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Semantic Convergence in Spanish–English Bilingual Children With Primary Language Impairment

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Abstract

Purpose—To examine the degree of convergence in word association responses produced by bilingual children with primary language impairment (PLI) in relation to bilingual age peers.

Method—Thirty-seven Spanish–English bilingual children with PLI, 37 typically developing (TD) controls, and a normative sample of 112 children produced associations to 24 English and Spanish words. The 5 most frequent responses for each stimulus were identified for the normative sample; then the frequency of occurrence of these frequent normative responses was tabulated and compared between the PLI and TD groups.

Results—Children with PLI generated fewer frequent normative responses than their TD peers. Spearman rank correlations revealed that the rank frequency of responses in the normative group was significantly correlated with that of the TD and PLI groups; however, in English, the correlation was stronger for the TD cohort. Cross-language associations were also revealed in the generation of frequent norming responses.

Conclusions—Semantic convergence is determined by multiple factors. Reduced production of frequent normative responses and weakened correlation with group association behavior in English suggest that children with PLI were delayed in converging on a central core of semantic knowledge that is characteristic of bilingual children with typical language skills.

Keywords

semantic convergence; word association; language impairment

The purpose of the present study was to examine the degree of semantic convergence among children with primary language impairment (PLI). Semantic convergence refers to the process of learning to use words in a way that mimics the words' usage by speakers from the same community (Adams & Bullock, 1987). To achieve this goal, we reanalyzed an existing corpus (Sheng, Peña, Bedore, & Fiestas, 2012) of word association responses produced by Spanish–English bilingual children with and without PLI and evaluated these children's responses against those produced by a larger sample of bilingual children who were from the same community and had similar language experience. A key feature of language use is its conventionality (Clark, 1995, 2007). To communicate effectively, speakers must use a shared code, including a common core of vocabulary and agreed-upon substitutions and

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collocations. Not only is semantic convergence part and parcel of conventional language use; it also underlies word meaning elaboration and network building, both of which are essential to word retrieval, a process that supports language comprehension and production. Thus, whether children with PLI are delayed in semantic convergence is a question of both theoretical and practical import. With this objective in mind, we provide a brief review of relevant research that inspired the current inquiry.

The word association task has been widely used to study semantic development in such fields as first-language acquisition (e.g., Entwisle, 1966; Sheng & McGregor, 2010), second-language acquisition (e.g., Fitzpatrick & Izura, 2011; Schmitt, 1998a, 1998b; Schoonen & Verhallen, 2008; Sheng, Bedore, Peña, & Fiestas, 2012; Sheng, McGregor, & Marian, 2006), and cognitive psychology (e.g., Noordman, Vonk, & Simons, 2000). In first-language acquisition, children show increased convergence in their association responses with age. Entwisle (1966) administered a discrete word association task and asked English-speaking children of various ages to respond with one association to each of 96 stimuli. Between kindergarten and fifth grade, commonality of association responses, defined as the total frequency of the three most popular associations within each age group, increased markedly. For example, the percentage of children producing *chair* to the stimulus *table* increased from 30% at age 4 to 58% at fifth grade. At the same time, the number of idiosyncratic associations (defined as responses produced by only one participant) decreased. Whereas these results indicate increased within-group convergence in association responses from younger to older children, older children also show greater convergence on adult semantic representations than younger children (Bjorklund, Thompson, & Ornstein, 1983). In the Bjorklund et al. study, four groups of participants (kindergartners, third graders, sixth graders, and college students) provided typicality ratings of category exemplars. Spearman rank order correlations were conducted between the typicality ratings of the college students and ratings by the child groups. Correlations between the children's and college students' ratings were generally significant for all three children's groups, but the average correlations increased with age.

If increased convergence in association responses in the older children reflects greater cumulative experience with a language, it follows that second-language learners should show gradual convergence on the semantic representations of native speakers as they have more practice with the second language. Such patterns were observed in a longitudinal study that assessed the native-likeness of adult English as a second language (ESL) learners' word associations (Schmitt, 1998b). Three ESL learners were repeatedly measured on their knowledge of 11 polysemous words over the course of a year. Two of the tasks were related to the words' meaning representations. In the meaning knowledge task, the participants explained all of the meanings they knew for each target word. In the word association task, the participants produced three associations to each word. The learners' associations were compared with a native speaker norming list and were categorized as zero (not native-like: none of the three responses matched any of those on the norming list), one (minimally native-like: some response matched infrequent ones on the norming list), two (native-like: responses were similar to those typical of the norming group), and three (highly native-like: responses were similar to those in the top half most frequent responses of the norming list). The learners showed steady progress in the native-likeness of their associations for a

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majority of the words. In addition, there was concurrent increase in the learners' word meaning scores and association scores. As meaning knowledge of the 11 words expanded, associations gradually became more native-like.

Unlike age and ESL status, which are indices of general language experience, expertise within a particular domain is an index of domain-specific language experience (Bjorklund, 2005; Noordman et al., 2000). In particular, experts in a discipline seem to share a core vocabulary about their domain of expertise that is not as accessible to nonexperts. Noordman et al. (2000) examined association responses to economic concepts by a group of experts (advanced economics students) and a group of nonexperts (advanced students in other disciplines). The experts generated a larger number of different associations to a given economic concept than the nonexperts in a 1-min time period, indicating that the experts have more concepts available and know more relations between concepts in their domain of expertise. Although the number of associations was larger, there was greater overlap in the actual responses among the experts than the nonexperts, suggesting that the experts and novices also differed in the organization of their knowledge. Specifically, the experts' knowledge represented a more consolidated and thematically coherent body of knowledge. Indeed, follow-up experiments in the same study showed that the knowledge of the experts was to a larger extent structured according to four clusters of economic concepts and that expert knowledge was highly organized in terms of causal relations.

These four studies (Bjorklund et al., 1983; Entwisle, 1966; Noordman et al., 2000; Schmitt, 1998b) provide a novel perspective in examining semantic representations that has yet to be applied to the study of language impairment. Taken together, these studies suggest that expertise, defined in variable forms, such as increased linguistic proficiency that comes with age, rich linguistic experiences associated with native speaker status, or familiarity with a particular academic discipline, has a significant impact on the breadth, depth, and organization of one's semantic knowledge. When performing semantic tasks, individuals with more linguistic expertise not only agree more with each other (Entwisle, 1966; Noordman et al., 2000) but they also show greater convergence on an external norm (Bjorklund et al., 1983; Schmitt, 1998b).

Typically developing children are experts at word learning (Capone & Sheng, 2010; McGregor, Sheng, & Ball, 2007), but the same cannot be said about children with PLI (Alt & Plante, 2006; Alt & Spaulding, 2011; Gray, 2003, 2005; Kan & Windsor, 2010; Rice, Oetting, Marquis, Bode, & Pae, 1994; Riches, Tomasello, & Conti-Ramsden, 2005; Windfuhr, Faragher, & Conti-Ramsden, 2002). In the current study, we examined the effect of PLI on semantic convergence. This was achieved by reanalyzing an existing corpus of word association responses (Sheng et al., 2012) produced by a group of Spanish–English bilingual children with PLI and their typically developing (TD) bilingual peers. We evaluated word association responses of the PLI and TD groups against those produced by a normative group of bilingual children with comparable verbal experience. The study of bilingual children can provide us with insights about semantic learning and organization because those who are bilingual typically use their two languages in different contexts and with different frequency, which may lead to cross-language variations in semantic convergence within the same individual. The current study aims to answer the following questions: (a) Do bilingual children with PLI show less convergence on association responses with a norm than their TD peers? (b) Does the degree of convergence vary by language? (c) What factors (e.g., age, current language use, vocabulary size) are the driving forces of semantic convergence?

Previous studies have suggested that semantic convergence is a gradual process driven by the intake of linguistic experience (Bjorklund et al., 1983; Schmitt, 1998b). Children with PLI have particular difficulties with the uptake of their language experience. For instance, Rice et al. (1994) found that children with PLI needed 10 exposures to demonstrate novel word learning, whereas TD peers needed only three exposures. Similarly, the preschoolers with PLI in Gray (2003, 2005) needed twice the amount of exposure to achieve the same level of word learning as their TD peers. In Windfuhr et al. (2002), children with PLI demonstrated a concave learning curve with poor performance in the initial sessions and a significant improvement in the final sessions, whereas the TD peers showed a convex learning curve with rapid gains in the initial sessions followed by stable performance. Taken together, it appears that children with PLI rely much more heavily on optimal learning conditions (e.g., frequent exposure) during novel word learning (Riches et al., 2005). Thus, we hypothesized that limitations in the uptake of language input on the part of children with PLI would lead to delays in semantic convergence. Specifically, these children would be less likely to produce responses that are typical of their age- and experience-matched peers.

With regard to the effect of language, the children in Sheng et al. (2012) showed greater semantic depth (defined as the production of mature semantic associations) in Spanish than in English. Therefore, we predicted that semantic convergence in these same children would be slower in the language associated with less cumulative experience and lower proficiency (in this case, English) and that the less used language would be more vulnerable to the negative effect of slow uptake. In other words, the PLI group's delay in semantic convergence would be exacerbated in English.

With regard to factors that affect semantic convergence, we predicted that both experiential factors (i.e., age and amount of language use) and expertise in word learning (i.e., extant vocabulary) would potentially drive the semantic convergence process. Given previous findings of cross-language associations in bilingual children's vocabulary development (Kan & Kohnert, 2008; Kohnert, 2010; Sheng, 2012; Sheng et al., 2012), we were also interested in possible cross-language facilitation in semantic convergence in the current group of bilingual children.

Method

Participants

A total of 186 Spanish–English bilingual children between the ages of 7 years and 9 years and 11 months participated in the current study. Among them were 112 typically developing children who were included in the normative group (NORM). Among the remaining children, 37 met criteria for PLI (for details regarding diagnosing PLI in bilingual children, see Sheng et al., 2012), and the other 37 were typically developing (TD). Children in the PLI and TD groups were matched pairwise on age, family socioeconomic status (SES), age of first English exposure, and percentage of language use. To ensure that children in the NORM and the experimental groups were from similar background and had similar bilingual experience, we conducted one-way analyses of variance to verify that the three groups were comparable in age, $F(2, 181) = 0.45, p = .64$; SES, $F(2, 176) = 0.06$, $p = .94$; and percentage of English–Spanish use, $F(2, 177) = 0.37$, $p = .69$. The NORM group had significantly higher current Spanish than English use, $t(105) = 4.19$, $p < .001$, $d = .81$. Similar but nonsignificant trends of greater Spanish than English use were observed for the PLI and TD groups (ps < .10).

With one exception, parents and teachers rated all three groups of children as having higher Spanish than English proficiency (ts > 2.93, ps < .005, ds > .45). The exception was due to a nonsignificant difference in teachers' ratings of the TD group's Spanish and English proficiency ($p = .18$). The NORM and TD groups received comparable proficiency ratings, and both were rated higher by parents and teachers than the PLI group in terms of English and Spanish proficiency (Fs ≥ 8.55, ps < .001, for all four comparisons). In addition, we calculated number of different words (NDW) in narrative samples to provide an estimate of vocabulary size for children in the TD and PLI groups. The PLI group showed a higher NDW in Spanish than English, $t(36) = 3.55, p = .001$, $d = .35$. The TD group showed roughly comparable NDW values in English and Spanish ($p = .21$). The TD group had higher NDW than the PLI group in both English, $t(72) = 4.82$, $p < .001$, $d = 1.12$; and Spanish, $t(72) = 4.54$, $p < .001$, $d = 1.05$. Finally, semantic depth scores (based on the maturity of word association responses; Sheng et al., 2012) were higher in the TD than PLI group in both English, $t(72) = 4.55$, $p <.001$, $d = 1.06$; and Spanish, $t(72) = 5.89, p < .001$, $d = 1.37$. Both the PLI and TD groups showed higher semantic depth scores in Spanish than in English: PLI, $t(36) = 3.52$, $p = .001$, $d = .47$; and TD, $t(36) = 1.96$, $p = .06$, $d = .38$. Information about the participants is presented in Table 1.

Stimuli

The stimuli were 12 pairs of Spanish and English translation equivalents belonging to the adjective (*delicious* [*delicioso*], *frozen* [*congelado*], *furry* [*peludo*], *nutritious* [*nutrivito*]), noun (*dinner* [*cena*], *forest* [*bosque*], *summer* [*verano*], *soup* [*sopa*]), and verb (*eat* [*comer*], *growl* [*gruñir*], *stretch* [*estirar*], *wear* [*vestirse*]) classes. These words belong to familiar semantic categories and represent curriculum targets according to the Texas Department of Education curriculum guidelines. The words' frequencies of occurrence in academic contexts in English (Davies, 2008) and Spanish (Davies, 2002) are listed in Table 2.

Procedure

Sheng and colleagues (2012) provided a full description of the task and procedures. Briefly, the Spanish and English items were administered on different days by trained bilingual speech-language pathologists or graduate students. A short practice was provided at the beginning of each session to familiarize the child with the task and to guide the child toward producing semantically related responses. Children were instructed to respond with a word that goes with the target. 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. The stimuli were semirandomized such that words belonging to the same theme (e.g., *delicious* and *eating*) did not occur together. Words were randomized respectively in English and in Spanish and were 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.

Data Analyses

For each stimulus, we generated a complete list of responses across the three elicitations and across the 112 children in the NORM group by using the "generate word list" function in Systematic Analysis of Language Transcripts (SALT; Miller & Iglesias, 2010). Using this complete list, we were able to identify the top five most frequent responses for each stimulus. This procedure was repeated for each stimulus, which resulted in a total of 24 five-item norming lists. For the stimulus *bosque* (*forest*), there was a four-way tie (*pasto* [*pasture* or *grass*], *parque* [*park*], *hojas* [*leaves*], and *casa* [*house*]) for the fourth most frequent response. Thus, seven responses were included in this list. For the stimulus *nutritivo* (*nutritious*), only the top four most frequent responses were included in the list because there was a seven-way tie for the fifth most frequent response. These adjustments resulted in a total of 121 word tokens across the 24 norming lists.

To evaluate the PLI and TD children' responses against the norming lists, we entered the five most frequent responses (or four and seven responses in the case of *nutritivo* and *bosque*, respectively) for each stimulus into the explore word and code list using the rectangular database function in SALT for Research (Miller & Iglesias, 2010). Then the responses of each individual child in the PLI and TD groups were cross-tabulated against this list to determine how many of the five most frequent responses in the norming sample were produced by each child. This procedure was repeated for each of the 24 stimuli and for each of the 74 children.

Results

Analysis of Covariance

The mean number of occurrences of the top five most frequent norming responses was calculated for English and Spanish in the PLI and TD groups, respectively. We included group and language (a repeated measure) as independent variables in the statistical model and examined their effects on the production of frequent norming responses. We also included in the model as a covariate mean NDW averaged over English and Spanish narrative samples (NDW-ES). NDW-ES was significantly correlated with the NDW value in both English and Spanish (rs ≥ .94, r^2s ≥ .89, ps < .001). This vocabulary measure was included because children with PLI have smaller vocabularies than their TD peers, and any claim about potential delays in the convergence of semantic representations for children with PLI must take into consideration differences in vocabulary size.

The analysis of covariance (ANCOVA) revealed a significant effect of the NDW-ES covariate, $F(1, 71) = 20.33$, $p < .001$, $\eta_p^2 = .22$. The group effect was also significant, $F(1, 71) = 10.84$, $p = .002$, $\eta_p^2 = .13$. The PLI group ($M = .35$, $SE = .051$; adjusted $M = .43$, adjusted $SE = .049$) produced fewer frequent norming responses than the TD group (M = .

76, *SE* = .051; adjusted *M* = .68, adjusted *SE* = .049) after controlling for group differences in NDW. The effect of language was not significant, $F(1, 72) = 0.16$, $p = .69$, with children producing comparable numbers of norming responses in English (*M* = .56, *SE* = .054) and Spanish (*M* = .55, *SE* = .039). Note that the degree of freedom for this language variable was different from that of the between-participant group effect. This is because main effects of repeated measures factors are independent of the between-participant covariate of NDW-ES (in the sense that participants had the same NDW-ES value when they generated each of their repeated scores); therefore, a pure repeated measures effect was reported from an analysis that excludes the covariate (Delaney & Maxwell, 1981).

The ANCOVA also yielded a significant interaction between language and NDW-ES, $F(1, 71) = 10.72$, $p = .002$, $\eta_p^2 = .13$. To unpack this interaction, we divided the 74 children into two groups by using the NDW-ES grand mean (88.99) as the cutoff: Children who had an NDW-ES higher than 88.99 ($n = 37$, including 28 children from the TD group and nine children from the PLI group) were grouped together, and those who had an NDW-ES lower than 88.99 ($n = 37$, including nine children from the TD group and 28 children from the PLI group) were grouped together. Of the nine children with PLI who had above-average NDW, there were one 7-year-old, three 8-year-olds, and five 9-year-olds (mean age = 9 years, 1 month). Of the nine TD children who had below-average NDW, there were six 7-year-olds and three 8-year-olds (mean age = 7 years, 8 months). As illustrated in Figure 1, children with above-average NDW-ES (most of whom were children from the TD group) achieved higher semantic convergence scores than those with below-average NDW-ES (most of whom were children from the PLI group) in both English, $t(72) = 6.95$, $p < .001$, $d = 1.62$; and Spanish, $t(72) = 5.52$, $p < .001$, $d = 1.28$; with the effect size being somewhat larger for English. In addition, children with above-average NDW-ES had higher semantic convergence scores in English than in Spanish, $t(36) = 2.68$, $p = .01$, $d = .36$; children with below-average NDW-ES showed the opposite pattern, $t(36) = 1.77$, $p = .08$, $d = .32$; although the difference was not significant.

To better understand these patterns, we conducted *t* tests to compare demographic features of the two groups (high and low NDW). The two groups had comparable ages of English onset, family SES, and parent ratings of Spanish (ps ≥ .13). However, in comparison to the low NDW group, the high NDW group was older, had higher amount of current English use, received higher English ratings by parents and teachers and higher Spanish ratings by teachers, and had higher NDW and semantic depth scores in both languages (all *p*s ≤.02, *d*s ≥ .57). Moreover, the group of children with above-average NDW showed comparable cross-linguistic profiles in teachers' proficiency rating, current language use, NDW, and semantic depth scores. The only between-language difference for this group was a higher average rating of Spanish than English proficiency by parents ($p = .02$, $d = .60$). Conversely, the group of children with below-average NDW showed a consistent Spanish advantage over English for all measures, including parent and teacher ratings, NDW, current language use, and semantic depth (all *p*s < .001, *d*s ≥ .63; see Table 1 for means).

Spearman Rank Correlations

To explore the degree of overlap in association responses between the experimental and NORM groups, we took the corpus of most frequent responses produced by the NORM group across the 12 English words and rank-ordered the responses in terms of how often each occurred. Across the 12 English stimuli, there were 60 frequent response tokens and 48 types. The 48 response types are listed on the *x*-axis of Figure 2, and their frequencies of occurrence are denoted by the *y*-axis. As seen in Figure 2, some of these frequent responses were produced by a large number of TD participants; some of them were even produced multiple times by the same participants in response to different stimuli. For instance, *yummy, clothes, trees, cold*, and *winter* each occurred over 10 times; *good, hot, breakfast*, and *lunch* each occurred over 20 times; and *food* occurred over 70 times among the 37 TD participants. In contrast, only four of these 10 frequent responses (i.e., *cold, hot, breakfast*, and *food*) were uttered over 10 times by the PLI group. We conducted Spearman rank correlation on the frequency ranking of these 48 responses between the NORM and PLI groups and between the NORM and TD groups. For English, Spearman rank correlations with NORM were .85 ($df = 46$, $p < .001$) for the TD group and .69 ($df = 46$, $p < .001$) for the PLI group. We used a Fisher *r*-to-*z* transformation to assess the difference in correlation coefficients and found that the correlation between NORM and TD was significantly greater than that between NORM and PLI ($z = 3.49$, $p < .001$). In other words, the TD group was more similar to the NORM than the PLI group.

For Spanish, the NORM corpus consisted of 61 response tokens and 52 response types. The 52 response types are listed on the *x*-axis of Figure 3, and their frequencies of occurrence are denoted by the *y*-axis. As seen in Figure 3, eight words were produced frequently by the TD group. Specifically, *pelo* (hair), *hielo* (ice), *bueno* (good), *invierno* (winter), *rico* (yummy), and *comer* (eat) each occurred over 10 times; *caliente* (hot) occurred over 20 times, and *comida* (food) occurred over 30 times in the TD group. Consistent with the English results, a smaller set (five) of these also occurred with this level of frequency in the PLI participants. These included *hielo, rico, comer, caliente*, and *comida*. However, there was one word, *ropa* (clothes) that occurred over 10 times in the PLI group but less than that in the TD group. Spearman rank correlations with the NORM group were .64 ($df = 50$, $p < .001$) for the TD group and .56 ($df = 50$, $p < .001$) for the PLI group. We used a Fisher *r*-to-*z* transformation to assess the difference in degree of correlation between the two samples. The difference was nonsignificant (mean *z* difference = 1.07, $p = .142$), indicating that the PLI and TD groups were equally similar (or dissimilar) to the NORM group.

Multiple Regression

Last, we conducted regression analyses to examine which individual factors predicted semantic convergence scores. Age, current English use, NDW-ES, and Spanish convergence scores were entered as predictors in a regression model with English convergence score as the dependent variable. These predictors were chosen because we were interested in the effects of experience, word learning ability, and cross-language facilitation on semantic convergence. The four factors accounted for 70% of the variance in English semantic convergence scores in a simultaneous regression, $F(4, 69) = 39.45$, $p < .001$, $R = .83$. Partial correlations showed that Spanish convergence scores (partial $r = .67$, $\beta = .57$, $p < .001$), percentage of English use (partial $r = .42$, $\beta = .27$, $p < .001$), and NDW-ES (partial $r = .40$, $\beta = .31$, $p < .001$) were significant predictors, whereas age was not.

To identify predictors of Spanish semantic convergence, we entered English convergence scores, age, current English use, and NDW-ES into a simultaneous regression. Together these factors accounted for 58% of the variance, $F(4, 69) = 24.16$, $p < .001$, $R = .76$. Two factors were significant predictors: English convergence scores (partial $r = .67$, $\beta = .78$, $p < .001$) and current English use (partial $r = -.37$, $\beta = -.28$, $p = .002$).

Discussion

Our first research goal was to examine the effect of PLI on semantic convergence. Our results indicated that, on average, children with PLI generated only 7% of the five most frequent norming responses that were typical of a larger sample of age- and experience-matched peers, whereas the TD controls generated 15.2% of those frequent responses. This difference was significant even when group differences in vocabulary size were factored out statistically. Therefore, the PLI group's delay in semantic convergence was not simply a reflection of the fact that the TD and NORM groups were more similar in verbal ability. Spearman rank correlations revealed positive correlations between the NORM and PLI groups as well as between the NORM and TD groups; however, the TD group showed a higher correlation with the NORM group in English.

These findings are consistent with our prediction. Like the older and linguistically more mature children in Bjorklund et al. (1983) and the ESL learners toward the end of the longitudinal study in Schmitt (1998b), the TD children in the current study achieved greater overlap in association behaviors with their age- and experience-matched peers. Convergent semantic representation is a requirement of effective communication and an inherent feature of a conventional linguistic system. As Clark (1995) has argued, conventionality is "characterized by the existence of collective agreements about language within a community of speakers" (p. 68). Applied to the semantic domain, the convergence process enables learners to grasp the conventional meaning and usage of words and fine-tune their own understanding so that it approximates the agreed-upon representation and usage of the community.

The significant Spearman rank correlations between the PLI and NORM groups suggest that children with PLI are not oblivious to conventional word use by speakers in the community; however, the weaker correlation they demonstrated in English relative to the TD group indicates reduced efficiency in semantic convergence. We postulate that slower semantic convergence is attributed to diminished uptake of ambient language input in children with PLI. Children with PLI are known for their difficulties in novel word learning: These children are more reliant on frequent exposure (Riches et al., 2005), they may need more than double the amount of training to achieve the same level of word learning (Gray, 2003, 2005; Rice et al., 1994), and they may show a qualitatively different learning trajectory (Windfuhr et al., 2002). In a similar vein, Tomblin, Mainela-Arnold, and Zhang (2007) showed that adolescents with PLI had difficulty noticing and remembering co-occurrence patterns in the visual domain and that weak pattern tracking skill was correlated with weak grammatical ability in these children. These difficulties with implicit rule learning persist into adulthood (Plante, Gómez, & Gerken, 2002; Richardson, Harris, Plante, & Gerken, 2006). It is possible that the same statistical learning process that underlies visual tracking and grammatical learning also contributes to learning the attributes and collocation patterns of words. This explanation is also in line with the substantial body of research suggesting a deficit in general information processing among children with PLI (Gillam & Hoffman, 2004; Leonard, 1998; Montgomery, 2002; Windsor, 2002). Reduced processing capacities may lead to delay in the social process of word meaning convergence as children with PLI require more exposures to register the statistical information that dictates the central core of a word's meaning.

At the same time, the correlations were also weaker (but statistically significant) in Spanish compared with English, with no differences between PLI and TD children. This finding occurred in the context of children as a group demonstrating stronger Spanish skills. This finding is somewhat unexpected as the previous studies would predict higher correlations in the language in which children had the most experience and skill. It may be that children's Spanish language skills—particularly in academic Spanish—are stalling or plateauing as their English skills are increasing. In the United States, children often learn English in what is considered a subtractive environment. That is, most of the curriculum is delivered in English, while the home language is used as support. The words we selected for this study were those expected in science and social studies curricula. It may be that many of these concepts and vocabulary associated with them were introduced in school in English. Another related possibility is that if these concepts were explained in Spanish, there were more varied ways that teachers (or parents) talked about them, and the weaker convergence reflects this experience. Bilingual teachers may have learned their Spanish in a number of ways (and from various countries), and they themselves may not use common vocabulary in the classroom to explain concepts (for a different but not mutually exclusive explanation, see the discussion, below, on hub words).

The Spearman rank analyses yielded yet another interesting finding. That is, several words (e.g., *food, good, hot, breakfast, lunch, comida* [food], *caliente* [hot]) were produced very frequently by the TD children as responses to multiple stimuli. Overexploitation of certain words has been studied in the context of the emergence of hub verbs among two groups of 3-year-olds (Dollaghan, 2007). The notion of hub verb was derived from the literature on the development of complex, self-organizing "small world" networks. Hubs are the small number of highly connected units that come to dominate the events in the networks of which they are a part and contribute to the efficiency and robustness of complex networks. Dollaghan questioned whether certain verbs in children's lexicon might act as hubs and whether the existence of hub verbs could differentiate children with and without language delay.

In the Dollaghan (2007) study, the two groups consisted of 10 children with the lowest mean length of utterance (MLU) in a cohort of 241 children and 10 children with the highest MLU from the same cohort. The verb types in each child's multiword utterances were identified and rank ordered by frequency of occurrence. The top 20% most frequently used verbs were then identified for each child, and the number of multiword utterances in the transcript that contained these top 20% verbs was counted. On average, the low-MLU children used their top 20% verbs in 18% (*SD* = 9%) of their multiword utterances, whereas the high-MLU group used their top 20% verbs in 75% (*SD* = 9%) of their multiword utterances. Because the emergence of hubs in other complex systems suggests that from chaos is coming order, Dollaghan argued that verbs may also act as hubs in children's language, organizing lexical and syntactic structures to enable efficient retrieval and conversational fluency.

The highly frequent responses in the TD corpus may be candidates of hub words in the localized semantic networks tapped by the current word association task. The word *food* would be an appropriate response for several stimuli, such as *dinner, delicious, nutritious, eating*, and *soup*. The overuse of such words may be an effective strategy to alleviate the demands of word retrieval and real-time language processing. A comparison between Figures 2 and 3 indicates that hub-word responses were more frequent in the TD than the PLI group, and this was true for English only. These highly frequent English hubs could have led to the stronger correlation between TD and NORM in English ($r = .85$) relative to Spanish (.64) and relative to the correlations between PLI and NORM (.69 for English and .56 for Spanish). The overuse of these potential "hubs" may be a mechanism by which the TD children break into their second language. The nature and function of hubs in semantic networks is a topic that warrants future investigations.

With regard to our second research question, we predicted that semantic convergence would be greater for the language associated with higher proficiency and more cumulative use. For these participants, higher Spanish than English proficiency was confirmed by parent ratings (for both groups), teacher ratings (for the PLI group), and lexical diversity measures (for the PLI group). Greater cumulative Spanish use was verified by earlier age of onset for Spanish (at birth for all children) than English (around 4 years of age) and trends toward greater current Spanish use (*p*s < .10 in both groups). Also, when the kinds (or maturity) of word association responses were compared between languages, these children earned higher semantic depth scores in Spanish than in English. Despite strong evidence for greater Spanish proficiency and usage, children achieved similar convergence scores in the two languages. This null effect, against the backdrop of stronger Spanish semantic abilities, suggests that semantic convergence and semantic depth are two related but separable constructs. Bilingual children may have less in-depth knowledge of words in their second language, but they were just as sensitive to the conventional usage of these words as that of words in their first language, at least when they were pitted against a bilingual norm.

The interaction between NDW (the covariate) and language yielded further insights on the semantic convergence process. Figure 1 indicated that children with above-average NDW showed an English advantage in semantic convergence that was small to medium in size ($d = .36$), whereas those with below-average NDW showed a trend toward a Spanish advantage with a small to medium effect size ($p = .08$, $d = .32$). Close examinations of participants' profiles indicated that the majority (76%) of the children with above-average NDW was from the TD group, whereas the remaining 24% mostly consisted of the some of the oldest children with PLI. In complement, 76% of the children with below-average NDW were from the PLI group, whereas the remaining 24% included mostly some of the youngest TD children. Hence, there was considerable but not perfect overlap between PLI diagnoses and word learning abilities, an observation that has been repeatedly documented in the literature (e.g., Gray, 2003; Sheng & McGregor, 2010). Moreover, *t* tests indicated that the children with higher extant vocabulary were older and relatively balanced in English and Spanish proficiency and use, whereas those with lower extant vocabulary were younger in age and relatively Spanish dominant.

These characteristics suggest that the two groups were at different stages of bilingual language development. Age-related shifts toward English dominance have been revealed in previous studies of Spanish–English bilinguals (Kohnert, 2002; Kohnert, Bates, & Hernandez, 1999). The present results suggest that semantic convergence, the social–pragmatic aspect of word learning, may lead the other aspects of lexical–semantic skills in the shift toward English dominance. Specifically, children who appeared to be balanced in terms of semantic depth, vocabulary size, and general proficiency were demonstrating an English advantage when it came to semantic convergence; those who were otherwise strongly Spanish dominant (effect sizes ranging from medium to very large, with the smallest $d = .63$) showed a smaller and statistically nonsignificant Spanish advantage ($d = .32$) with regard to semantic convergence. Perhaps at the social–pragmatic level, bilingual children were already becoming more tuned in to word usage in English than Spanish, and this mechanism may act as the catalyst for dominance shift.

Also worth noting is the finding that the more advanced word learners (i.e., those with above-average NDW) exceeded the less advanced word learners in convergence scores in both languages, but the gap appeared to be larger for English. Reduced receptivity to linguistic input at the social-pragmatic level, coupled with reduced cumulative experience with English and on the part of the less advanced learners, may have rendered it more challenging for these children to generate the core set of semantic responses to the English stimuli.

Our third research goal was to identify factors that drive semantic convergence. The results indicated that for English, semantic convergence is codetermined by the child's degree of semantic convergence in Spanish, expertise in word learning (as indexed by NDW), and amount of current English use. Children who achieved greater semantic convergence in Spanish had larger combined-language vocabulary and used English to a greater extent generated more of the core set of English responses. For Spanish, the two predictors were semantic convergence scores in English and amount of current English use, with children who achieved higher English convergence scores and used more Spanish generating more of the core set of Spanish responses. The mutually predictive relationship between Spanish and English semantic convergence scores supports the notion of cross-language semantic bootstrapping as suggested by previous studies of bilingual lexical–semantic development (Kan & Kohnert, 2008; Kohnert, 2010; Sheng, 2012; Sheng et al., 2012). These cross-language associations may be attributed to the mediation of central conceptual and processing mechanisms and/or the structural similarities between English and Spanish vocabularies (see Kohnert, 2010, for a review).

The predictive power of the experiential factor (current language use) reinforces the importance of experience on semantic convergence. Conversely, NDW, a measure of vocabulary learning expertise, was a unique predictor for English but not Spanish convergence scores. It is possible that the effect of word learning expertise varies by the stage of language learning. Because children have had a longer learning history and a larger experiential base in Spanish, their overall facility with word learning may be less important.

To conclude, bilingual children with PLI produced fewer of the highly frequent responses generated by an age-and experience-matched bilingual normative sample than did their TD peers. Children with PLI also showed a weaker correlation in English association behaviors with the normative group. Both patterns suggest delays in semantic convergence. These deficits are postulated to be a result of limited information-processing capacity and slow uptake of language experience. Semantic convergence is influenced by myriad factors, such as amount of use, cross-language facilitation, and word learning expertise, which overlaps a great deal with but also differs from diagnostic status.

Several future directions may be taken to expand on the current study. First, the present findings are novel and await replication in monolingual children with PLI to help us understand the relative role of bilingualism and language impairment in semantic convergence patterns. Second, to help disentangle the effects of PLI and bilingualism on semantic convergence, future studies may also explore other norms. We opted to use a norm that consisted of bilingual children of comparable age and verbal experience. Although this approach allows us to pinpoint the effect of PLI, using monolingual age norms may better address the effect of bilingualism on semantic convergence. Another future direction is to investigate other metrics of semantic convergence. In the current study, the degree of semantic convergence, defined as the production of the top five most frequent norming responses, appeared to be quite low (ranging from 5% to 17% depending on language and NDW group). This may have to do with the particular metric chosen. Because children had three opportunities to respond and given all the possible legitimate responses, the chances of producing any five given words would not be very high. Future studies may explore other approaches to measuring semantic convergence (for alternative approaches, see Noordman et al., 2000; Schmitt, 1998a, 1998b) to yield insights from a methodological standpoint.

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References

Adams, AK., Bullock, D. Apprenticeship in word use: Social convergence processes in learning categorically related nouns. In: Kuczaj, SA., Barrett, MD., editors. The development of word meaning. New York, NY: Springer; 1987. p. 155-197.

Alt M, Plante E. Factors that influence lexical and semantic fast mapping of young children with specific language impairment. Journal of Speech, Language, and Hearing Research. 2006; 49:941–954. DOI: 10.1044/1092-4388(2006/068)

Alt M, Spaulding T. The effect of time on word learning: An examination of decay of the memory trace and vocal rehearsal in children with and without specific language impairment. Journal of

Communication Disorders. 2011; 44:640–654. DOI: 10.1016/j.jcomdis.2011.07.001 [PubMed: 21885056]

Bjorklund, DF. Children's thinking: Cognitive development and individual differences. Belmont, CA: Wadsworth; 2005.

Bjorklund DF, Thompson BE, Ornstein PA. Developmental trends in children's typicality judgments. Behavioral Research Methods & Instrumentation. 1983; 15:350–356. DOI: 10.3758/BF03203657

Capone, N., Sheng, L. Individual differences in word learning: Implications for clinical practice. In: Weiss, A., editor. Perspectives on individual differences affecting therapeutic change in communication disorders. New York, NY: Psychology Press; 2010. p. 29-56.

Clark, EV. The lexicon in acquisition. Cambridge, England: Cambridge University Press; 1995.

Clark EV. Conventionality and contrast in language and language acquisition. New Directions for Child and Adolescent Development. 2007; 115:11–23. DOI: 10.1002/cad

Davies, M. Corpus del Español (100 million words, 1200s– 1900s). 2002. Retrieved from www.corpusdelespanol.org

Davies, M. The Corpus of Contemporary American English (COCA): 400+ million words, 1990–present. 2008. Retrieved from www.americancorpus.org

Delaney HD, Maxwell SE. On using analysis of covariance in repeated measures designs. Multivariate Behavioral Research. 1981; 16:105–123. DOI: 10.1207/sl5327906mbrl601_6 [PubMed: 26800630]

Dollaghan, C. Could verbs be hubs?. In: Paul, R., editor. Language disorders from a developmental perspective. Mahwah, NJ: Erlbaum; 2007. p. 297-313.

Entwisle, D. Word associations of young children. Baltimore, MD: Johns Hopkins University Press; 1966.

Fitzpatrick T, Izura C. Word association in L1 and L2. Studies in Second Language Acquisition. 2011; 33:373–398. DOI: 10.1017/S0272263111000027

Gillam, RB., Hoffman, LM. Information processing in children with specific language impairment. In: Verhoeven, L., van Balkom, H., editors. Classification of developmental language disorders: Theoretical issues and clinical implications. Mahwah, NJ: Erlbaum; 2004. p. 137-157.

Gray S. Word learning by preschoolers with specific language impairment: What predicts success? Journal of Speech, Language, and Hearing Research. 2003; 46:56–67. DOI: 10.1044/1092-4388(2003/005)

Gray S. Word learning by preschoolers with specific language impairment: Effect of phonological and semantic cues. Journal of Speech, Language, and Hearing Research. 2005; 48:1452–1467. DOI: 10.1044/1092-4388(2005/101)

Hollingshead, AB. Four factor index of social status. Unpublished manuscript, Yale University; New Haven, CT: 1975.

Kan PF, Kohnert K. Fast mapping by bilingual preschool children. Journal of Child Language. 2008; 35:495–514. DOI: 10.1017/S0305000907008604 [PubMed: 18588712]

Kan PF, Windsor J. Word learning in children with primary language impairment: A meta-analysis. Journal of Speech, Language, and Hearing Research. 2010; 53:941–954. DOI: 10.1044/1092-4388(2009/08-0248)

Kohnert K. Picture naming in early sequential bilinguals: A 1-year follow-up. Journal of Speech, Language, and Hearing Research. 2002; 45:759–771. DOI: 10.1044/1092-4388(2002/061)

Kohnert K. Bilingual children with primary language impairment: Issues, evidence and implications for clinical actions. Journal of Communication Disorders. 2010; 43:456–473. DOI: 10.1016/j.jcomdis.2010.02.002 [PubMed: 20371080]

Kohnert K, Bates E, Hernandez AE. Balancing bilinguals: Lexical–semantic production and cognitive processing in children learning Spanish and English. Journal of Speech, Language, and Hearing Research. 1999; 42:1400–1413.

Leonard, LB. Children with specific language impairment. Cambridge, MA: MIT Press; 1998.

McGregor KK, Sheng L, Ball T. Complexities of expressive word learning over time. Language, Speech, and Hearing Services in Schools. 2007; 38:353–364. DOI: 10.1044/0161-1461(2007/037)

Miller, J., Iglesias, A. Systematic Analysis of Language Transcripts (SALT) [Research Version 2010]. Madison, WI: SALT Software LLC; 2010.

Montgomery JW. Information processing and language comprehension in children with specific language impairment. Topics in Language Disorders. 2002; 22:62–84. DOI: 10.1097/00011363-200205000-00007

Noordman, LGM., Vonk, W., Simons, WHG. Knowledge representation in the domain of economics. In: Lundquist, L., Jarvella, RJ., editors. Language, text, and knowledge: Mental models of expert communication. New York, NY: Mouton de Gruyter; 2000. p. 235-260.

Plante E, Gómez R, Gerken LA. Sensitivity to word order cues by normal and language/learning disabled adults. Journal of Communication Disorders. 2002; 35:453–462. DOI: 10.1016/S0021-9924(02)00094-1 [PubMed: 12194564]

Rice M, Oetting J, Marquis J, Bode J, Pae S. Frequency of input effects on word comprehension of children with specific language impairment. Journal of Speech and Hearing Research. 1994; 37:106–122. [PubMed: 8170118]

Richardson J, Harris L, Plante E, Gerken L. Subcategory learning in normal and language learning-disabled adults: How much information do they need? Journal of Speech, Language, and Hearing Research. 2006; 49:1257–1266. DOI: 10.1044/1092-4388(2006/090)

Riches NG, Tomasello M, Conti-Ramsden G. Verb learning in children with SLI: Frequency and spacing effects. Journal of Speech, Language, and Hearing Research. 2005; 48:1397–1411. DOI: 10.1044/1092-4388(2005/097)

Schmitt N. Quantifying word association response: What is native like? System. 1998a; 26:389–401. DOI: 10.1016/S0346-251X(98)00019-0

Schmitt N. Tracking the incremental acquisition of second language vocabulary: A longitudinal study. Language Learning. 1998b; 48:281–317. DOI: 10.1111/1467-9922.00042

Schoonen R, Verhallen M. The assessment of deep word knowledge in young first and second language learners. Language Testing. 2008; 25:211–236. DOI: 10.1177/0265532207086782

Sheng L. Lexical-semantic skills in bilingual children who are becoming English-dominant: A longitudinal study. 2012 Manuscript under review.

Sheng L, Bedore LM, Peña ED, Fiestas CE. Semantic development in Spanish–English bilingual children: Effects of age and language experience. Child Development. 2012; Advance online publication. doi: 10.1111/cdev.l2015

Sheng L, McGregor KK. Lexical-semantic organization in children with specific language impairment. Journal of Speech, Language, and Hearing Research. 2010; 53:146–159. DOI: 10.1044/1092-4388(2009/08-0160)

Sheng L, McGregor KK, Marian V. Lexical–semantic organization in bilingual children: Evidence from a repeated word association task. Journal of Speech, Language, and Hearing Research. 2006; 49:572–587. DOI: 10.1044/1092-4388(2006/041)

Sheng L, Peña ED, Bedore LM, Fiestas CE. Semantic deficits in Spanish-English bilingual children with language impairment. Journal of Speech, Language, and Hearing Research. 2012; 55:1–15. DOI: 10.1044/1092-4388(2011/10-0254)

Tomblin JB, Mainela-Arnold E, Zhang X. Procedural learning in adolescents with and without specific language impairment. Language Learning and Development. 2007; 3:269–293. DOI: 10.1080/15475440701377477

Windfuhr K, Faragher B, Conti-Ramsden G. Lexical learning skills in young children with specific language impairment (SLI). International Journal of Language and Communication Disorders. 2002; 37:415–432. DOI: 10.1080/1368282021000007758 [PubMed: 12396842]

Windsor J. Contrasting general and process-specific slowing in language impairment. Topics in Language Disorders. 2002; 22:49–61. DOI: 10.1097/00011363-200205000-00006

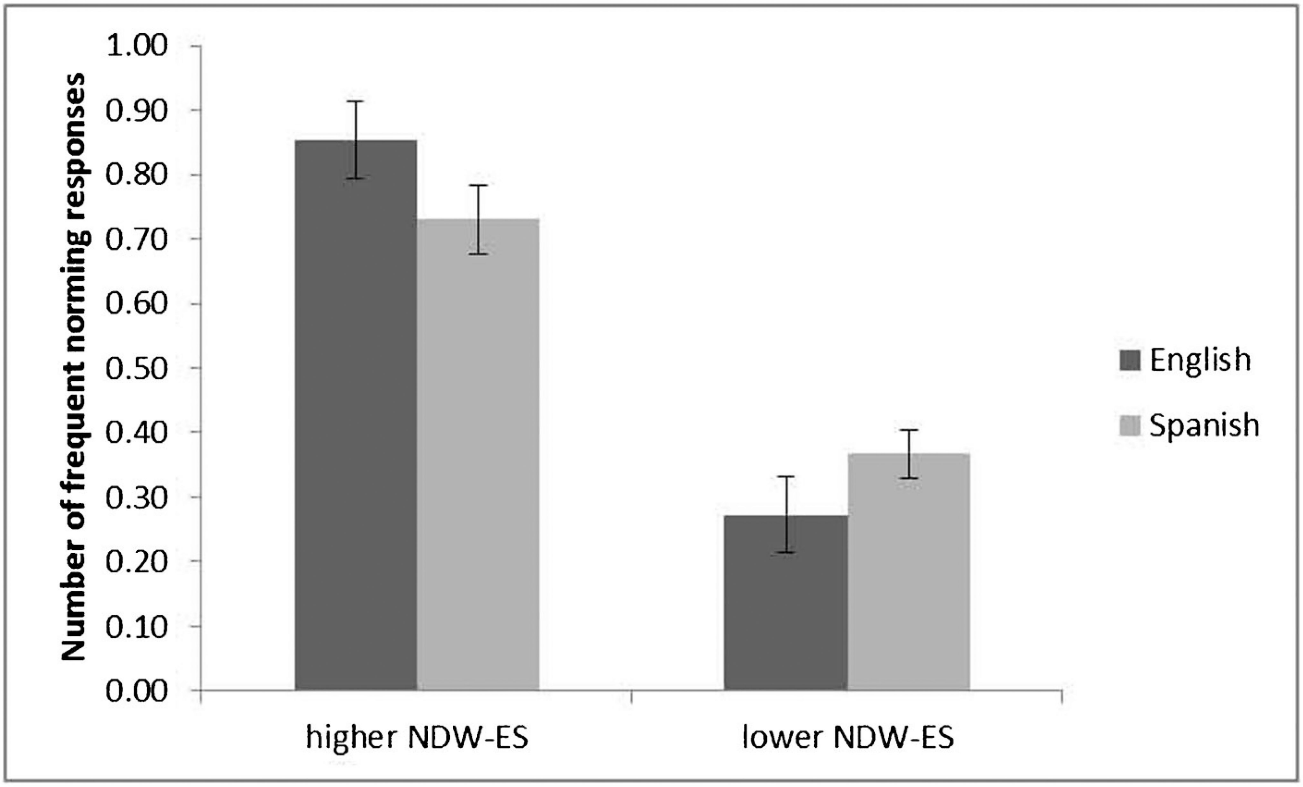

Figure 1.
Number of frequent norming responses produced in English and Spanish by children with higher (above-average) and lower (below-average) number of different words averaged over English and Spanish narrative samples (NDW-ES). Bars denote standard errors.

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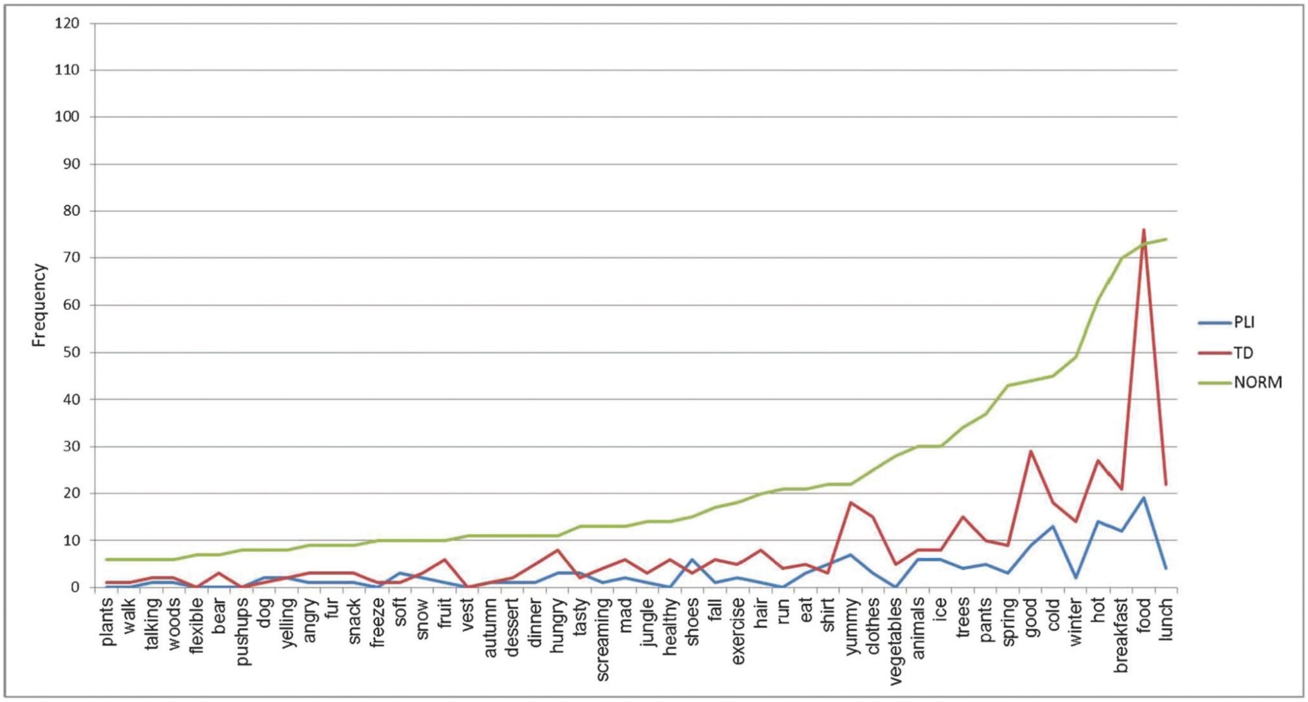

Figure 2.

Frequency of occurrence of the norming responses in the English task in the PLI, TD, and NORM groups.

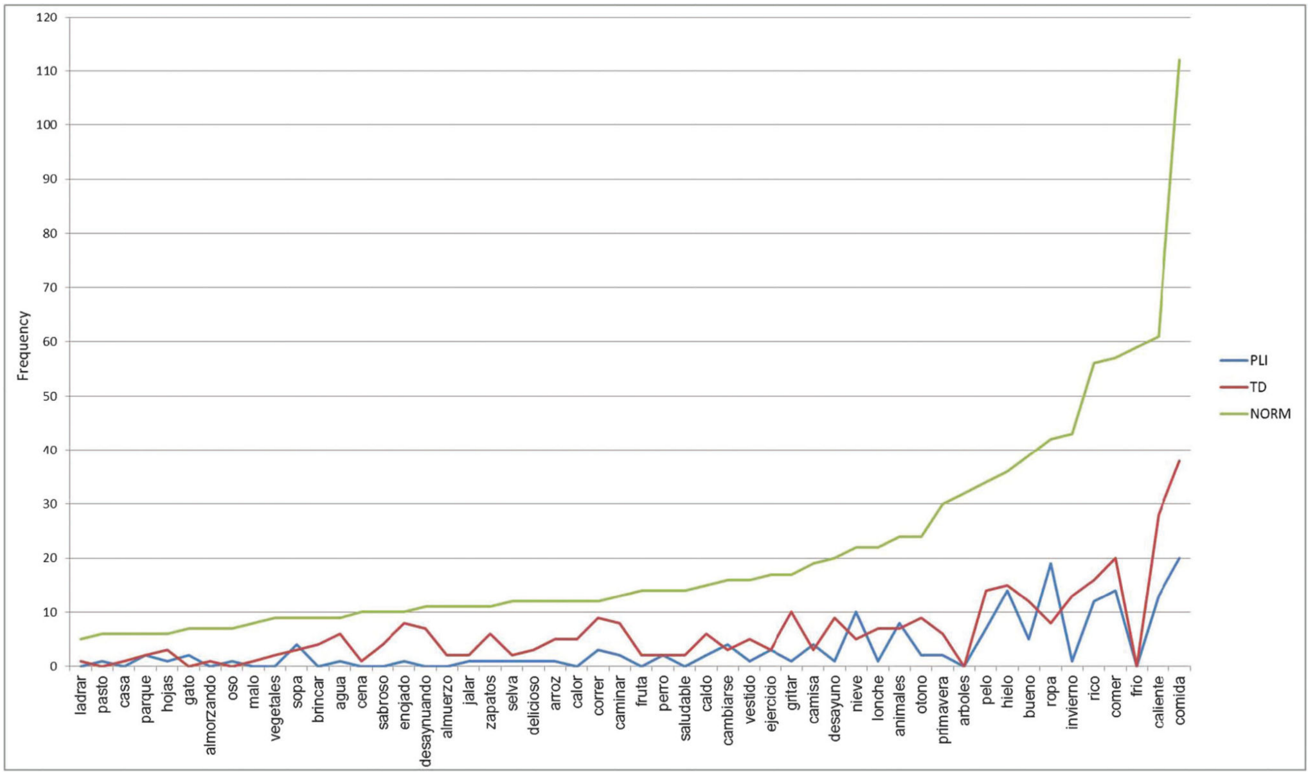

Figure 3.

Frequency of occurrence of the norming responses in the Spanish task in the PLI, TD, and NORM groups.

Table 1

Participant information presented in means (*SD*s).

Variable	NORM	PLI	TD	Lower NDW	Higher NDW
n	112	37	37	37	37
Sex	57 girls, 55 boys	9 girls, 28 boys	19 girls, 18 boys	13 girls, 24 boys	15 girls, 22 boys
Age in months	101 (9.24)	100 (11.94)	100(11.78)	96 (10.51)	105(11.35)
SES[a]	21.38(8.54)	20.91 (8.82)	21.32 (8.96)	21.74(11.41)	20.74 (5.28)
Age of English exposure		4.08(1.86)	3.95(1.72)	4.24(1.67)	3.78 (1.87)
English use (%)	44(9)	43 (13)	43 (12)	40 (14)	51 (16)
English rating[b] (parent)	3.74 (0.86)	2.93 (0.94)	3.92 (0.76)	2.82 (1.04)	3.99 (0.68)
Spanish rating[b] (parent)	4.59 (0.48)	3.94 (0.71)	4.60 (0.47)	4.15(0.71)	4.39 (0.64)
English rating[b] (teacher)	3.82 (0.95)	2.69 (0.83)	3.81 (0.92)	2.56 (0.81)	3.90 (0.77)
Spanish rating[b] (teacher)	4.29(1.27)	3.32 (0.66)	4.24(1.49)	3.45 (0.99)	4.13 (1.37)
NDW—English		64.83 (35.13)	104.35(35.35)	52.38(21.36)	116.81 (26.39)
NDW—Spanish		76.43(31.10)	110.35(33.16)	66.16 (20.03)	120.62 (27.08)
Semantic depth—English		.20 (.15)	.40 (.20)	.17 (.16)	.43 (.16)
Semantic depth—Spanish		.27 (.13)	.46 (.15)	.26 (.12)	.47 (.14)

Note. Semantic depth scores were calculated in Sheng et al. (2012). NORM = normative; PLI = primary language impairment; TD = typically developing; NDW = number of different words; SES = socioeconomic status.

[a]The Hollingshead (1975) Four Factor Index of Social Status was used to calculate SES scores.

[b]Proficiency rating was based on a 5-point rating scale (1 = *low proficiency*, 5 = *high proficiency*).

Table 2

Word stimuli, frequency of occurrence, and most frequent associations produced by the NORM group.

English			Spanish		
Word	Frequency[a]	Most frequent associations	Word	Frequency[b]	Most frequent associations[c]
frozen	10.1	cold: 45	*congelado*	1.2	*frio* (cold): 59
		ice: 30			*hielo* (ice): 36
		hot: 20			*caliente* (hot): 22
		snow: 10			*nieve* (snow): 22
		freeze: 10			*agua* (water): 9
delicious	1.9	good: 31	*delicioso*	1.6	*rico* (delicious): 56
		yummy: 22			*bueno* (good): 28
		tasty: 13			*comida* (food): 14
		food: 11			*sabroso* (tasty): 10
		hungry: 11			*sopa* (soup): 9
nutritious	1.3	healthy: 14	*nutritivo*	4.6	*fruta* (fruit): 14
		good: 13			*saludable* (healthy): 14
		vegetables: 11			*bueno* (good): 11
		fruit: 10			*vegetales* (vegetables): 9
		food: 8			
furry	0.2	hair: 20	*peludo*	0.2	*pelo* (hair): 34
		soft: 10			*perro* (dog): 10
		fur: 9			*gritar* (to shout): 8
		dog: 8			*oso* (bear): 7
		bear: 7			*gato* (cat): 7
forest	115.2	trees: 34	*bosque*	172.2	*arboles* (trees): 32
		animals: 30			*animales* (animals): 24
		jungle: 14			*selva* (jungle): 12
		woods: 6			*pasto* (pasture): 6
		plants: 6			*parque* (park): 6
					hojas (leaves): 6
					casa (house): 6

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English			Spanish		
Word	Frequency[a]	Most frequent associations	Word	Frequency[b]	Most frequent associations[c]
summer	80.2	winter: 49	*verano*	82.4	*invierno* (winter): 43
		spring: 43			*primavera* (spring): 30
		hot: 27			*caliente* (hot): 25
		fall: 17			*otoño* (fall): 24
		autumn: 11			*calor* (heat): 12
dinner	15.1	breakfast: 45	*cena*	9.4	*comida* (food): 45
		lunch: 44			*comer* (eat): 40
		food: 26			*lonche* (lunch): 22
		dessert: 11			*desayuno* (breakfast): 20
		snack: 9			*almuerzo* (lunch): 11
soup	4.4	eat: 21	*sopa*	1.6	*comida* (food): 23
		hot: 14			*comer* (to eat): 17
		food: 11			*caldo* (soup): 15
		vegetables: 9			*caliente* (hot): 14
		lunch: 8			*arroz* (rice): 12
eating	68.5	breakfast: 25	*comer*	48.6	*comida* (food): 25
		lunch: 22			*delicioso* (delicious): 12
		food: 17			*desaynuando* (eating breakfast): 11
		dinner: 11			*cena* (dinner): 10
		vegetables: 8			*almorzando* (eating lunch): 7
wearing	67.4	clothes: 27	*vestirse*	40.2	*ropa* (clothes): 42
		pants: 37			*camisa* (shirt): 19
		shirt: 22			*vestido* (dress): 16
		shoes: 15			*cambiarse* (to change clothes): 16
		vest: 11			*zapatos* (shoes): 11
stretching	25.1	run: 21	*estirar*	8	*ejercicio* (exercise): 17
		exercise: 18			*caminar* (walking): 13
		pushups: 8			*correr* (to run): 12
		flexible: 7			*jalar* (to pull): 11
		walk: 6			*brincar* (to jump): 9

English			Spanish		
Word	**Frequency**[a]	**Most frequent associations**	**Word**	**Frequency**[b]	**Most frequent associations**[c]
growling	0.6	mad: 13	*gruñir*	0.8	*enojado* (mad): 10
		screaming: 13			*gritar* (to shout): 9
		angry: 9			*malo* (bad): 8
		yelling: 8			*ladrar* (to bark): 5
		talking: 6			*perro* (dog): 4

Note. Words are arranged by word class (adjectives, nouns, verbs) and frequency of occurrence in English. Numbers after the colons indicate the number of children among the 112 children in the NORM group who produced the associations.

[a]Frequency of occurrence per million according to Davies (2008). Mean frequency = 32.50 (*SD* = 39.60).

[b]Frequency of occurrence per million according to Davies (2002). Mean frequency = 30.90 (*SD* = 51.50).

[c]English translations of Spanish words are in parentheses.