material, Description of instruction). Word stimuli were repeated the second day as time allowed to ensure that all children were exposed to the same stimuli by the end of intervention. It is well known that multiple exposures to stimuli promote the learning of numerous skills, such as vocabulary and word recognition (e.g., National Institute of Child Health and Human Development [NICHD], 2000). Similarly, repetition of PA stimuli provided children with opportunities to use prior feedback and tackle the stimuli more independently, presumably enhancing their learning. Ultimately, children received a minimum of one and a maximum of two exposures to each training word/set.
On the third day, the examiner retested the children. It is important to note that the training words did not replicate any of the test items from the TOPPS or C–TOPP; thus, neither children in the control group nor the experimental group received training or feedback on items that were used to measure outcomes.

Statistical Design

A two-way within-subjects repeated measures multivariate analysis of variance (MANOVA) was computed to analyze the effects of time (Time 1, Time 2) and language (Spanish, English) on the children's scores on the four PA subtests. Correlation and regression analyses were conducted to examine the relationships between vocabulary, WM, and PA in each language. Means and standard deviations for these variables are presented in Table 2.

Results

Impact of L1 Instruction

For the experimental group, there was a significant main effect for time, $F(4, 21) = 14.61$, $p < .01$, $\eta_p^2 = .74$, indicating that PA instruction in Spanish led to a general increase in PA skills across both languages. Cohen's *d* (1988) effect sizes were calculated to evaluate the magnitude of gains, yielding similar, moderate effect sizes of .66 in Spanish and .64 in English. Pairwise comparisons using the Bonferroni adjustment to control for Type I error revealed significant increases ($p < .01$) on all four PA subtests in each language. For the control group, the main effect for time was not significant, $F(4, 6) = .52$, $p = .724$, $\eta_p^2 = .26$, revealing no change in either language from Time 1 to Time 2. This indicates that the gains that were achieved by the experimental group resulted from the PA instruction and not from test familiarity.

To further evaluate the impact of instruction, PA gains in the L1 and L2 were compared. The main effect for language was significant, $F(4, 21) = 6.97$, $p = .001$, $\eta_p^2 = .57$, with higher PA performance in Spanish than English. Interestingly, the interaction between time and language was not significant, $F(4, 21) = .58$, $p = .680$, $\eta_p^2 = .10$, revealing that the differences between Spanish and English gains were insignificant for all four PA subtests. The percentage of overlap of the distributions (Cohen, 1988) was 92.3% ($r^2 = .002$), indicating substantial similarities across the four PA subtests. Effect sizes for Initial Sound Matching, Final Sound Matching, Blending, and Segmenting in Spanish were .39, .43, .75, and .62, respectively, and in English were .44, .28, .80, and .62. These effect sizes suggest moderate blending gains in Spanish, large blending gains in English, moderate segmentation gains in both languages, and small initial and final sound matching gains in both languages.

TABLE 2. Experimental group means and standard deviations for the dependent variables.

	Time 1		Time 2		Gain	
Subtest	*M*	*SD*	*M*	*SD*	*M*	*SD*
Initial Sound Matching						
Spanish	6.56	3.34	7.80	3.04	1.24	2.05
English	5.36	3.60	6.92	3.56	1.56	1.83
Final Sound Matching						
Spanish	3.60	3.65	5.16	3.56	1.56	2.20
English	3.04	3.36	4.04	3.89	1.00	1.61
Blending						
Spanish	4.12	4.21	7.64	5.17	3.52	3.82
English	3.64	3.72	7.04	4.70	3.40	3.44
Segmenting						
Spanish	2.12	4.73	5.48	6.01	3.36	4.02
English	1.84	4.33	4.88	5.38	3.04	3.25
Total						
Spanish	16.40	12.86	26.08	16.10	9.68	7.06
English	13.88	12.00	22.88	16.03	9.00	6.21

Relationships Between Vocabulary, WM, and PA in the L1 and L2

Next, correlation coefficients between vocabulary, WM, and PA gains in each language were computed. Using the Bonferroni approach to control for Type I error across the 21 correlations, a *p* value <.002 (.05/21 = .002) was required for significance. Vocabulary and WM skills were indeed related to PA gains, although the patterns of relationship varied by skill and language (see Table 3). The correlation between the ROWPVT–Spanish and Spanish PA gains ($r = .72$, $p < .001$) was large and statistically significant. The correlation between the ROWPVT–English and English PA gains was moderate ($r = .48$, $p < .05$), but not statistically significant after application of the Bonferroni correction. Interestingly, the correlation between English PA gains and the ROWPVT–Spanish ($r = .56$, $p < .01$) was larger than the correlation between English PA gains and the ROWPVT–English, although this correlation also was not significant.

To evaluate the relationship between total vocabulary and PA gains, raw scores from the ROWPVT–Spanish and ROWPVT–English were added together to obtain the ROWPVT–Total score. The correlation between Spanish PA gains and total vocabulary ($r = .71$, $p < .001$) was very similar to the correlation between Spanish PA gains and Spanish vocabulary ($r = .72$, $p < .001$). In contrast, English PA gains were more highly related to total vocabulary ($r = .68$, $p < .001$) than to either Spanish or English vocabulary alone; moreover, this was the only statistically significant relationship among the three. Relative to memory, there was a large and significant correlation between performance on the COST–Early Spanish and Spanish PA gains ($r = .68$, $p < .001$). NWR performance was strongly and significantly

TABLE 3. Bivariate correlations between major variables, including total vocabulary.

	1	2	3	4	5	6
1. ROWPVT–Spanish	—					
2. ROWPVT–English	.19	—				
3. ROWPVT–Total	.81*	.74*	—			
4. COST–Early Spanish	.61*	.25	.57	—		
5. Nonword repetition	.31	.15	.31	.67*	—	
6. Total Spanish gains	.72*	.35	.71*	.68*	.45	—
7. Total English gains	.56	.48	.68*	.42	.51	.78*

Note. ROWPVT–Total = ROWPVT–Spanish and ROWPVT–English raw scores combined. COST–Early Spanish = Complex Span Task—Early Spanish.

*$p < .002$ (.05/21 = .002).

related to the COST–Early Spanish ($r = .67$, $p < .001$) but was not significantly related to PA gains in either language.

Subsequently, linear regression analyses were conducted to determine how well total vocabulary and WM predicted PA gains. As can be seen in Table 4, all R^2 values of interest were statistically significant. First, the ROWPVT–Total was a large predictor of Spanish PA gains, $R^2 = .50$, adjusted $R^2 = .48$, $F(1, 23) = 23.37$, $p = < .001$. Additionally, the ROWPVT–Total was a large predictor of English PA gains, $R^2 = .46$, adjusted $R^2 = .43$, $F(1, 23) = 19.38$, $p < .001$, predicting twice the amount of variance as English vocabulary alone, $R^2 = .23$, adjusted $R^2 = .20$, $F(1, 23) = 6.849$, $p < .05$. The COST–Early Spanish was a large predictor of Spanish PA gains, $R^2 = .46$, adjusted $R^2 = .44$, $F(1, 23) = 19.89$, $p = < .001$, and a moderate predictor of English gains, $R^2 = .18$, adjusted $R^2 = .14$, $F(1, 23) = 4.92$, $p < .05$. In contrast, NWR performance was a large predictor of English PA gains, $R^2 = .26$, adjusted $R^2 = .22$, $F(1, 23) = 7.86$, $p < .05$, and a moderate predictor of Spanish PA gains, $R^2 = .21$, adjusted $R^2 = .17$, $F(1, 23) = 5.97$, $p = < .05$.

Next, a multiple regression analysis was conducted to determine how well the linear combination of memory, the COST–Early Spanish and NWR measures entered together, predicted PA gains. This linear combination of memory was significantly related to Spanish PA gains, $R^2 = .46$, adjusted $R^2 = .42$, $F(2, 22) = 9.51$, $p = <.01$, but did not predict more variance in Spanish gains than the COST–Early Spanish alone. The linear combination was also significantly related to English PA gains, $R^2 = .27$, adjusted $R^2 = .200$, $F(2, 22) = 4.00$, $p < .05$, but predicted only 1% more variance than NWR alone.

Finally, a series of hierarchical regressions was conducted to compare the predictive power of vocabulary and WM on PA gains. Although not specifically part of the research questions, the well-documented influence of age and letter knowledge on PA warranted inclusion of these variables in the analysis. Age and letter knowledge were entered as the first and second tiers and were held constant. The ROWPVT–Total was entered as a third variable, and the COST–Early Spanish and NWR scores were entered into a fourth tier (see Table 5). Based on the adjusted R^2, the measures of age, letter knowledge, vocabulary, and memory together accounted for 55% of the variance in Spanish PA gains and 51% of the variance in English gains. Because the unique contributions of vocabulary and memory to PA gains were of most interest, the R^2 change was examined when each variable was entered at step 4, after the other three variables were controlled. When entered at step 4, vocabulary accounted for 11% of the variance in Spanish PA gains, and memory accounted for 13%. For English gains, vocabulary accounted for 21% of the variance and memory 11%. Based on these results, memory accounted for slightly more variance in Spanish than English gains. In contrast, vocabulary accounted for much more variance in English than Spanish gains.

Discussion

The two goals of this study were to examine the impact of short-term PA instruction presented in Spanish (L1) on ELLs' gains in both Spanish and English (L2) and the relationships between vocabulary size, WM, and PA in both languages. Overall, results revealed significant PA gains in both languages and complex relationships between these skills that varied by task and language.

Impact of L1 Instruction

Results clearly indicated positive PA gains in both languages of the children in the experimental group. Although several investigations have indicated significant associations between PA skills in ELLs' two languages, to the author's knowledge, PA gains in L2 resulting from a brief period of instruction in L1 have not been documented. Because this was a focused, short-term intervention, English PA gains can be attributed to Spanish PA instruction rather than to increased English proficiency and literacy experience, thereby addressing the methodological concern raised by Manis et al. (2004). According to a meta-analysis conducted by the National Reading Panel (NICHD, 2000), the mean effect size of children's phonemic awareness gains following training ranging from 1 to 4 hr in duration was .61. Analysis of gains in the current study revealed moderate effect sizes of .66 in Spanish and .64 in English, indicating positive results from this training. Although the investigator had anticipated a degree of gains in English, the statistically equivalent gains in both languages were unexpected. Overall, these results provide compelling support for Durgunoglu and colleagues' (1993) assertion that enhancing children's

TABLE 4. Linear regressions of vocabulary and memory as predictors of PA gains.

	Total Spanish gains				Total English gains			
	R^2	*Adj* R^2	$R^2\ \Delta$	*SE*	R^2	*Adj* R^2	$R^2\ \Delta$	*SE*
ROWPVT–Spanish	.52	.50	.52***	5.01				
ROWPVT–English					.23	.20	.23*	5.56
ROWPVT–Total	.50	.48	.50***	5.08	.46	.43	.46***	4.67
COST–Early Spanish	.46	.44	.46***	5.28	.18	.14	.18*	5.75
Nonword repetition	.21	.17	.21*	6.42	.26	.22	.26*	5.57
Memory (linear combination)	.46	.42	.46**	5.40	.27	.20	.27*	5.50

*$p < .05$, **$p < .01$, ***$p < .001$.

TABLE 5. Hierarchical regression analysis with PA gains as dependent variables and age, letter knowledge, vocabulary, and memory as predictors.

	Total Spanish gains				Total English gains			
Steps 1–4	R^2	Adj R^2	R^2 Δ	*SE*	R^2	Adj R^2	R^2 Δ	*SE*
1. Age	.03	–.01	.03	7.10	.02	–.02	.02	6.28
2. Memory	.47	.40	.44**	5.49	.27	.16	.25*	5.68
3. Vocabulary	.63	.56	.16**	4.70	.60	.52	.33**	4.32
4. Letter Knowledge	.64	.55	.01	4.76	.61	.51	.02	4.33
2. Letter Knowledge	.20	.13	.17*	6.60	.27	.20	.25*	5.56
3. Memory	.54	.44	.34**	5.27	.40	.28	.06	5.26
4. Vocabulary	.64	.55	.11*	4.76	.61	.51	.21**	4.33
2. Vocabulary	.50	.46	.48**	5.19	.46	.41	.44**	4.77
3. Letter Knowledge	.52	.45	.01	5.25	.51	.44	.05	4.66
4. Memory	.64	.55	.13	4.76	.61	.51	.11	4.33

*$p < .05$, **$p < .01$.

PA skills in the native language also benefits their skills in English.

Relationships Between Vocabulary, WM, and PA in L1 and L2

As discussed previously, numerous studies, though not all, have suggested that vocabulary size and WM are among the critical factors that contribute to PA development in English speakers. The current study, which was conducted to address the critical need for increased understanding of development in Spanish-speaking ELLs, appears to provide supportive evidence for the roles of vocabulary and WM in PA development.

Relative to vocabulary, the most remarkable finding was the nonsignificant relationship between children's English PA gains and their English vocabulary size. Recall that several scholars have proposed that expansion in vocabulary size stimulates phonological segmentation and restructuring of the lexicon (e.g., Fowler, 1991), possibly on a word-by-word basis, such that more familiar and early acquired words should be easier than other words to analyze during PA tasks (Metsala & Walley, 1998). In line with these theories, participants displayed higher PA skills in their L1 than L2, and Spanish vocabulary and Spanish PA gains were significantly and highly correlated. However, English PA gains were more highly correlated with Spanish vocabulary than English vocabulary, which is consistent with Anthony et al.'s findings (2009). In terms of bilingual lexical development, these results also support Grosjean's (1982) assertion that the two languages of bilinguals are not autonomous. Moreover, PA gains in Spanish and English were surprisingly equivalent despite differences in vocabulary size, word familiarity, and age of acquisition between the two languages. Together, these findings suggest that phonological restructuring of English words in Spanish-speaking ELLs' lexicon is not a prerequisite for successful PA performance in English. Thus, restructuring may not be a driving factor of their PA development in English, as it may be in their L1. Instead, English PA gains were most strongly related to total vocabulary size.

The finding that total vocabulary predicted 46% of the variance in English PA gains and 50% of the variance in Spanish PA gains would support the view that development in and restructuring of the combined L1 and L2 lexicon contributes to children's overall PA development. When L2 words are relatively unfamiliar, ELLs may access phonological templates of L1 words stored in long-term memory and transfer this phonological knowledge to support PA performance on these words. Indeed, these results support the view that a central, more general cognitive mechanism or metalinguistic ability underlies PA in both languages (Cisero & Royer, 1995; Cummins, 1980; Durgunoglu et al., 1993; Leafstedt & Gerber, 2005; Lindsey, Manis, & Bailey, 2003).

Similar to vocabulary, WM was also significantly related to PA change, with patterns of association varying by task and language. Specifically, the COST–Early Spanish was a strong predictor (46%) of Spanish PA gains and a moderate predictor (18%) of English PA gains, and NWR was a strong predictor (26%) of English gains and a moderate predictor (21%) of Spanish gains. There are two issues inherent in these findings that compelled some explanatory hypotheses. First, why were the relationships between PA and NWR greater in English than Spanish? Although these results may not be surprising, they merit an explanation. Second, why did the complex memory task predict more variance in Spanish PA than English PA?

With respect to the first question, it is useful to recall that the participants displayed more developed language skills in Spanish than English. It is probable that words on the English C–TOPP were less familiar than Spanish words on the TOPPS, and even that various English stimuli were unfamiliar to some children, similar to nonwords. Therefore, there would conceivably be less developed or no prior neural representation of English stimuli. It is possible that phonological analysis of new or less familiar words places greater demands on the storage and rehearsal processes of WM; therefore, what may be considered simpler phonological storage tasks, such as NWR, may better predict ELLs' PA performance on new or less familiar words, such as words in their L2. In contrast, the more familiar Spanish words may be conceived as having more elaborate neural representation at phonological, lexical, and semantic levels. As words become more familiar with more elaborate neural representation, metalinguistic analysis and the ability to limit the scope of attention to analyze the phonological level of words may place greater demands on both the central executive and phonological loop components of WM. As a result, memory tasks that tap simultaneous processing and storage processes, such as the COST–Early Spanish, may better predict PA performance on more familiar words, such as words in the L1. Further exploration of these hypotheses is warranted.

Examining the two measures together, the linear combination of the COST–Early Spanish and NWR strongly predicted PA change in both Spanish and English, accounting for 46% and 27%, respectively, of the variance in gain scores. Results from the current study corroborate the view that it is important to include tasks that tap both complex processing and simple storage components when evaluating WM skills (Daneman & Carpenter, 1980; Leather & Henry, 1994; Oakhill & Kyle, 2000). In addition, it appears that the experimental COST–Early Spanish measure was relatively effective in tapping the complex processing component of verbal WM in Spanish-speaking prereaders.

Finally, the comparison of the power of vocabulary and memory to predict PA gains in each language yielded intriguing results. After controlling the effects of age and letter knowledge, total vocabulary predicted nearly twice the amount of variance in English gains (21%) than Spanish gains (11%). In contrast, the memory composite accounted for similar amounts of variance in Spanish and English gains (13% and 11%, respectively). In their research with English speakers, Gathercole et al. (1992) proposed that relationships between language, memory, and PA may vary at different stages of development. In the current study with ELLs, total vocabulary and phonological storage skills (presumably tapped by NWR) were stronger predictors of English gains than Spanish gains. Spanish gains were more strongly predicted by simultaneous processing and storage skills (presumably tapped by the COST–Early Spanish) than storage skills alone. Considering that children in the current study were in earlier stages of lexical and phonological development in English than Spanish, these results would appear to support Gathercole et al.'s view that relationships between these variables vary by developmental stage. Overall, results from the current study clearly reflect the natural entanglement of vocabulary, WM, and PA. Consequently, although not the only factors involved, this evidence supports Gupta and Tisdale's (2009) proposal that models of PA development require both memory and lexical components.

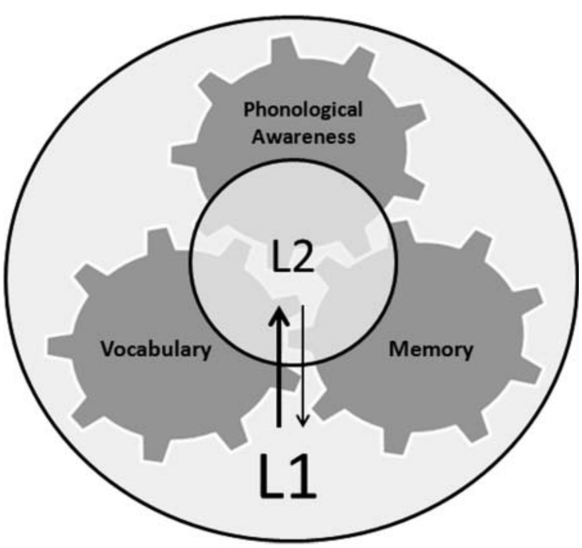
Limitations and Future Directions

There are limitations in measuring and comparing skills in different languages. Measurement of vocabulary knowledge in each language is challenging due to numerous factors, such as differences in word frequency and the various contexts in which bilinguals are exposed to each language (Peña & Kester, 2004). The authors of the TOPPS selected words that are common in Spanish with features that correspond as closely as possible to English words on the C–TOPP, but due to phonological differences between the languages, perfect matches were difficult to achieve (Malabonga et al., 2002). Evaluation of vocabulary and verbal WM in isolation also presents a significant challenge. Performance on nearly any verbal WM task will likely be influenced by linguistic knowledge to an extent. The COST–Early Spanish was designed to tap storage and processing components of WM to a greater extent than prior knowledge of linguistic concepts, but vocabulary is still embedded in the task, and a strong correlation between the two variables was observed. Similarly, NWR tasks are intended to reflect phonological storage skills rather than long-term vocabulary knowledge, yet as discussed previously, there is a bidirectional relationship between these skills. In addition, continued investigation to increase the psychometric properties of WM assessments for Spanish speakers, including the COST–Early Spanish, is necessary. The TOPPS is the most extensively researched test to date, yet validation data are pending. Some of its NWR stimuli rhyme with or contain syllables that correspond to real Spanish words, which may obscure the unique contributions of short-term memory processes and long-term lexical knowledge. Modifications to reduce wordlikeness of stimulus items may be warranted. Finally, sequential bilingual learners in the early stages of both reading and learning English were chosen to participate in the present study. Given the vast heterogeneity of bilinguals, inclusion of participants with varying linguistic profiles would broaden the scope of this research.

Clinical Implications

Although it is evident that there is limited research to guide best practices for PA intervention with children learning two languages, results from the present study offer important insights for clinical practice. Based on the current knowledge base, a model of PA assessment and intervention for young ELLs is proposed in Figure 1.

FIGURE 1. Model of phonological awareness development in English language learners.



First, the model illustrates the well-documented interrelationships between skills in the L1 and L2, as results from this study have also supported. Results indicated direct and equivalent PA gains in both the treated and untreated language, supporting the benefits of L1 instruction. Nevertheless, there are important differences between Spanish and English phonological systems related to phonemes, phonotactic constraints, syllable structures, and word length. Because of these differences, the author concurs with Leafstedt and Gerber (2005), who suggested that bilingual instruction may ultimately yield the best results for children who are learning to read in two languages. Given the interdependence of the languages, it is conceivable that instruction in the L2 may also lead to gains in the L1, as depicted in the model. However, PA tasks often involve new terminology (e.g., sounds in words, syllables, first, last, same, different) such that many ELLs in the early stages of L2 acquisition will better grasp the concepts when the language of instruction is L1. Therefore, initial instruction in L1 is recommended for these children. If English is used in the classroom, the clinician may gradually incorporate English instruction during a portion of the session or alternating intervals as children's task comprehension increases.

Relative to incorporation of English word stimuli into intervention, data from the current study do not suggest an ideal timeline. However, because English proficiency was not a prerequisite for successful PA performance on English words, clinical decisions regarding this particular timeline need not be based on children's English proficiency. Given that both total vocabulary and memory predicted children's gains, clinicians may find that children with stronger total vocabulary and/or WM skills will be successful with English stimuli earlier than will children with weaker skills. Ultimately, clinicians will need to carefully monitor individual children's response to instruction and make modifications as needed.

Next, the model depicts the significant interrelationships between vocabulary, WM, and PA. Based on cumulative evidence supporting their contributions, it is recommended that clinicians include vocabulary and memory in a comprehensive PA assessment and intervention protocol. Numerous tools for evaluating the skills of Spanish-speaking preschoolers and kindergartners are available to clinicians, including most of the assessments that were administered in the current study (i.e., C–TOPP, ROWPVT–SBE, SALT, COST–Early Spanish). Other commercially available tests include the Test of Phonological Awareness in Spanish (Riccio, Imhoff, Hasbrouck, & Davis, 2004); the Spanish and English versions of the MacArthur-Bates Communicative Development Inventories (Fensen et al., 2007; Jackson-Maldonado et al., 2003), which are used to evaluate vocabulary skills in infants, toddlers, or older children with developmental delays; and the Spanish and English versions of the Clinical Evaluation of Language Fundamentals (Semel, Wiig, & Secord, 2003, 2006), which include WM and PA subtests. Additional NWR measures referred to earlier include those published by Ebert et al. (2008) and by Gutiérrez-Clellen and Simón-Cerejido (2010).

In terms of intervention, it is recommended that clinicians employ an integrated approach that considers the interrelationships between vocabulary, WM, and PA. In addition, empirically supported literacy interventions for young readers integrate skills through balanced approaches that combine explicit teaching and contextualized practice during reading and writing tasks (Mathes et al., 2007; Vaughn et al., 2006). For prereaders, such a balanced approach that includes contextualized practice at a developmentally appropriate level is also recommended. Relative to enhancing children's memory skills, a growing body of research indicates positive effects of computerized memory training, such as programs for preschoolers that target attention and recall (Thorell, Lindqvist, Nutley, Bohlin, & Klingberg, 2009) and programs for school-age children that teach memory strategies including rehearsal, visual imagery, story creation, and grouping (St. Clair-Thompson, Stevens, Hunt, & Bolder, 2010). Although further research on the effects of programs specifically designed to enhance memory is needed, clinicians may consider promoting children's use of computerized training programs in intervention, their classrooms, or at home. Computer programs that target both PA and recall may also be considered, as positive effects on children's PA skills have been reported (e.g., Gillam et al., 2008). In addition, Gillam and van Kleeck (1996) found that children who received PA intervention demonstrated enhanced PA and NWR performance. Therefore, clinicians may find that PA training simultaneously benefits children's memory skills.

Relative to vocabulary, it is well known that vocabulary knowledge supports children's word decoding and reading comprehension. Moreover, even before children read, strong vocabulary skills appear to promote children's PA development. Consequently, total vocabulary development is a high priority for early assessment, intervention, and prevention efforts. It is recommended that clinicians target sophisticated, high-frequency words (Tier 2) and monitor children's knowledge of concrete words (Tier 1), which they generally learn incidentally (Beck, McKeown, & Kucan, 2002). Effective instruction requires a variety of methods to enhance both the breadth and depth of vocabulary knowledge (NICHD, 2000). To achieve this, August, Carlo, Dressler, and Snow (2005) recommended several instructional strategies for enhancing ELLs' vocabulary development, including reviewing and reinforcing new words through read-alouds, story retells, word books, story maps, narration, and dramatization. In addition, clinicians can also promote children's awareness of cognates in their two languages, use computer technology to reinforce vocabulary and academic language, and share vocabulary activities with families for use at home. Finally, clinicians should provide accurate information to families about the benefits of supporting their children's language and literacy development in the home language and share effective ways in which they can foster these skills.

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Appendix

Complex Span Task—Early Spanish

			Correct	# Foods	
1a	La gente come huevos.* (*eggs*) (sí o no?)	Sí	1	0	
	La gente come carros. (*cars*)	No	1	0	
	¿Qué he dicho que se puede comer?				/1
1b	La gente come tacos.* (*tacos*)	Sí	1	0	
	La gente come botas. (*boots*)	No	1	0	
	¿Qué he dicho que se puede comer?				/1
2a	La gente come papas.* (*potatoes*)	Sí	1	0	
	La gente come uvas.* (*grapes*)	Sí	1	0	
	La gente come llaves. (*keys*)	No	1	0	
	¿Qué he dicho que se puede comer?				/2
2b	La gente come jamón.* (*ham*)	Sí	1	0	
	La gente come dulces. (*candy*)	Sí	1	0	
	La gente come velas. (*candles*)	No	1	0	
	¿Qué he dicho que se puede comer?				/2
3a	La gente come carne.* (*meat*)	Sí	1	0	
	La gente come queso.* (*cheese*)	Sí	1	0	
	La gente come arroz.* (*rice*)	Sí	1	0	
	La gente come mesas. (*tables*)	No	1	0	
	¿Qué he dicho que se puede comer?				/3
3b	La gente come fresas.* (strawberries)	Sí	1	0	
	La gente come pastel.* (cake)	Sí	1	0	
	La gente come sopa.*(soup)	Sí	1	0	
	La gente come fotos. (photos)	No	1	0	
	¿Qué he dicho que se puede comer?				/3
4a	La gente come cereal.* (cereal)	Sí	1	0	
	La gente come melón.* (melon)	Sí	1	0	
	La gente come pollo.* (chicken)	Sí	1	0	
	La gente come salsa.* (salsa)	Sí	1	0	
	La gente come libros. (books)	No	1	0	
	¿Qué he dicho que se puede comer?				/4
4b	La gente come chile.* (chili pepper)	Sí	1	0	
	La gente come yogurt.* (yogurt)	Sí	1	0	
	La gente come pizza.* (pizza)	Sí	1	0	
	La gente come limón.* (lime/lemon)	Sí	1	0	
	La gente come camas. (beds)	No	1	0	
	¿Qué he dicho que se puede comer?				/4
		Total			/20

Note. English translations of target foods and foils are in parentheses.