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Semantic deficits in Spanish-English bilingual children with language impairment

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Abstract

Purpose—To examine the nature and extent of semantic deficits in bilingual children with language impairment (LI).

Method—Thirty-seven Spanish-English bilingual children with LI (age 7;0 to 9;10) and 37 typically-developing (TD) age-matched peers generated three associations to 12 pairs of translation equivalents in English and Spanish. Responses were coded as paradigmatic (e.g., *dinner – lunch*, *cena – desayuno* [*dinner – breakfast*]), syntagmatic (e.g., *delicious – pizza*, *delicioso – frijoles* [*delicious – beans*]), and errors (e.g., *wearing – where*, *vestirse – mal* [*to get dressed – bad*]). A semantic depth score was derived in each language and conceptually by combining children's performance in both languages.

Results—The LI group achieved significantly lower semantic depth scores than the TD group after controlling for group differences in vocabulary size. Children showed higher conceptual scores than single-language scores. Both groups showed decreases in semantic depth scores across multiple elicitations. Analyses of individual performances indicated that semantic deficits (1SD below the TD mean semantic depth score) were manifested in 65% of the children with LI and 14% of the TD children.

Conclusion—School-age bilingual children with and without LI demonstrated spreading activation of semantic networks. Consistent with the literature on monolingual children with LI, sparsely linked semantic networks characterize a considerable proportion of bilingual children with LI.

Keywords

language impairment; bilingual; Spanish-English; semantic network; spreading activation

Research on language impairment in bilingual children has grown rapidly in recent years. Parallel to research on monolingual children who have language impairment, studies have aimed to identify phenotypic markers of language impairment among bilingual populations. Specific types of morphosyntactic knowledge (Gutiérrez-Clellen, & Simon-Cereijido, 2007; Gutiérrez-Clellen, Simon-Cereijido, & Wagner, 2008; Jacobson & Schwartz, 2002; Paradis, 2010; Restrepo & Kruth, 2000) and phonological memory (Girbau & Schwartz, 2008;

Windsor, Kohnert, Lobitz, Pham, 2010) have both been implicated as behavioral markers of language impairment among bilingual children. In comparison, the interface of language impairment and bilingual semantic development has been largely neglected. The present study aims to remedy this gap in our knowledge by examining the effects of language impairment on the development of semantic knowledge in Spanish-English bilingual children. Guided by a spreading activation model of semantic processing, we used a repeated word association task to quantify the semantic knowledge and deficits exhibited by bilingual children with language impairment in comparison to their typically developing bilingual peers for a set of low-frequency academic vocabulary. In addition, we investigated the extent of individual variability in semantic development among bilingual children.

The Repeated Word Association Task

The word association task has been widely used in both first language (e.g., Cronin, 2002; Entwisle, 1966; Nelson, 1977) and second language (e.g., Fitzpatrick, 2009; Schmitt, 1998; Schoonen & Verhallen, 2008) acquisition research to examine representation and organization of semantic knowledge. Cronin (2002) and Entwisle (1966) both used a discrete word association task with English-speaking children of various ages. Children responded with one association to each of a list of words. Several developmental changes are notable. Preschoolers are highly likely to produce sound-based or phonologically related responses (e.g., *cold – old*, *dog – log*), unrelated responses (e.g., *cold – sit*, *dog – five*), or no response. Around age 5, many children respond with a word that follows the stimulus in a syntactic sequence (e.g., *cold – outside*; *dog – bark*). By age 9, many children respond with a word from the same word class or paradigm (e.g., *cold – hot*; *dog – cat*). These latter two types of responses were consequently termed *syntagmatic* and *paradigmatic* and this developmental change the *syntagmatic-paradigmatic shift* (Entwisle, 1966; Nelson, 1977).

In a recent investigation with typically developing Mandarin-English bilingual children, Sheng, McGregor, and Marian (2006) used a repeated word association task and asked children (aged 5 to 8) to produce three associations to each of a set of high-frequency, early-acquired words. In the first elicitation, children produced a comparable number of paradigmatic and syntagmatic responses. However, at the second and third elicitations, paradigmatic responses decreased and syntagmatic responses increased and far exceeded the former in number. These relative changes in response types are indicative of an emerging paradigmatic organization principle among these children. In the present study, we extend this task to the study of Spanish-English bilingual children with language impairment.

Semantic Development in Monolingual Children with Language Impairment

Language impairment (LI) negatively affects semantic processing. Sheng and McGregor (2010a) investigated the organization of the semantic networks in 5- to 8-year-old English-speaking children with and without specific language impairment (SLI). Children generated three associations to each of 48 stimulus words. Word associations were coded as semantic (with paradigmatic and syntagmatic responses combined) (e.g., *chair – table*, *sit*), phonological (e.g., *chair – hair*), or unrelated (e.g., *chair – run*). In comparison to typically-developing age peers, the children with SLI produced fewer semantic responses, more

phonological responses, and more errors. In comparison to younger expressive vocabulary-matched peers, significantly fewer semantic responses and more errors in the children with SLI were found in analyses over items, but not participants. These results indicate that as a group, children with SLI demonstrate immaturities in semantic representations that are generally in line with their delays in vocabulary size; however, certain individuals with SLI may have extraordinary difficulties with semantic representation that go beyond their vocabulary delays. In addition to the finding of overall fewer semantic associations, the SLI group differed from both age peers and vocabulary peers in response patterns across the three elicitation trials. Specifically, across the three trials, the SLI group showed a stable rate of semantic responses whereas the two typically developing groups showed a decrease of these responses.

These patterns can be explained by the spreading activation model of semantic processing (Collins & Loftus, 1975). In this model, semantic memory is construed as a network wherein different words are represented as nodes linked to other nodes that share semantic relationships. A mature and efficient semantic network consists of many links between nodes and the strength of the links varies depending on the degree of meaning overlap between words and frequency of co-occurrence of words. The spread of activation in a mature semantic network is initially strong but gradually diminishes as it propagates through the network. This change in activation strength was labeled the rippling effect (Nevid, 2009, p.215). In Sheng and McGregor (2010a), the association patterns of the two typically developing groups exhibited traits of a mature semantic network. In contrast, the SLI group's performance profiles suggested that these children had fewer and less robust links in their semantic network. Because semantic links were tenuous, hearing a word did not automatically create a rippling effect that sent spreading activation from the stimulus to other semantically related words. Instead, children with SLI resorted more to sound properties of the stimuli or produced more unrelated responses.

Research on naming errors provides converging evidence on semantic weaknesses in children with SLI (e.g., McGregor, 1997; McGregor, Newman, Reilly & Capone, 2002; Sheng & McGregor, 2010b). These studies reveal that not only do children with SLI make more picture naming errors, the distribution of their errors also differs from their peers. Although semantic errors are the most predominant error type for all children, compared to age peers, children with SLI make *proportionally* fewer semantically related errors and more unrelated and uninformative (don't know) errors. These results are indicative of less elaborated semantic representation and fewer links to semantically related words.

Despite findings of overall delays in semantic network development, great individual variations exist in children with SLI. For instance, using the mean proportion of semantic responses of the younger expressive-vocabulary matched peers as the cutoff, Sheng and McGregor (2010a) found that 8 of the 14 children in the SLI group (57%) scored below this value and were hence categorized as poor responders. Applying the same criterion, 7 of the 28 TD children (25%) also fell into this category. Similar results of individual differences can be found in a series of studies on word learning, in which preschoolers with SLI were trained to comprehend and produce a set of novel words in a supported learning context (Gray, 2003, 2004; Kiernan & Gray, 1998). In Kiernan and Gray (1998), only a minority

(27%) of the children with SLI performed below normal limits on the number of words learned. In Gray (2003), 53% of the children with SLI demonstrated poor word comprehension and 77% showed poor word production. Among the typically developing peers, 7% showed poor word comprehension and 10% showed poor word production. Finally, in Gray (2004), 70% of the children with SLI and 5% of the typically developing children learned fewer words than age norms. Although factors that predict word learning success are still unclear, these findings suggest that children with SLI are a heterogeneous group (Bishop, 2006) and that lexical-semantic deficits characterize a considerable proportion, but not all children diagnosed with LI.

Semantic Development in Bilingual Children with LI

How does LI affect semantic development in bilingual children? Emerging literature indicates that bilingual children with LI, like their monolingual counterparts (Gray, 2004; Munro, 2007; Nash & Donaldson, 2005), show difficulties with learning new words. For instance, Peña, Iglesias, and Lidz (2001) found that Spanish-English bilingual children with typical language made significant gains on a single-word labeling task after a short-term mediated learning experience, whereas the bilingual children with low language abilities made virtually no gains from pretest to posttest despite having participated in the same intervention. Similarly, in a detailed case study of one Spanish-English bilingual child with LI, Restrepo and Kruth (2000) reported difficulty acquiring both Spanish and English vocabulary, resulting in limited overall vocabulary knowledge and subsequent repetition of kindergarten.

Consistent with studies of monolingual children with LI (Marinellie & Johnson, 2002; McGregor et al., 2002), bilingual children with LI also demonstrate weak semantic representations and difficulties with word meanings. Gutiérrez-Clellen and DeCurtis (1999) investigated the quality of definitions produced by Spanish-English bilingual children with and without LI. The children with LI used non-specific vocabulary, provided infrequent elaborations, and were unable to account for multiple and/or colloquial word meanings (e.g. *burro* as a donkey and a person with little knowledge). Also using a word definition task, Fiestas, Peña, Bedore, and Sheng (in preparation) found that Spanish-English bilingual children with LI had particular difficulties providing category labels and describing functions of objects nouns.

Although the existing literature on semantic performance of bilingual children with LI is limited there are many similarities between monolingual and bilingual children with LI. Both groups showed deficits in lexical learning and semantic representation. These similarities suggest that semantic network organization would also be vulnerable among bilingual children with LI. The present study was designed to test this hypothesis.

The Current Study

The purpose of this study was to examine the status of semantic network development in a group of bilingual children from the general LI population, that is, those selected without reference to vocabulary deficits. The specific questions were:

1. Do bilingual children with LI have deficits in the number and accessibility of semantic links? If so, what is the extent of these deficits? Are these deficits commensurate with their general delays in vocabulary? Do these deficits affect all bilingual children with LI?
2. What is the developmental profile of the bilingual children's first language (L1), second language (L2), and combined semantic systems?
3. What individual and environmental factors are related to semantic development?
4. What is the relationship between adult proficiency rating and children's semantic task performance?

With regard to the first question, we hypothesized that as a group, bilingual children with LI would exhibit more sparsely linked semantic networks. Specifically, we predicted that when called to provide word associations, these children may produce more immature responses that were sound-based (e.g., *eating – beating*), unrelated (e.g., *furry – moon*), or uninformative (don't know) and fewer mature responses that are paradigmatically (e.g., *dinner – lunch*) or syntagmatically related to the stimuli (e.g., *dinner – eat*). However, because children with LI are likely to have smaller vocabulary than their typical peers (Kohnert & Medina, 2009) and given the symbiotic relationship between vocabulary size and semantic depth (Vermeer, 2001), it is important to determine whether or not the semantic deficits in bilingual children with LI are simply a reflection of their smaller vocabulary or extend beyond their general delays in vocabulary. To answer this question, we obtained a measure of lexical diversity – number of different words (NDW) in narrative discourse, and used it as a covariate to partial out the effect of inadequate vocabulary size on semantic depth. In regard to the accessibility of semantic links, a previous study found that unlike typical peers, monolingual children with SLI whose mean age was 7 years 2 months did not show the expected rippling effect (i.e., an initial peak level of semantic responses followed by a decrease of such responses over multiple elicitations), suggesting difficulties accessing existing semantic links. However, because the participants in the current study were on average 14 months older, it remained possible that these older children with LI would show the anticipated rippling effect characteristic of more mature semantic networks. Finally, in light of findings of large individual variability in lexical-semantic learning among the LI population (Gray, 2003, 2004; Sheng & McGregor, 2010a), we predicted that impaired semantic performance would be manifested in some but not all children with LI.

Our second question pertained to the relative status of the bilingual's L1, L2, and combined semantic-conceptual system. It is widely accepted that lexical-semantic knowledge is distributed across a bilingual's two languages (e.g., Patterson, 1998; Pearson, Fernández, & Oller, 1993, 1995; Peña, Bedore, & Zlatić-Giunta, 2002). Thus, we predicted that a combined semantic performance score would be higher than either single-language score. Given the critical role of experience in lexical-semantic learning (Capone & Sheng, 2010; Pearson & Fernández, 1994; Vermeer, 2001), we predicted that bilingual children would show higher performance in the language with which they have had more cumulative experience. This question is also of practical interest because it can shed light on the sensitivity of different scoring methods in uncovering semantic deficits among bilingual children with LI. We predicted that a combined conceptual scoring approach would be the

most sensitive in capturing semantic delays in bilingual children with LI because this approach accounted for the highest level of development unconfounded by experiential factors associated with single-language scoring.

To answer the third question, we investigated the relationship between individual variables, such as age and age of onset of English exposure, environmental variables, such as family SES and percent of current language use, and performance on the semantic task. These factors were of interest because they were found to predict lexical-semantic growth in previous studies (Cronin, 2002; Entwisle, 1966; Golberg, Paradis, & Crago, 2008).

To address the last question, we examined the strength of relationship between adult (parent and teacher) ratings of general language proficiency and performance on the semantic task. The lack of assessment tools for bilingual populations often necessitates the use of adult concern or adult proficiency rating as converging evidence for diagnosis (Bedore, Peña, Joyner, & Macken, in press; Gutiérrez-Clellen & Kreiter, 2003; Restrepo, 1998; Sheng, Lu, & Kan, 2011). Answer to this question can provide insights regarding the value of adult proficiency rating in diagnosing semantic deficits bilingual children with LI.

Method

Participants

Participants were 74 bilingual Spanish-English children between the ages of 7;0 (years; months) and 9;11 (37 children with LI and 37 age- and language-matched children with typical development). The children were selected from a group of 280 children that were part of a larger, ongoing study of bilingual (English-Spanish) semantic and syntactic development and impairment using a battery of tasks. All children were of Hispanic ethnicity. They were recruited from school districts in the Austin, TX and Denver, CO metropolitan areas that served large number of Hispanic students. Children were invited to participate in the study if they spoke Spanish and English. Results for developmental differences in semantic depth among typically developing children are reported in Sheng, Bedore, Peña, and Fiestas (in review).

All children's parents were interviewed by phone to obtain information about their children's use of Spanish and English and to inquire if they had concerns about their children's language skills. The interview form is part of the Bilingual English Spanish Assessment - Middle Elementary (BESA-ME; Peña, Bedore, Gutiérrez-Clellen, Iglesias, & Goldstein, in development). We also asked about the parent's education history and current job status to obtain information about SES. Based on Hollingshead (1975), education was scored from 0 through 7 (where 0 = no formal education, 4 = high school graduate, and 7 = graduate degree); occupation was scored from 0 to 9 (0 = unemployed, 4 = skilled worker, 9 = professionals, executives). We additionally consulted Hauser and Warren (1996) to score occupations not included in the Hollingshead index. To obtain the family SES score, the education score was multiplied by 3 and the occupation score multiplied by 5. The two scores were added together and mother and father scores were averaged to obtain the family SES score. In cases where the child lived with one parent, only that parent's data were used. For mother occupation the mode score was 0 (stay-at-home mom); mother education mode

was 4 (high school level education); father occupation mode was 2, restaurant and construction worker were reported the most under this descriptor; father education mode was 4 which indicated high school education.

To determine the age of first exposure to English we asked parents to indicate on a year by year basis if children used English, Spanish, or both. To determine current use of Spanish and English we asked parents to indicate on an hour-by-hour basis the language the child heard and spoke on a typical week day and on a typical weekend day. These were combined in a weighted average that served as an indicator of current input and output. The children's teachers were also asked to complete a comparable questionnaire. They provided data about the use of Spanish and English in the classroom on an hour by hour basis. Data from parent and teacher report were combined to capture a fuller account of the children's current use and are included in Table 1 along with data on the children's age of first English exposure and SES.

We used a combination of parent and teacher ratings of language proficiency, parent and teacher concern, clinician concern, grammaticality calculations from language samples and current enrollment in speech and language services to determine the children's language status.

Parents and teachers each rated the children's language proficiency across languages (Spanish and English) and domains (comprehension, speech, sentence length, grammatical ability, and vocabulary) on a five-point-scale (1 = low proficiency; 5 = high proficiency) (see Table 1). If an individual child's average rating was more than 1 standard deviation below the mean for the participant pool the score was interpreted as indicating possible language impairment. In addition parents and teachers were asked if they had concerns about the child's language development. A certified speech language pathologist reviewed the interview transcripts and categorized concerns into valid and invalid indicators of concern about language impairment. Examples of valid and invalid concerns are listed in Appendix A. Other sources of information used to classify children were clinician concern (based on difficulties at the time of testing) and grammaticality in narrative discourse (less than 80% grammatical utterances for the narrative samples in both languages). There was converging concern for 37 of the 280 children tested and they were placed in the language-impaired (LI) group. Thirty-five of the 37 children identified were enrolled in speech and language therapy in their schools. The remaining two children were not enrolled in therapy but they met the following 3 criteria: 1) received a parent proficiency rating below one standard deviation of the LI group average (based on scores from the 35 children who had a diagnosis of speech language disorder) in both languages; 2) had a valid concern from both a parent and a teacher; and 3) had a grammaticality score of less than 80% in both languages.

Each child in the LI group was matched pair-wise to a typically-developing (TD) peer on age (within 4 months), language dominance (within 12% based on percent of English/Spanish use), and age of English onset (within one year; there were three exceptions: two pairs were matched within two years and one within 3 years. These pairs were all sequential bilinguals). To be identified as TD, a child must either 1) not be in services and have neither teacher nor parent concern; or 2) be identified as LI by the school, but have neither teacher,

nor parent nor clinician concern and have a > 80% grammaticality score for language samples in one or both languages. All 74 children additionally met the following exclusionary criteria: 1) did not have a neurological impairment; 2) did not have a hearing impairment; and 3) did not have an autism spectrum disorder.

T-tests indicated that the two groups were equivalent in age, $t(72) = .17, p = .87$; percent of English and Spanish language use, $t(72) = .07, p = .94$; SES, $t(72) = .28, p = .78$, age of first English exposure, $t(72) = .32, p = .75$, and grade level, $t(70) = .36, p = .72$. The TD group received higher parental ratings than the LI group on both English proficiency, $t(67) = 4.83, p < .001, d = 1.16$, and Spanish proficiency, $t(72) = 4.64, p < .001, d = 1.08$ (see Table 1 for means). The TD group also received higher teacher rating of both English, $t(71) = 5.47, p < .001, d = 1.28$, and Spanish proficiency $t(64) = 8.06, p < .001, d = 1.99$. Finally, we obtained number of different word (NDW) values collected from the Test of Narrative Language (Gillam & Pearson, 2004) and comparable stories developed for Spanish based on the Test of Narrative Language elicitation procedure to index vocabulary knowledge. The TD group had higher NDW than the LI group in both English, $t(72) = 4.26, p < .001, d = .99$ and Spanish, $t(72) = 4.59, p < .001, d = 1.08$. The LI group produced a higher NDW in Spanish than English, $t(36) = 3.29, p = .003, d = .33$; however, NDW was not significantly different between the two languages for the TD group, $t(34) = 1.62, p = .11$.

Stimuli

The stimuli were 12 pairs of Spanish and English translation equivalents belonging to the adjective (*delicious* [*delicioso*], *frozen* [*congelado*], *furry* [*peludo*], *nutritious* [*nutritivo*]), noun (*dinner* [*cena*], *forest* [*bosque*], *summer* [*verano*], *soup* [*sopa*]), and verb (*eat* [*comer*], *growl* [*gruñir*], *stretch* [*estirar*], *wear* [*vestirse*]) classes. All the words were curriculum targets according to the Texas Department of Education grades 1 to 3 curriculum guidelines. The words were selected from familiar themes such as animal, food, weather, and exercising. The words' frequency of occurrence in academic contexts was obtained from the *Corpus of Contemporary American English* (Davies, 2008) and *Corpus Del Español* (Davies, 2002) and listed in Table 2.

Procedures

Children participated in the Spanish and English versions of the repeated word association task on two different days with order of test language counterbalanced. The examiners included bilingual speech-language pathologists and trained graduate students in SLP who were proficient bilinguals. Testing took place in a quiet space at the children's schools. The stimuli were semi-randomized such that words belonging to the same theme (e.g., *eating* and *dinner*) did not occur consecutively. Words were randomized respectively in English and in Spanish and presented in the same order across children. The English verbs were presented in the present progressive form and the Spanish verbs were presented in the infinitive form. A short practice was given at the beginning to familiarize the children with the task. During practice, children were instructed to respond with a word that goes with the target (i.e., *car* [*carro*], *run* [*correr*]). The examiner repeated the target word twice to elicit a total of three consecutive responses. The examiner also used finger counting to cue the child for three different responses. During practice, if the child responded with a syntagmatic association

(e.g., *car-drive* [*carro-manejar*]), the examiner reinforced the child's response and offered a model of a paradigmatic response by saying “*Yes, drive goes with car, and another word is truck* [*camioneta*]”. If the child gave another syntagmatic response in the second elicitation (e.g., *car-wheels* [*carroruedas*]), the examiner offered *transportation* [*transportación*] as an alternate example. For the target *run, jump* [*brincar*] and *exercise* [*ejercicio*] were offered as alternate examples when necessary. A maximum of two models were provided for each of the two practice items. During the actual testing, the examiner provided non-contingent feedback to all responses. The children's responses were recorded verbatim on a scoring form. The sessions were also recorded on a digital audio recorder.

Coding

Responses were categorized into three main categories: paradigmatic, syntagmatic, and errors. The first two types are both semantically related to the targets. Similar to Sheng, et al. (2006), paradigmatic associations were defined as responses from the same semantic and grammatical category (e.g., *furry-hairy*; *peludo-rasposo* [*furry-rough*]; *dinner-meal*; *cenadesayuno* [*dinner-breakfast*]; *eating-drinking*; *comiendo-mordiendo* [*to eat-to bite*]). Syntagmatic associations included responses that shared functional, physical, causative, locative, or thematic relations with the stimulus (e.g., *nutritious-bread*; *delicioso-almuerzo* [*deliciouslunch*]; *forest-green*; *bosque-animales* [*forest-animals*]; *wearing-pants*; *vestirse-zapato* [*get dressed-shoe*]). Errors encompassed 1) no responses, which included “don't know” and repetitions of the stimuli or of earlier responses; 2) phonological responses (e.g., *soup-super*; *bosque-mosque* [*forest-mosque*]); 3) translations (e.g., *summer-verano*); and 4) unrelated responses (e.g., *soup-ceiling*; *cena-detruir* [*dinner-non word*]). Code-switched (CS) responses (e.g., *bosque* [*forest*]-*prairie*) were noted and received dual codes (e.g., CS: paradigmatic) to denote both the shift in response language and the semantic relation between the stimulus and response.

Reliability

Two proficient bilingual research assistants blind to the identity of the participants independently coded all responses using a detailed coding guideline. Point-to-point agreement was 97.7% in English and 97.8% in Spanish. All disagreements were resolved by consensus.

Semantic Depth Score

A semantic depth score was derived for each child at each elicitation trial. This was done by assigning a score of 2 to paradigmatic responses, 1 to syntagmatic responses, and 0 to errors, and adding them up to obtain a total score for a particular trial. This scoring hierarchy reflected the assumption that paradigmatic responses were later emerging and developmentally more sophisticated than syntagmatic responses, and both were more mature than errors (Entwisle, 1966; Nelson, 1977; Sheng, et al., 2006). Semantic depth score was derived in each individual language as well as conceptually, combining the child's performance in both languages. Specifically, we compared a child's responses to each pair of translation equivalents and selected the more advanced response to represent performance for that pair. Consider a child's responses to the English word *forest* of *jungle*, *ocean*, and *animales* [*animals*], and its Spanish equivalent *bosque* of *árboles* [*trees*], *forest*, and

zoológico [zoo]. This child received scores of 2 (paradigmatic), 2 (paradigmatic), and 0 (CS: syntagmatic) in English; 1 (syntagmatic), 0 (translation), and 2 (paradigmatic) in Spanish; and 2, 2, and 2 conceptually. As illustrated in this example, code-switched responses were treated as errors when calculating single-language scores but accepted when calculating conceptual scores. For each round of elicitation, the possible total semantic depth score was 24 (2 points $\times$ 12 words). Total scores were divided by 24 and converted to proportions.

Results

Preliminary Analyses

Because the two groups were not matched on sex and NDW, we conducted a series of regression analyses to examine the contribution of these factors to children's performance. Results showed that NDW (averaged across English and Spanish) accounted for a significant 32% of the total variance in conceptual semantic depth scores, 38% of the variance in English semantic depth scores, and 31% of the variance in Spanish scores, $p < .001$ in all cases. Sex, however, did not contribute any significant portion of the variance (less than 1%, $p > .50$ in all cases). Thus, we excluded the sex factor from subsequent analyses but included NDW as a covariate.

Analysis of Covariance

Mean semantic depth scores are shown in Table 3. We conducted a mixed-model ANCOVA, with ability group (LI, TD) as the between-participant factor, language of scoring (conceptual, Spanish, English) and elicitation trial (trials 1, 2, 3) as the within-participant repeated measures, and mean NDW (averaged across the two languages) as the covariate. Effect sizes (η_p^2) were calculated and interpreted using the following guidelines: .00–.10 = negligible, .10–.25 = small, .25–.50 = moderate, .50–.80 = large, and .80–1.00 = very large (Cohen, 1988). As expected, the effect of NDW was significant, $F(1, 71) = 20.02$, $p < .001$, $\eta_p^2 = .22$. The effect of ability group on semantic depth was also significant $F(1, 71) = 14.20$, $p < .001$, $\eta_p^2 = .17$. The children with LI ($M = .29$, $SE = .021$) had lower semantic depth than their TD peers ($M = .49$, $SE = .021$) even after variations in NDW were statistically controlled. There was a main effect of language, $F(2, 144) = 89.74$, $p < .001$, $\eta_p^2 = .55$. Posthoc tests with Bonferroni corrections indicated that conceptual semantic depth score ($M = .50$, $SE = .018$) was higher than both Spanish ($M = .37$, $SE = .016$) and English ($M = .30$, $SE = .021$) scores, and Spanish score was higher than English score, all $ps < .001$. There was a main effect of trial, $F(2, 144) = 63.90$, $p < .001$, $\eta_p^2 = .47$. Semantic depth scores decreased from trial 1 ($M = .46$, $SE = .02$) to trial 2 ($M = .39$, $SE = .017$), and from trial 2 to trial 3 ($M = .32$, $SE = .017$), $ps < .001$. Finally, the three-way interaction among group, language, and trial was significant, $F(4, 288) = 2.97$, $p = .02$, $\eta_p^2 = .04$. As illustrated in Figure 1, while the conceptual score advantage over single-language scores was significant at all trials for all groups, the Spanish advantage over English was only significant for the TD group at trial 3 and for the LI group at trials 1 and 2, $F_s = 24.61$, $ps < .001$, (η_p^2)s = .41.

Paradigmatic and Syntagmatic Responses

To further investigate the source of group difference in semantic depth, we closely inspected the production of specific types of associations. Table 3 also presents the mean proportions of paradigmatic, syntagmatic, and error responses. Three patterns were noticeable. First, for all three languages of scoring, paradigmatic responses decreased and errors increased across elicitation trials. In the meantime, syntagmatic responses remained largely stable across trials except for Spanish scores in the LI group, which showed a 10% decrease from trial 1 to trial 3. Second, the size of the LI-TD performance gap appeared to vary by response type and language of scoring (Figure 2). Specifically, for paradigmatic responses, the gap was the largest in conceptual score (difference in mean = .22, $t(72) = 6.30$, $p < .001$, $d = 1.46$), smaller in Spanish score (difference = .16, $t(72) = 5.43$, $p < .001$, $d = 1.26$), and the smallest in English score (difference = .14, $t(72) = 4.23$, $p < .001$, $d = .98$); for syntagmatic response, the gap was the largest in English (difference = .10, $t(72) = 2.14$, $p = .04$, $d = .50$), smaller in Spanish (difference = .07, $t(72) = 1.94$, $p = .06$, $d = .45$), and disappeared in conceptual score (difference = .01, $t(72) = .11$, $p > .5$). Third, the conceptual score advantage over single-language scores was significant for both paradigmatic and syntagmatic responses in the LI group and paradigmatic responses in the TD group; the Spanish advantage over English was significant in syntagmatic, but not paradigmatic responses; $F_s = 7.81$, $p_s < .001$, $(\eta_p^2)s = .18$.

Association Errors

Subtypes of association errors are summarized in Table 4. In both groups, no response appeared to be the largest category, taking up between 46–67% of total errors. Unrelated errors were the next most common category, ranging from 20–42%. Phonological responses and translations were rare, never exceeding 5% of total errors in any of the conditions. In comparison to the TD group, the LI group had proportionally more no responses, especially when the response language was Spanish. The TD group produced proportionally more unrelated responses in English (42%) than Spanish (26%) and than the LI group (25% in Spanish and 20% in English). The LI group code-switched more from English to Spanish (19%) than from Spanish to English (4.2%); whereas the TD group code-switched more from Spanish to English (20.3%) than the reverse (9.4%). The TD group also had the most success when code-switching from Spanish to English, as 93% of their CS responses resulted in either paradigmatic or syntagmatic associations. On the other hand, the rate of success was respectively 74%, 67%, and 73% for LI (Spanish to English), LI (English to Spanish), and TD (English to Spanish).

Individual Performance

So far we have examined the degree of semantic deficits at the group level. In the following we investigated individual performances on this semantic task and the extent to which performance on this task can differentiate bilingual children with and without LI. Normative values were determined using the TD group mean in semantic depth scores and setting the cutoff as 1 SD below the TD mean. Each participant in the LI and the TD group was compared to this determined standard. To allow for unconfounded calculations, each TD child's mean was removed from the TD group means and SDs to which that child was

compared. On the English task, 46% (17) of the children in the LI group and 22% (8) of the children in the TD group were categorized as poor responders using this criterion. On the Spanish task, 57% (21) of the LI group and 19% (7) of the TD group met the criterion for poor responders. Finally, using conceptual scoring, 65% (24) of the LI group and 14% (5) of TD group were categorized as poor responders.

Correlation Analyses

To determine factors that were related to individual differences in semantic development, we ran a series of correlations between individual characteristics and semantic depth and between parent/teacher rating of language proficiency and semantic performance. An adjusted p value of .0017 (.05 divided by 30 analyses per group) was used to correct for the number of analyses. Table 5 presents the correlational coefficients and highlights the significant values. Among the demographic variables (age, SES, age of English onset, English use), only percent of current English use showed a significant positive correlation with English semantic depth scores in both groups of children. Of the two measures of lexical diversity, NDW in English was positively correlated with English scores in both groups and conceptual score in the LI group. NDW in Spanish also showed a positive correlation with English scores in the LI group. Among the four proficiency ratings, the teacher's English rating correlated positively with English and conceptual semantic depth scores in both groups. Parental ratings and the teacher's Spanish rating were not significantly correlated with children's performance.

Discussion

In this study we set out to examine the nature and the extent of semantic deficits in bilingual children with and without LI. At the group level, bilingual children with LI appeared to have more shallow semantic knowledge for a set of academic words than their TD peers. At the individual level, semantic deficits characterized the performance of a majority of the children with LI and a small number of the TD peers. In the following, we reiterate our research questions and discuss the main findings of each analysis.

Semantic Deficits in Bilingual Children with LI

Group Effects—Our first research question pertained to the nature and the extent of semantic deficits in bilingual children with LI. Regardless of language (or method) of scoring, bilingual children with LI demonstrated significantly lower semantic depth scores than their TD peers. The fact that we statistically controlled for group differences in lexical diversity suggests that this deficit extends beyond the children's general delays in vocabulary size and reflects extraordinary difficulties in building semantic depth. These results are consistent with the existing literature on semantic deficits in monolingual children with LI (Gray, 2004; McGregor et al., 2002; Munro, 2007; Nash & Donaldson, 2005; Sheng & McGregor, 2010a, 2010b) as well as the emerging literature on bilingual children with LI (Gutierrez-Clellen & DeCurtis, 1999; Peña et al., 2001). From a spreading activation perspective, these findings indicate that the children with LI have fewer links in their semantic networks both within and across languages relative to their TD peers. An example of one TD child's responses to *congelado* [frozen] of *frio* [cold], *hielo* [ice] and *caliente*

[*hoʔ*] provided an illustration of such a robust network. In contrast, a child with LI (matched by age and percentage of English/Spanish use) demonstrated a network that was much less elaborate. In response to the same word *congelado*, this child responded only with *frio*.

Further analyses revealed that children with LI possessed fewer links of both paradigmatic and syntagmatic kinds than their peers. However, performance gaps for these two response types were moderated by language of scoring. Interestingly, using a conceptual approach and crediting any indications of semantic connections, the LI group's deficits in paradigmatic relations were accentuated and those in syntagmatic relations were compensated. The literature on typical semantic development suggests that connections depicting physical, functional, causal, thematic, and collocational relationships are relatively early emerging. On the other hand, acquiring advanced semantic relations that serve contrastive or substitutive discourse roles (e.g., synonymy, antonymy, superordination, coordination, and subordination) takes a prolonged period of time (Entwisle, 1966; Nelson, 1977; Sheng et al., 2006). Our results are consonant with these views and suggest that building paradigmatic connections may be particularly challenging for bilingual children with LI.

Two more group differences were manifested in error distribution. Specifically, the children with LI failed to respond proportionally (and numerically) more often, suggesting inadequate connections in the semantic network. This pattern agrees with studies of naming errors in which monolingual children with SLI produced proportionally fewer semantically related errors and more don't know errors than their TD peers (McGregor, 1997; McGregor et al., 2002; Sheng & McGregor, 2010b). Second, the children with LI code-switched more from English to Spanish, whereas the TD children code-switched more from Spanish to English. Given that both groups of children in the current study performed better in Spanish than in English (see below for a more detailed discussion of language effect), the TD group's frequent and highly successful code-switches to English may foreshadow an eventual shift in language dominance in these bilinguals (Kohnert, Bates, & Hernandez, 1999). As these children continue to develop semantic networks in Spanish, they are able to leverage what they know in Spanish to make semantic connections in English (Kan & Kohnert, 2005). An alternative but not mutually exclusive explanation is that the typical children may be activating their school schema and may find it easier to use the school language when completing this verbal task and answering questions from a knowledgeable adult. On the other hand, the bilingual children with LI may be less capable at cross-linguistic bootstrapping and/or slower at activating the school schema. Finally, both groups of children generated a paradigmatic or syntagmatic response for at least two thirds of their code-switched responses, suggesting that code-switching is an effective and ubiquitous strategy used among bilinguals (Heredia & Altarriba, 2001).

Trial Effects—Both groups of children in the current study demonstrated decrements in semantic depth scores across multiple trials. This pattern is reminiscent of the rippling effect, as semantic activation becomes attenuated along its path of travel from the node of origin (Collins & Loftus, 1975; Nevid, 2009). The between-group similarities suggested common structural and processing features in the two groups' semantic networks; however, the LI group had fewer words represented and weaker links between words in their

networks. Close inspections of Table 3 indicate that the decrements in semantic depth scores were caused by a decrease in paradigmatic associations and an increase in errors. At the same time, syntagmatic associations stayed relatively stable over trials. These patterns differed from those in a previous study wherein typically developing Mandarin-English bilingual children between ages 5 and 8 showed 1) a higher percentage of paradigmatic associations (31% in Mandarin and 35% in English) than the TD children in the present study, and 2) a decrease in paradigmatic associations accompanied by a simultaneous increase in syntagmatic associations (Sheng et al., 2006). Although we might expect the current participants between the ages of 7 and 9 to produce more paradigmatic responses or to be able to maintain an uptick of syntagmatic responses, it is likely that the difficulty or frequency of the stimuli utilized in this experiment affected their performance. The documented syntagmatic-paradigmatic shift may not occur based on development alone, but be moderated by characteristics of the words such as frequency of occurrence, familiarity, and part of speech (Entwisle, 1966; Nelson, 1977; Sheng et al., 2006).

Individual Variability—Consistent with previous research of monolingual children with LI (Gray, 2003, 2004; Sheng & McGregor, 2010a), the bilingual children with LI demonstrated wide variability in their semantic performance. Depending on language of scoring, between 35% and 54% of the children with LI achieved semantic depth score that were within normal limits. These numbers were comparable to those documented in previous research with monolingual children. Although not ideal, conceptual scoring appeared to be the best approach in differentiating bilingual children with and without LI as two thirds of the children with LI were identified using this approach. Poor semantic performance also characterized the performance of 5 (14%) typically developing children. Three of these 5 children also scored outside the normal range in both English and Spanish, and the other two scored below normal in English but not Spanish. Given that there were no other concerns about these children's language ability, these patterns may be a reflection of natural variations in typical semantic development.

We were also interested in delineating the factors that related to individual variability in semantic development (question 3). In a recent investigation of children who were learning English as an L2, Golberg et al. (2008) found that higher maternal education (an index of family SES) and older age of onset of English exposure were associated with an increased rate of lexical growth but English use in the home was not. In contrast, we found that SES and English onset age were not associated with children's performance but overall English use was. These inconsistencies can be attributed to differences in study design, tasks, participants, and how the factors were estimated. Golberg et al. used a longitudinal design and tracked vocabulary changes over a span of two years whereas we employed a cross-sectional design and sampled semantic performance at one time point. Goldberg et al. measured lexical growth with *The Peabody Picture Vocabulary Test – III* (Dunn & Dunn, 1997), a single-word receptive vocabulary task; we probed depth of semantic knowledge using repeated word association. The participants in Golberg et al. were recent immigrants to Canada; our participants were mostly from second- or third-generation immigrant families in the United States. Finally, Golberg et al. used maternal education alone as an index of SES because the parents' relative income and occupation status in their home country was

often quite different from what it was in Canada at the time of testing; we used education and occupation of both parents to calculate SES. With regard to age of English onset, Golberg et al. obtained a fine grained estimate (in months); we obtained an estimate in increments of years. Because we were asking parents to report on this retrospectively for children between the ages of 7 and 9, a report based on months could be unreliable. This level of precision may be reliable with infants and toddlers but can be questionable with children of this age. Perhaps Golberg et al. were able to obtain mean age of English exposure in months because the participants were all recent immigrants to Canada and onset of English exposure likely coincided with date of immigration, which was less susceptible to incorrect recall.

Although English was the less used language for our bilingual participants, our results indicated that percent of English use (across both home and school settings) showed a significant positive correlation with English semantic depth score in both groups. At the same time, percent of Spanish use were not related to Spanish semantic depth scores. It is possible that the children spent more time using English on academically oriented tasks and subjects. The nature of their English use (rather than the amount of time of English use) may have led to a tighter connection with children's performance on this decontextualized task.

L1, L2, and Combined Semantic Systems

With regard to our second question, we found that conceptual score was almost always higher than either single-language score regardless of the dependent measure (semantic depth score, paradigmatic, syntagmatic). Clearly, conceptual scoring provides a boost to bilingual children's performance by accepting the child's best response for each pair of translation equivalents, code-switched or not. Spanish scores were higher than English scores when overall semantic depth and syntagmatic responses were compared; the difference was in favor of Spanish but did not reach significance when paradigmatic responses were compared. This Spanish advantage was not surprising given that these children had greater cumulative experience using Spanish and higher current use of Spanish. Many of the children also showed higher NDW in Spanish than English. These findings are in line with our prediction and previous research (Pearson & Fernández, 1994; Vermeer, 2001) which showed that language use determines the status of lexical-semantic development. The lack of a Spanish advantage for paradigmatic responses corroborates the view that learning paradigmatic relationships is a lasting endeavor such that it takes longer for the dominant language advantage to surface.

Adult Rating of Language Proficiency and Semantic Performance

Our last research question pertained to the relationship between adult ratings of language proficiency and children's performance on this semantic task. Contrary to previous findings of significant correlations between parent proficiency ratings and children's lexical-semantic performance (Bedore, et al., in press; Sheng, et al., in press), we found that only the teacher's English proficiency rating correlated with the children's English and overall conceptual scores. The parent's English proficiency rating showed a moderate correlation with children's English performance that was significant at the .01 level but missed our adjusted p value of .0017. These findings suggest that whereas parent ratings of English

proficiency may predict lexical-semantic skills in bilingual toddlers and preschoolers, teacher ratings of English may be more reliable indicators of English as well as overall semantic skills in bilingual children of middle elementary-school age. Similarly, Gutierrez-Clellen and Kreiter (2003) found that teacher's rating of language proficiency correlated with grammaticality performance in bilingual school-age children. Proficiency ratings by parents were not obtained in Gutierrez-Clellen and Kreiter (2003).

We also found that parent ratings of Spanish proficiency did not correlate with children's semantic performance. This may be due to the fact that there was not enough variability in parental ratings of Spanish proficiency, a reflection of more uniform Spanish skills in the children. Teacher ratings of Spanish proficiency did not correlate with children's semantic performance, either. Perhaps the teachers did not have enough opportunities to observe the children's Spanish usage or did not know enough about Spanish language development, thereby unable to provide an accurate estimate (Gutierrez-Clellen & Kreiter, 2003).

Limitations

The present study yields useful information regarding semantic development in bilingual children with LI. Nevertheless, two caveats are noted. First, although we were able to control for the effect of vocabulary size through the NDW measure, it is possible that NDW in a narrative sample is not the best index of lexical breadth. Therefore, the present results need to be replicated when a psychometrically sound vocabulary measure becomes available for this bilingual population. Second, we were only able to sample semantic knowledge for a small number of academic targets and we did not systematically manipulate the properties of these words. Future studies should use a larger number of stimuli and investigate word-level factors associated with richer semantic representation.

Conclusion and Clinical Implication

This study is among the first to document the nature and extent of semantic deficits in bilingual children with LI. As a group, bilingual children with LI demonstrated fewer paradigmatic and syntagmatic links within their semantic networks. These deficits were related to vocabulary size but remained significant even when group differences in vocabulary size were partialled out. These deficits characterized the performance of close to two thirds of the bilingual children with LI. The results from this study corroborate the use of a word association paradigm in assessing deep semantic knowledge in bilingual learners (Fitzpatrick, 2009; Schoonen & Verhallen, 2008). Clinically, speech-language pathologists should be aware that bilingual school-aged children with LI may have difficulties forging links of both paradigmatic and syntagmatic kinds and both types of semantic relationships should be targeted in intervention. Finally, we replicated the finding that conceptual scores best captures bilingual children's existing semantic knowledge (Patterson, 1998; Pearson et al., 1993, 1995; Peña et al., 2002) and extended this result to bilingual children with LI. Also of clinical import is the finding that conceptual scoring of paradigmatic responses maximized the difference between bilingual children with and without LI. Clinicians and researchers should be aware that this scoring approach may lead to improved classification of semantic development status among bilingual children.

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Appendix A

PARENT/TEACHER EXPLICIT CONCERN EXPRESSIONS

We looked at all children whose parents or teachers expressly reported a concern about the way their child speaks and determined if the reason for their concern was *valid*. By *valid* we mean, the expressed concern represents a possible speech language disorder, NOT a weakness in one language over the other, nor a vaguely expressed concern.

VALID	INVALID
<i>Kids make fun of him. They don't understand him.</i>	<i>She is shy.</i>
<i>Se frustra porque no puede decir algunas palabras. He gets frustrated because he can't say some words.</i>	<i>Trouble with reading in English</i>
<i>Does not use complete sentences.</i>	<i>Can't pronounce /r/</i>
<i>Can't explain things well.</i>	<i>She takes a long time to talk in Spanish.</i>
<i>Confunda muchas letras cuando habla y escribe. She confuses a lot of letters when she talks and writes</i>	<i>She can't read in English.</i>
<i>Forgets words in both languages and mispronounces words.</i>	<i>Does not use Spanish very much so his Spanish is not very good.</i>

Figure 1. Semantic depth scores by group, language, and trial. Error bars denote 95% confidence interval. LI = children with language impairment. TD = children who were typically developing.

Figure 2.

Proportion of paradigmatic and syntagmatic responses by group and language. Error bars denote 95% confidence interval. LI = children with language impairment. TD = children who were typically developing.

Table 1

Participant information presented in means (SDs) and ranges (n = 37 per group)

	LI	TD
Sex	9f, 28m	19f, 18m
Age in months	99.92 (11.94)	100.22 (11.78)
	84–118	84–119
SES ^a	20.91 (8.82)	21.32 (8.96)
	3–48	6–62
Age first English exposure	4.08 (1.86)	3.95 (1.72)
	0–8	0–6
English use	43% (13%)	43% (12%)
	21–75%	21–68%
English rating (parent)	2.93 (.94)	3.92 (.76)
	0–4.8 ^b	2.25–5
Spanish rating (parent)	3.94 (.71)	4.60 (.47)
	2.2–5 ^b	3–5
English rating (teacher)	2.69 (.83)	3.81 (.92)
	1.25–4.2	1.2–5
Spanish rating (teacher)	3.32 (.66)	4.65 (.68)
	2–4.6	0–5
NDW-English	64.83 (35.13)	101.76 (39.29)
	13–143	0–199 ^c
NDW-Spanish	75.89 (32.26)	109.26 (29.29)
	0–145 ^c	56–177

^aHollingshead (1975) four-factor index of social status was used to calculate SES (socioeconomic status) scores.

^bThree out of the 37 children (8%) had a parent rating of 5 in one language; none of the 37 children in the LI group had both teacher and parent rating of 5 in any language.

^cThe minimum was 0 because there was one child in the group who refused to produce a narrative sample in a certain language. NDW- number of different words in narrative samples.

Table 2

Frequency of occurrence of word stimuli

English Word	Frequency ^a	Spanish Word	Frequency ^b
Delicious	1.9	Delicioso	1.6
Frozen	10.1	Congelado	1.2
Furry	0.2	Peludo	0.2
Nutritious	1.3	Nutritivo	4.6
Dinner	15.1	Cena	9.4
Forest	115.2	Bosque	172.2
Soup	4.4	Sopa	1.6
Summer	80.2	Verano	82.4
Eating	68.5	Comiendo	48.6
Growling	0.6	Grunir	0.8
Stretching	25.1	Estirar	8
Wearing	67.4	Vestirse	40.2
Mean	32.50	Mean	30.90
(SD)	(39.60)	(SD)	(51.50)

Note.

^afrequency of occurrence per million according to Davies (2008).^bfrequency of occurrence per million according to Davies (2002).

Table 3

Mean semantic depth scores (standard deviation) and mean proportions (standard deviations) of paradigmatic, syntagmatic, and error responses as a function of score type, group, and trial

		Conceptual				Spanish				English				
		T1	T2	T3	All	T1	T2	T3	All	T1	T2	T3	All	
LI	Semantic depth	.46	.39	.31	.38	.35	.26	.20	.27	.25	.20	.17	.20	
		(.20)	(.15)	(.16)	(.15)	(.16)	(.14)	(.13)	(.13)	(.22)	(.15)	(.13)	(.15)	
	Paradigmatic	.24	.16	.10	.17	.16	.09	.06	.10	.12	.07	.05	.08	
		(.21)	(.13)	(.09)	(.12)	(.15)	(.11)	(.08)	(.09)	(.17)	(.09)	(.05)	(.09)	
	Syntagmatic	.44	.46	.40	.43	.38	.34	.28	.34	.25	.26	.24	.25	
		(.19)	(.19)	(.21)	(.17)	(.17)	(.19)	(.19)	(.16)	(.21)	(.21)	(.22)	(.20)	
	Error	.32	.39	.49	.40	.46	.56	.66	.56	.63	.67	.71	.67	
		(.23)	(.21)	(.26)	(.21)	(.21)	(.21)	(.22)	(.19)	(.30)	(.24)	(.24)	(.24)	
	TD	Semantic depth	.68	.62	.53	.61	.54	.47	.39	.46	.48	.40	.32	.40
			(.19)	(.16)	(.17)	(.15)	(.18)	(.17)	(.16)	(.15)	(.23)	(.22)	(.21)	(.20)
		Paradigmatic	.48	.40	.30	.39	.34	.25	.18	.26	.29	.23	.14	.22
			(.24)	(.20)	(.18)	(.18)	(.20)	(.18)	(.13)	(.15)	(.23)	(.20)	(.16)	(.18)
Syntagmatic		.40	.44	.46	.44	.40	.43	.41	.41	.37	.35	.34	.35	
		(.20)	(.19)	(.22)	(.18)	(.19)	(.20)	(.22)	(.18)	(.22)	(.25)	(.23)	(.22)	
Error		.11	.16	.24	.17	.26	.31	.41	.33	.34	.42	.52	.43	
		(.18)	(.17)	(.23)	(.18)	(.21)	(.21)	(.24)	(.20)	(.28)	(.29)	(.30)	(.27)	

Note. LI = children with language impairment. TD = children who are typically developing. T1 = trial 1. T2 = trial 2. T3 = trial 3. All = three trials combined.

Table 4

Number of responses in each error category in the LI and TD groups (numbers in parentheses indicate percent of a certain type of errors over all errors)

	LI- Spanish	LI- English	TD-Spanish	TD-English
CS: Paradigmatic	6 (0.8%)	28 (3.1%)	43 (9.8%)	13 (2.3%)
CS: Syntagmatic	17 (2.3%)	86 (9.6%)	40 (9.1%)	26 (4.6%)
Translation	5 (0.7%)	25 (2.8%)	6 (1.4%)	7 (1.2%)
Clang	27 (3.6%)	5 (0.6%)	21 (4.8%)	12 (2.1%)
No response	498 (66.8%)	512 (57.3%)	209 (47.6%)	259 (45.5%)
Unrelated	185 (24.8%)	181 (20.3%)	114 (26%)	238 (41.8%)
CS: Unrelated	8 (1.1%)	56 (6.3%)	6 (1.4%)	14 (2.5%)

Note. LI = children with language impairment. TD = children who are typically developing. CS: Paradigmatic = code-switched responses that had paradigmatic relations to the stimuli. CS: Syntagmatic = code-switched responses that had syntagmatic relations to the stimuli. CS: Unrelated = code-switched responses that were unrelated to the stimuli.

Table 5

Correlation matrices

	LI Semantic Depth Score			TD Semantic Depth Score		
	Conceptual	Spanish	English	Conceptual	Spanish	English
Age	.22	.25	.34	.31	.33	.32
SES	.02	.02	-.18	.39	-.10	.46
English onset	.02	.03	-.10	-.33	-.08	-.40
English use	.44	.42	.61 [*]	.41	-.13	.50 [*]
NDW (English)	.53 [*]	.44	.70 [*]	.34	.26	.50 [*]
NDW (Spanish)	.44	.43	.58 [*]	.10	.27	.21
English rating (parent)	.08	.02	.49	.46	.28	.47
Spanish rating (parent)	-.22	-.19	.01	-.19	.24	-.33
English rating (teacher)	.54 [*]	.38	.70 [*]	.77 [*]	.29	.80 [*]
Spanish rating (teacher)	.24	.14	.39	.11	.09	-.09

* significant at an adjusted *p* value = or < .0017