Research Article

Novel Morpheme Learning in Monolingual and Bilingual Children

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Purpose: The purpose of the present study was to examine the utility of a novel morpheme learning task for indexing typical language abilities in children characterized by diverse language backgrounds.

Method: Three groups of 5- to 6-year-old children were tested: monolingual speakers of English, native speakers of Spanish who also spoke English (Spanish-L1 bilinguals), and native speakers of English who also spoke Spanish (English-L1 bilinguals). All children were taught a new derivational morpheme /ku/ marking part-whole distinction in conjunction with English nouns. Retention was measured via a receptive task,

and sensitivity and reaction time (RT) data were collected.

Results: All three groups of children learned the novel morpheme successfully and were able to generalize its use to untaught nouns. Furthermore, language characteristics (degree of exposure and levels of performance on standardized measures) did not contribute to bilingual children's learning outcomes.

Conclusion: Together, the findings indicate that this particular version of the novel morpheme learning task may be resistant to influences associated with language background and suggest potential usefulness of the task to clinical practice.

The difficulty in establishing whether low scores on language measures in bilingual children reflect an underlying language impairment or a temporary lag in language-specific knowledge is well known (Kohnert, 2010). A number of alternatives to standardized assessments have been considered, with limited training tasks gaining prominence as evidence accumulates of their sensitivity to language impairment in both monolingual (Bellaire, Plante, & Swisher, 1994; Connell, 1987; Connell & Stone, 1992; Ravid, Levie, & Avivi-Ben Zvi, 2003) and bilingual (Roseberry & Connell, 1991) children. These limited training tasks, where children are exposed to the to-be-learned information briefly and are then tested on their ability to retrieve and apply this information, are clinically appealing because of the ease with which they can be administered, scored, and interpreted.

The limited training task that has been explored most frequently by prior studies is one where children are taught a new derivational morpheme, typically indexing a

part-whole distinction. This task can successfully identify *monolingual* children with language impairment (Connell, 1987; Connell & Stone, 1992); however, its ability to do so with *bilingual* populations is not clear (Restrepo, 1998). In order to understand whether the morpheme-learning task can become a useful diagnostic tool in the bilingual assessment process, it is important to examine whether this task is similarly sensitive to typical language abilities in children characterized by different language backgrounds. To this end, in the present study we administered a novel morpheme learning task to three groups of age-matched typically developing children: bilingual children who acquired Spanish first, followed by English; bilingual children who acquired English first, followed by Spanish; and monolingual English-speaking children.

Derivational Morpheme Learning and Language Impairment

The acquisition of *derivational morphemes* (which change the word's meaning or its part of speech; e.g., the suffix *-ness* in English) has often been likened to lexical rather than syntactic learning (e.g., Anderson, 2001). However, just like *inflectional morphemes* (which express grammatically required features but do not change the word's meaning or part of speech; e.g., the past tense suffix *-ed* in English), derivational morphemes are governed by rules.

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Therefore, although inflectional morphology is considered to be the primary area of difficulty in children with specific language impairment (SLI; Leonard, 1998), it is not surprising that there is also some evidence suggesting that children with SLI have difficulty with derivational morphology (Dalalakis, 1994; Piggott & Kessler Robb, 1999; Ravid et al., 2003; Ullman & Gopnik, 1999).

The first studies to examine whether an artificial morpheme learning paradigm would be sensitive to an impairment in the linguistic system in childhood were conducted by Connell (1987) and Connell and Stone (1992). In both studies, children with SLI and children with typical language skills were taught an invented derivational morpheme whereby a suffix (the vowel schwa) was attached to a noun to represent a part of the object denoted by the noun (e.g., *book* – *book-ə*). The children with SLI had marked difficulty with learning the new derivational morpheme, especially when it was taught via modeling only and when *production* (rather than *comprehension*) of the new morpheme was probed. Therefore, the interpretation of these findings was that children with SLI do not have difficulties with the derivational process itself but with the ability to retrieve it online under processing-heavy conditions.

A number of follow-up studies to Connell (1987) and Connell and Stone (1992) were published over the past three decades, with the findings generally confirming that children with SLI have difficulty learning novel derivational morphology (Bellaire et al., 1994; Kiernan & Snow, 1999; Ravid et al., 2003), that this difficulty is more pronounced for the more difficult production tasks than for comprehension tasks (Bellaire et al., 1994; Ravid et al., 2003), and that these deficits extend from the preschool to the school-age period (Bellaire et al., 1994). In general, the patterns of findings are consistent and compelling enough across studies to indicate that limited training tasks where children are taught a new derivational morpheme have potential for reliably distinguishing children with language impairment from children without language impairment. These tasks were therefore very appealing to researchers aiming to develop suitable tools for the diagnosis of language impairment in bilingual children; however, the enthusiasm for such tasks has since weakened as their ability to accurately index language function in *typically developing* bilingual children has been called into question.

Novel Morpheme Learning in Bilingual Children

The first study to examine the utility of a morpheme-learning task for accurately distinguishing bilingual children with and without language impairment was conducted by Roseberry and Connell (1991). Using the paradigm developed by Connell et al. (Connell, 1987; Connell & Stone, 1992), Roseberry and Connell (1991) tested the acquisition of the part-whole morpheme /-ə/ in Spanish-English bilingual children, who were either acquiring English typically or who were suspected of having SLI. The children were taught the morpheme in the context of English nouns, and their retention of the novel morpheme was tested expressively.

Roseberry and Connell (1991) found that children suspected of having SLI performed markedly less well on this novel morpheme task than did their typically developing, age-matched peers. Because the task was administered to the children in their weaker, second language (i.e., English), the findings were interpreted to suggest that the usual difficulties associated with administering English-only standardized measures to bilingual children in order to document a language impairment do not apply to learning tasks. However, this conclusion did not find support in another study of bilingual children with and without SLI (Restrepo, 1998). That is, Restrepo (1998) found that performance on a novel morpheme learning task did not discriminate between Spanish-speaking children with and without SLI. In both studies, learning was probed via a production measure; however, a number of differences exist between the two studies that may have contributed to the differences in the results. These differences include, but are not limited to, the ages of the children and the characteristics of the children defined as having SLI, the phonological structure of the novel morpheme, the task parameters, and the language of task administration (i.e., English in Roseberry & Connell, 1991; Spanish in Restrepo, 1998). Nevertheless, the noncongruent findings raise concerns regarding the degree to which morpheme-learning tasks may be useful in indexing the atypicality of the language system in bilingual children. Furthermore, the patterns of *typically developing* bilingual children's performance on learning-type paradigms appear to be rather complex and cast some doubt on the utility of limited-training tasks in the diagnostic process.

There is significant variability in typically developing bilingual children's performance on novel morpheme-learning tasks, and this variability poses a challenge to the ability to dissociate typical from atypical performance in the bilingual population. For instance, Hwa-Froelich and Matsuo (2005) examined young typically developing Vietnamese children's performance on a number of learning tasks, including the novel morpheme learning task developed by Connell and colleagues (Connell, 1987; Connell & Stone, 1992; Roseberry & Connell, 1991). The children spoke some Vietnamese and some English, but Vietnamese was spoken in the homes of all the children. The novel morpheme learning task involved children learning to apply a novel derivational suffix /po/ to mark part-whole relationships. This novel morpheme resembled a Vietnamese syllable but was paired with English words. Both receptive and expressive retention measures were utilized, and yielded distinct findings. Although most children (86%) demonstrated successful receptive learning of the new morpheme, the vast majority of these same children struggled with the expressive retention task, and 12 out of the 21 children tested attained only 25% accuracy or less on the expressive measure.

In another study of bilingual children's novel morpheme learning, Kohnert and Danahy (2007) tested two groups of young typically developing Spanish-English bilingual children who were dominant in Spanish. The question at the core of this study was whether language

experience shapes bilingual children's performance on morpheme-learning tasks. One group of children was taught the same novel derivational morpheme in English as in the Roseberry and Connell (1991) study—namely, the schwa vowel denoting “part of” when attached as a suffix to the English noun. The second group of children was taught the same derivational contrast in Spanish, where the suffix /be/ was designed to be consistent with Spanish phonotactic constraints and was attached to Spanish nouns. The children's retention of the new morpheme was tested expressively. Kohnert and Danahy (2007) hypothesized that if language experience and levels of language knowledge indeed play no role in how children perform on morpheme-learning tasks, then there should be no differences between the two groups. However, they found very strong effects of language experience, such that the majority of the children who were taught the Spanish version of the suffix learned it, whereas the vast majority of the children who were taught the English version of the suffix failed to learn it. It is important to note here that in another study where bilingual children were taught the same two derivational suffixes (i.e., /ə/ and /be/) using both languages, a different pattern of findings was obtained. Specifically, Boyer and Martin (2012) taught the part-whole distinction in just English or in both English and Spanish to Spanish-English bilingual children 3 to 5 years of age. They found reliable age effects in their morpheme-learning data (measured via the same expressive procedure as in Kohnert & Danahy, 2007), but no language of administration effects. However, unlike Kohnert and Danahy, Boyer and Martin (2012) taught the Spanish version of the morpheme alongside the English version of the morpheme and manipulated language (i.e., English only vs. Spanish-English) within (rather than across) subjects. It is therefore unclear to what extent the different methodological approaches in the two articles contributed to the different findings.

In interpreting the results of their study, Kohnert and Danahy (2007) concluded that the strength of the language system constrains the ability to learn new morphology within that system: the stronger the system, the better the learning. This conclusion casts some doubt on the ability to utilize the morpheme-learning task to index language impairment in bilingual children because it means that typically developing bilingual children's performance on this task varies with their level of experience with the language of administration. Thus, the inherent value of the task as conceptualized by Roseberry and Connell (1991)—that is, its imperviousness to fluctuations in language knowledge associated with experience—would be compromised. However, we would argue that this conclusion is premature and is likely to be anchored to the use of expressive measures to index morpheme-learning performance. It is well known that bilingual children tend to make expressive gains in their L2 at a slower pace than receptive gains (e.g., Gibson, Oller, Jarmulowicz, & Ethington, 2012; Gibson, Peña, & Bedore, 2014; Junker & Stockman, 2002; Kan & Kohnert, 2005; Pearson, Fernandez, & Oller, 1993; Yan & Nicoladis, 2009). Therefore, it is highly likely that their ability to apply the

newly acquired derivational morpheme to words in their second language expressively is strongly linked to their overall levels of expressive ability in their second language. Conversely, comprehension tasks (which are usually easier than production tasks) may capture bilingual children's typical morpheme-learning abilities even when their expressive second language skills are relatively low.

Of course, one important point to consider is that in the *monolingual* literature, production rather than comprehension tasks tend to distinguish children with SLI from children with typical language skills (Bellaire et al., 1994; Connell, 1987; Connell & Stone, 1992; Ravid et al., 2003). However, the use of production tasks in the second language appears to render morpheme-learning performance in typically developing bilingual children so low as to be uninterpretable (Hwa-Froelich & Matsuo, 2005; Kohnert & Danahy, 2007), and the usefulness of such production tasks in demarcating language impairment in bilingual children is also uncertain (Restrepo, 1998). In light of these considerations, in the present study, we focused on a comprehension measure as the index of morpheme-learning performance in bilingual children and asked whether comprehension performance on the morpheme-learning task would be sensitive to distinct levels of language experience within a sample of typically developing bilingual children. We also examined whether the structure of children's native language would influence their morpheme-learning performance.

Morpheme Learning in the Context of Language Structure and Language Knowledge

One possibility considered by Kohnert and Danahy (2007) when interpreting their participants' lower levels of morpheme learning in English versus Spanish was that this finding may have been driven by differences between the English and the Spanish morphological systems. Indeed, languages differ in how consistently, reliably, and redundantly they mark morphosyntactic categories. Specifically, Spanish differs from English in that Spanish is characterized by a highly regular and redundant morphological system where the nouns, determiners, and adjectives are all marked to index plurality and gender. There is a wealth of data indicating that learners are highly sensitive to cue redundancy and that a co-occurrence of cues acts to strengthen the acquisition of morphological contrasts (Billman & Knutson, 1996; Lew-Williams & Fernald, 2007; Yoshida & Smith, 2005). Differences in cue redundancy to morphosyntactic categories across languages influence the timeline of morphological acquisition. For example, Arijas-Trejo, Cantrell, Smith, and Alva Canto (2014) showed that children acquiring Spanish demonstrated successful comprehension of noun morphology at age 2;0 (years; months), a full year earlier than children acquiring English. The authors attributed this finding to the fact that, in Spanish, the structure of plurals is more redundant and phonologically more consistent than in English. A similar possibility was contemplated by Kohnert and Danahy (2007)

when interpreting their findings: Because Spanish has a more rich system of noun morphology than does English, a novel derivational morpheme marking a distinction on a noun may have been easier for the children to accept when introduced to them in Spanish. Together, these findings point to a possibility that morpheme-learning tasks are in fact susceptible to variability in language experience and knowledge within the gamut of *typical* language skills. However, there is very little research examining whether levels of language experience and knowledge predict performance on morpheme-learning tasks, and the research that does exist does not paint a cohesive picture.

A number of prior studies that have examined novel morpheme learning in children have done so in the context of tasks that also involved the learning of novel words. In such studies, there is reliable evidence that children's performance on word-learning tasks is associated with their ability to retain and generalize the use of a novel morpheme (Hwa-Froelich & Matsuo, 2005; Nakamura, Plante, & Swisher, 1990; Swisher & Snow, 1994). For instance, Swisher and Snow (1994) found a nonlinear relationship between word-learning performance and generalization of the newly learned bound morpheme, such that high levels of morpheme generalization occurred only in children who attained high levels of word learning. Further, this was the case for both children with typical language and children with SLI. With respect to bilingual children, Hwa-Froelich and Matsuo (2005) found significant relationships between morpheme-learning and fast-mapping performance in Vietnamese-English-speaking children in their study. Conversely, Restrepo, Swisher, Plante, and Vance (1992) did not observe a relationship between children's morpheme-learning performance and their receptive vocabulary skills tested via a standardized measure. Similarly, in the sample of bilingual children tested by Boyer and Martin (2012), teacher ratings of children's language abilities (i.e., strong vs. weak language learner) did not align with children's morpheme-learning performance.

In summary, then, the relationship between children's performance on morpheme-learning tasks and their linguistic experiences remains unclear. On the one hand, it appears that language experience can shape morpheme-learning performance (e.g., Kohnert & Danahy, 2007). On the other hand, studies that have attempted to link children's morpheme-learning performance with their language abilities as indexed by knowledge-based measures have yielded rather inconsistent findings (e.g., Restrepo et al., 1992). Therefore, one goal of the present study was to examine whether bilingual children's performance on a morpheme-learning task would be related to the morphological structure of their native language and to their language skills.

The Present Study

Prior work indicates that a novel morpheme learning task can reliably distinguish monolingual children with SLI from children with typical language skills (Bellaire et al., 1994; Connell, 1987; Connell & Stone, 1992; Kiernan &

Snow, 1999; Ravid et al., 2003). However, in bilingual children, the usefulness of a novel morpheme learning task for identifying SLI is not clear (Restrepo, 1998), and indeed, its ability to index typical language abilities in bilingual populations has been called into question (Kohnert & Danahy, 2007). To us, it appeared that to move this line of research forward, at least three questions had to be answered. First, how do children characterized by different language experiences perform on the same morpheme-learning task? Second, does the structure of children's native language (and specifically, the density of its morphological markers) influence their performance on the morpheme-learning task? And third, is there an association between children's language experience (as captured by measures of language knowledge and, for bilingual children, levels of language exposure) and their performance on the morpheme-learning task? The present study was designed to address these three questions.

To this end, we tested three groups of typically developing children between the ages of 5 and 6 years: monolingual English-speaking children, bilingual children who spoke Spanish as their native language and acquired English as their second language, and bilingual children who spoke English as their native language and acquired Spanish as their second language. The children were taught a new morpheme, /ku/, denoting a part-whole distinction when added to the end of high-frequency, early acquired English nouns. Testing was conducted receptively because expressive testing measures have yielded very poor levels of morpheme-learning performance in bilingual children tested in their second language (e.g., Hwa-Froelich & Matsuo, 2005; Kohnert & Danahy, 2007). Unlike prior studies of morpheme-learning performance that targeted only accuracy at testing, we collected both accuracy data and reaction time (RT) data.

Two considerations motivated the collection of RT data. First, RT measures could yield crucial information for the effort of designing a morpheme-learning task that would capture typical language abilities in bilingual children. Processing deficits are well established in children with SLI (e.g., Bishop, 1992; Gathercole & Baddeley, 1990; Hanson & Montgomery, 2002; Leonard et al., 2007; Leonard, McGregor, & Allen, 1992), such that children with SLI are characterized by slower RTs than their typically developing peers on a wide array of linguistic and nonlinguistic tasks. Therefore, the speed—rather than (or in addition to) the accuracy with which children perform the morpheme-learning task—could speak to the status of their language system. Second (and related), if we found that the children in the three typically developing groups attained similar accuracy levels on the morpheme-learning task but took different amounts of time to do so, the findings would speak to different amounts of cognitive effort required for task completion across the three groups.

The goal behind testing two groups of bilingual children who spoke English and Spanish but acquired the two languages in a different sequence was to segregate the impact of being tested in the second language from the

impact of knowing a language with a dense morphological system. Because Spanish has a denser noun morphology than does English, experience with Spanish may facilitate children's ability to acquire a new bound morpheme that modifies nouns. Thus, were we to test only the Spanish–English bilingual group, and were we to find similar levels of performance between them and the monolingual English-speaking children, an argument could be made that experience with Spanish compensated for the bilingual children's weaker English language skills, thus nullifying group differences. Therefore, we reasoned that if experience with Spanish facilitates performance on the novel morpheme task, then English–Spanish bilingual children tested in their native language would outperform the monolingual children. Conversely, if we were successful in designing a task that would not be sensitive to levels of experience either with English or with Spanish, the two groups of bilingual children should perform similarly to each other and to the monolingual group.

Method

Participants

The current study included three groups of 5- to 6-year-old children: (a) 25 monolingual English-speakers with no more than 5% current exposure to another language during a typical week and no significant past exposure, (b) 28 Spanish-L1 bilinguals who acquired Spanish from birth and English during infancy or early preschool years, and (c) 19 English-L1 bilinguals who acquired English from birth and Spanish through dual-language immersion programs.¹ The children were recruited through the Madison, WI, public schools and local community centers. Exclusion criteria included significant current exposure (more than 5% during a typical week) to a language other than English or Spanish, significant past exposure to a language other than English or Spanish, diagnosed language impairment or low standard language scores (below 75) in both languages combined with parent concerns, learning disabilities, psychological/behavioral disorders, neurological impairment, and other developmental disabilities. All children passed a pure tone hearing screening at 20 dB at 1000 Hz, 2000 Hz, and 4000 Hz bilaterally. Four children (one monolingual, two Spanish-L1 bilinguals, and one English-L1 bilingual) who initially met eligibility criteria were excluded because they provided null responses on more than 50% of the trials during the morpheme-learning task, and two children were excluded due to a recording error.

Demographic information for the three groups is provided in Table 1. The groups did not differ in age, but they differed significantly in socioeconomic status (SES; as

indexed by parental level of education) and English language skills and marginally in nonverbal IQ. Specifically, the Spanish-L1 bilingual children came from lower SES and had poorer English language skills than the other two groups, and the English-L1 bilingual children had marginally lower nonverbal IQ scores than did the monolingual group. Ethnic background varied by group, with the majority of monolingual and English-L1 bilingual children identifying as White/Caucasian and the majority of Spanish-L1 bilinguals identifying as Hispanic.

Children's parents were thoroughly interviewed regarding the children's language acquisition and language exposure history. Current levels of language exposure were determined by asking the parent to complete an hour-by-hour exposure assessment grid such that for every day of a typical week (including the weekend), the parent indicated which language (English, Spanish, or both) was spoken around the child. The total number of hours for which a child was exposed to each language during a typical week was divided by the child's total waking hours to determine percent exposure to each language. The two bilingual groups represented distinct bilingual acquisition experiences. Compared to the English-L1 group, the Spanish-L1 group acquired Spanish earlier and English later, was exposed to Spanish more frequently during a typical week, was more likely to hear Spanish in the home, and had better Spanish language abilities in all areas except receptive language. Characteristics of the two bilingual groups are provided in Table 2.

Procedure

The children participated in two to three testing sessions in a research laboratory. The novel morpheme-learning task was always administered at the beginning of a session. Parents were interviewed in their preferred language about their child's developmental history, education, language use and exposure, relevant medical history, and family background. In addition, parents provided information about their education level (as a proxy for SES) and about their own language background by completing the Language Experience and Proficiency Questionnaire (LEAP-Q; Marian, Blumenfeld, & Kaushanskaya, 2007). Education level was scored using a Likert scale: 1 = *less than high school*; 2 = *high school or General Educational Development (GED)*; 3 = *some college*; 4 = *college*; and 5 = *at least some graduate school*. These Likert scale values were converted to *z* scores for analyses.

Novel Morpheme Learning Task

We designed an experimental task to teach children a novel derivational morpheme, /ku/, which signified “part of” when added to the end of an English noun. The phonological structure of the morpheme was carefully considered: we aimed to target phonology and syllable structure that would not be conditioned by familiarity with either English or Spanish. Thus, we followed Anderson (2001), Havas,

¹At the time of the study, the dual-language immersion programs in Madison followed the 90/10 model, where children were exposed to Spanish 90% of the time during the first grade, 80% during the second grade, and so on.

Table 1. Participant characteristics ($N = 72$).

Characteristic	Monolingual	Bilingual Spanish-L1	Bilingual English-L1	<i>F</i>
<i>n</i>	25 (13 boys, 12 girls)	28 (14 boys, 14 girls)	19 (7 boys, 12 girls)	
Age (years)	6.18 (0.55)	6.13 (0.54)	6.32 (0.37)	0.83
SES (education levels 1–5) ^c	4.04 (0.93) ^a	3.18 (1.56) ^b	4.16 (1.17) ^a	4.45*
Nonverbal IQ (KBIT-2)	112.40 (17.40) ^a	105.43 (15.80)	100.11 (16.77) ^b	3.04 [†]
English Core Language ^d	118.20 (11.54) ^a	95.65 (20.97) ^b	112.94 (11.34) ^a	13.95***
English Receptive Language ^d	117.32 (7.97) ^a	105.25 (14.39) ^b	112.37 (10.79)	7.32***
English Expressive Language ^d	117.12 (12.17) ^a	94.23 (20.32) ^b	111.65 (11.06) ^a	14.72***
English Morphology ^e	11.92 (2.34) ^a	9.18 (3.26) ^b	10.89 (2.13)	7.03**
Ethnicity: Hispanic	0	23	0	
Race				
White/Caucasian	23	8	19	
Black/African American	1	0	0	
Multi-racial	1	0	0	
Unreported	0	20	0	

Note. Significant group differences yielded by one-way ANOVA. KBIT-2 = Kaufman Brief Intelligence Test–Second Edition (Kaufman & Kaufman, 2004).

^{a,b}Different superscript letters (^a, ^b) indicate groups that differed significantly from each other in Bonferroni follow-up comparisons.

^cSocioeconomic status (SES) was indexed by the highest level of education completed by the child's primary caregiver, where 1 = *less than high school*; 2 = *high school or General Educational Development (GED)*; 3 = *some college*; 4 = *college*; 5 = *at least some graduate school*.

^dStandard scores from the Clinical Evaluation of Language Fundamentals–Fourth Edition (CELF-4; Semel, Wiig, & Secord, 2003). ^eWord Structure subtest scaled score from the CELF-4.

[†] $p < .06$. * $p < .05$. ** $p < .01$. *** $p \leq .001$.

Waris, Vaquero, Rodriguez-Fornells, and Laine (2015), and Kohnert and Danahy (2007) in selecting a consonant–vowel (CV) syllable rather than a single vowel or a single consonant as the target morpheme, considering that the CV syllable structure is common both in English and in Spanish. In choosing the particular sounds /k/ and /u/, we were motivated by the fact that both sounds exist in both languages and are realized rather similarly phonetically. The vowel in particular had to be carefully selected, because vowels /a/

and /o/ in Spanish are associated with gender markings (see Havas et al., 2015), and the vowel /i/ in combination with most consonants of English yields a real English word or existing affix. Because word-final /u/ is rarely used in multisyllabic words in both English and Spanish, it was ideally suited for the present study. That is, independent of their experience with English or Spanish, all children should have been equally unfamiliar (or familiar) with this particular CV combination at the end of a word. One caveat to this is

Table 2. Characteristics of bilingual participants.

Characteristic	Bilingual Spanish-L1	Bilingual English-L1	<i>t</i>
Age of exposure to English (months)	14.42 (20.42)	0 (0)	3.601***
Age of exposure to Spanish (months)	1.19 (4.80)	56.94 (10.84)	−19.97***
Current % exposure to English ^a	48.42% (19.67)	63.17% (11.67)	−3.22**
Current % exposure to Spanish ^a	51.46% (19.62)	36.84% (11.67)	3.20**
School language ^b			
English-only	46%	0%	
At least 50% instruction in Spanish	54%	100%	
Language heard at home ^b			
English	21.5%	100%	
Spanish	71.5%	0%	
Both	7%	0%	
Spanish Core Language ^c	95.04 (14.96)	78.67 (15.51)	3.31**
Spanish Receptive Language ^c	104.89 (15.71)	101.58 (12.20)	0.77
Spanish Expressive Language ^c	92.52 (14.24)	72.13 (15.00)	4.30***
Spanish Morphology ^d	7.86 (3.67)	3.44 (2.46)	4.49***

^aExposure to each language calculated as a proportion of waking hours during a typical week. ^bPercentages reflect the percent of children from the group in each category. ^cStandard scores from the Clinical Evaluation of Language Fundamentals–Fourth Edition, Spanish (CELF-4 Spanish; Wiig, Semel, & Secord, 2006). ^dWord Structure subtest scaled score from the CELF-4 Spanish.

** $p < .01$. *** $p \leq .001$.

that, in English, the word “coo” does exist; however, it is late-acquired and extremely low in frequency (Kuperman, Stadthagen-Gonzalez, & Brysbaert, 2012), and so is therefore highly unlikely to have been familiar to the children.

Twelve pictures were selected from the International Picture Naming Project (Center for Research in Language, 2011) to have English and Spanish labels that were similar in frequency of use ($M_{\text{English}} = 3.73$, $SD = 1.32$; $M_{\text{Spanish}} = 3.56$, $SD = 1.17$; calculated as $\ln[1 + \text{freq per million}]$ based on the Corpus of Contemporary American English [Davies, 2008] and the Corpus del Español [Davies, 2002]), age of acquisition (acquired in both languages before age 30 months or in both languages after age 30 months, based on ratings from the English and Spanish versions of the MacArthur Communicative Development Inventories provided in the International Picture Naming Project database [Center for Research in Language, 2011]), and number of alternate names (no more than two alternate names in each language, based on norms collected by Bates et al. [2003]). All images were set to a size of 300×300 pixels with a resolution of 72 pixels/inch. This set of 12 items was divided into two lists, List A (*bed, couch, door, flag, helmet, table*) and List B (*book, hat, heart, pencil, shovel, wheel*). The lists did not differ significantly from each other in English frequency of use, $Mdn_A = 3.78$, $Mdn_B = 3.46$, $U = 17.0$, $z = -0.16$, $p = .873$; Spanish frequency of use, $Mdn_A = 3.71$, $Mdn_B = 3.10$, $U = 16.0$, $z = -0.32$, $p = .749$; English age of acquisition rating; $\chi^2(2) = 0.476$, $p = .788$; or Spanish age of acquisition rating, $\chi^2(2) = 0.667$, $p = .717$. Items with two-syllable names in English were distributed evenly between lists.

The stimuli consisted of simple black-and-white line drawings of the 12 objects, which were animated in Adobe Flash CS3 (Adobe Systems, 2007) and combined with voice recordings to create videos. Recordings of the English names of each object with and without the novel ending /ku/ were made by a young adult female from Wisconsin. The recordings were normalized for intensity using Praat (Boersma & Weenink, 2011). The drawings were animated to wiggle, and an audio track was integrated to create a video such that the wiggling image was presented together with the audio recordings. Four types of videos of each item were created for the testing phase by combining a video of a whole object or partial object with a recording of the corresponding English noun with or without the /ku/ ending. See Figure 1 for a schematic of the learning and testing phases.

During the learning phase, the children were presented with a video of a wiggling object (e.g., wheel) for 500 ms. While the object wiggled on the screen, they heard the English word for the object (e.g., “wheel”) twice with a 2-s pause between repetitions. After a 1500-ms interval with a blank screen, children heard the English word with /ku/ added on the end (e.g., “wheelku”) as they watched a piece break off and float away from the object. They heard the English word with the /ku/ ending again while a small piece of the object remained on the screen and wiggled. This sequence was repeated for all six items, with a 2-s interval

between each trial. Half of the children were trained on the items from List A, and half of the children were trained on the items from List B. The presentation order of the items in each list was randomized.

In the testing phase, the children were presented with a video of either a whole object wiggling or a piece of the object floating away and the remaining piece wiggling. Each video was paired with a recording of either the English noun by itself or the English noun with the /ku/ ending. Children were instructed to press a green button (positioned over the “f” key on the keyboard) if what they heard went with the picture (e.g., partial object paired with noun-/ku/) and to press a red button (positioned over the “z” key on the keyboard) if what they heard did not go with the picture (e.g., whole object paired with noun-/ku/). The children had 5 s to respond. The testing phase presented the same six items on which the child had been trained, plus an additional six items on which the child had not been trained. Each item appeared four times, twice as a match (whole object + noun; partial object + noun-/ku/) and twice as a mismatch (whole object + noun-/ku/; partial object + noun). There were a total of 48 trials presented in random order with a 1-s interval between trials.

Coding

Both accuracy and RT data were collected for each trial. Accuracy coding was adjusted to account for accidental shifts in positioning of the child’s fingers. If a child pressed a key within a 1-key radius of the target key the child received credit for a correct response. Occasionally, children pressed a response key before they had heard the auditory stimulus, either as a late response from the previous trial or as an impulsively quick response for the current trial. Trials with response times shorter than 500 ms (i.e., before the audio began playing) were removed, resulting in the removal of 55 trials (1.6 % of total). In addition, trials were removed from the RT analysis if they were more than 3 *SDs* slower than the mean RT for that participant. This resulted in the removal of 26 trials (1.2% of total viable RT trials). The RT data also were screened for across-participant outliers; however, no child had a mean RT more than 3.29 *SDs* from the group mean.

Accuracy was operationalized using *A'* values to denote sensitivity to correct usage of the morpheme.² In yes/no tasks in which participants are asked to discriminate between a signal (in the current study, trials in which the image matched the audio) and noise (in the current study, trials in which the image did not match the audio), measures of sensitivity are generally thought to be a better index of performance than proportion-correct values (Stanislaw & Todorov, 1999). In the field of language development,

²The *A'* statistic is a nonparametric version of the *d'* statistic. It is often preferred to the *d'* statistic when analyzing yes/no data because the assumptions that govern the validity of the *d'* (namely, the normality of the signal and noise distributions and similar standard deviations for the two distributions) cannot be tested for yes/no tasks and, in fact, are often not tenable (see Stanislaw & Todorov, 1999, for further detail).

Figure 1. Visual schematic of task.

Phase	Example Stimuli
Training (6 items) "You are going to see some pictures on the screen. Pay attention to the pictures you see and what you hear." Testing (6 trained items, 6 generalization items) "You are going to see more pictures on the screen. Press the green button if what you see goes with what you hear. Press the red button if what you see doesn't go with what you hear."

sensitivity measures have been useful in interpreting low levels of performance on a linguistic task because they can separate lack of knowledge of a target linguistic distinction from other factors that may contribute to performance (e.g., Evans, Viele, Kass, & Tang, 2002; Johnson, 2005). This is because sensitivity scores take into account both *hits* (in the current study, trials when children identified correct marking of part or whole), and *false alarms* (in the current study, trials when children indicated that part-whole distinctions were marked correctly when in fact they were not). To exhibit sensitivity, and thus learning, of the novel morpheme, children's *hit rate* (number of hits/total match trials) should be more frequent than their *false-alarm rate* (number of false alarms/total mismatch trials). A' values were calculated using one of the following two formulas, depending on whether or not the hit rate (H) exceeded the false alarm rate (FA):

$$A' = \begin{cases} 0.5 + \frac{(H - FA)(1 + H - FA)}{4H(1 - FA)} & \text{when } H \geq FA \\ 0.5 - \frac{(FA - H)(1 + FA - H)}{4FA(1 - H)} & \text{when } H < FA \end{cases} \quad (1)$$

A' values can range from 0 to 1.0, with 1.0 indicating perfect sensitivity and .5 indicating that the child could not distinguish between correct and incorrect marking of part or whole. Values below .5 are uncommon and suggest response confusion (Stanislaw & Todorov, 1999). One complication with the use of A' scores arises when children do not make a response: null responses on mismatch trials cannot be clearly designated as false alarms, and null responses on match trials cannot be clearly designated as misses. Therefore, in the analyses presented below, no-response trials were excluded prior to calculating sensitivity. Across the 72 participants, there were a total of 203 no-response trials, making up 5.97% of the total trials. The number of no-response trials ranged from 0 to 18 trials per child ($M = 2.82$).

For completeness, we present the results of analyses in which sensitivity values were calculated including

no-response trials in online Supplemental Material S1. Although the sensitivity values are higher when no-response trials are excluded, the patterns of findings when comparing groups and conditions remain unchanged whether or not no-response trials are included in the analyses.

Standardized Measures

Children completed the Visual Matrices subtest of the Kaufman Brief Intelligence Test–Second Edition (KBIT-2; Kaufman & Kaufman, 2004) as a measure of nonverbal intelligence and the Clinical Evaluation of Language Fundamentals–Fourth Edition (CELF-4; Semel, Wiig, & Secord, 2003) as a measure of their receptive and expressive language abilities in English. Bilingual children also completed the Clinical Evaluation of Language Fundamentals–Fourth Edition, Spanish (CELF-4 Spanish; Wiig, Semel, & Secord, 2006) as a measure of their receptive and expressive language abilities in Spanish.

Analyses

First, to examine whether the children were able to learn the novel morpheme, one-sample t tests compared the sensitivity values for each of the three participant groups, for both trained and untrained items, to .5. A value of .5 indicates lack of sensitivity to correct versus incorrect marking of part-whole distinctions using the novel morpheme. A chi-square analysis compared the proportion of children with sensitivity values of .5 or below across the three language experience groups. Independent-samples Mann–Whitney U tests compared the demographic and language characteristics of the small subset of children with sensitivity values at or below .5 to the larger group of children with values above .5.

Second, to investigate whether linguistic experience influenced the sensitivity and the RT scores on the morpheme-learning task, we conducted two 3 (group) $\times$ 2 (trained vs. untrained) repeated measures analyses of variance (ANOVAs). Significant interactions were further investigated through follow-up analyses conducted separately for each group. Third, we conducted linear regressions, separately for

monolinguals and bilinguals (collapsed across the two groups), to examine factors that may predict children's sensitivity to the novel morpheme. The outcome variable in all the analyses was overall sensitivity (collapsed across trained and untrained trials). Model 1 included background variables (i.e., age, socioeconomic status, and nonverbal IQ). For the monolinguals, we added English receptive language skills in Model 2. For the bilinguals, we considered both English and Spanish experience. For the English experience models, we added current weekly English exposure to create Model 2. In Model 3, we added English receptive language skills and the interaction with group to examine whether English abilities contributed to learning differently in our two bilingual groups. For the Spanish predictors, we added current weekly Spanish exposure to create Model 2. In Model 3, we added Spanish receptive language skills and the interaction with group to examine whether Spanish abilities contributed to learning differently in our two bilingual groups.

Results

Sensitivity to the Novel Morpheme

All three groups of children demonstrated sensitivity significantly greater than .5 for both trained items, $M_{\text{mono}} = .78$, $SD = .25$, $t(24) = 5.55$, $p < .001$; $M_{\text{EngL1}} = .73$, $SD = .22$, $t(17) = 4.33$, $p < .001$; $M_{\text{SpanL1}} = .66$, $SD = .24$, $t(24) = 3.39$, $p = .002$, and untrained items, $M_{\text{mono}} = .80$, $SD = .22$, $t(24) = 7.00$, $p < .001$; $M_{\text{EngL1}} = .74$, $SD = .23$, $t(17) = 4.49$, $p < .001$; $M_{\text{SpanL1}} = .70$, $SD = .22$, $t(25) = 4.50$, $p < .001$. Thus, all three groups demonstrated learning and generalization of the novel morpheme.

Relatively few children (4 out of 25 monolinguals, 7 out of 27 Spanish-L1 bilinguals with valid A' values, and 4 out of 18 English-L1 bilinguals with valid A' values) exhibited a lack of sensitivity to correct use of the novel morpheme, as demonstrated by sensitivity values of .5 or below. Chi-square analyses revealed that these children were not differentially distributed across the three language experience groups, $\chi^2(2) = 0.77$, $p = .681$. Mann-Whitney U tests revealed that children exhibiting a lack of sensitivity had lower parental education ($Mdn = 3.0$ [some college]), than did children exhibiting sensitivity greater than .5 ($Mdn = 4.0$ [college]), $U = 224.00$, $z = -2.81$, $p = .005$. Children exhibiting a lack of sensitivity also had lower English receptive language skills ($Mdn = 105$), than did children with sensitivity greater than .5 ($Mdn = 117$), $U = 256.50$, $z = -2.24$, $p = .025$. However, they did not differ in age ($Mdn_{\leq .5} = 6.08$ vs. $Mdn_{>.5} = 6.33$, $U = 294.50$, $z = -1.69$, $p = .091$), current English exposure ($Mdn_{\leq .5} = 67.00\%$ vs. $Mdn_{>.5} = 70.50\%$, $U = 332.50$, $z = -1.07$, $p = .285$), or nonverbal IQ ($Mdn_{\leq .5} = 97$ vs. $Mdn_{>.5} = 110$, $U = 305.50$, $z = -1.53$, $p = .125$).

Effects of Language Group on Learning

Sensitivity

The 3×2 ANOVA yielded no significant effect of group, $F(2, 65) = 1.47$, $p = .237$, $\eta_p^2 = .04$; no significant

effect of training, $F(1, 65) = 2.81$, $p = .098$, $\eta_p^2 = .04$; and no interaction between group and training, $F(2, 65) = 0.28$, $p = .754$, $\eta_p^2 = .01$. See Figure 2 for a visual depiction of the sensitivity values for trained and untrained items in each participant group.

RT

For RTs, the 3 (group) $\times$ 2 (training) ANOVA yielded no significant effect of group, $F(2, 69) = 1.22$, $p = .302$, $\eta_p^2 = .03$, and no significant effect of training, $F(1, 69) = 1.45$, $p = .232$, $\eta_p^2 = .02$, but there was a marginal interaction between group and training, $F(2, 69) = 2.66$, $p = .077$, $\eta_p^2 = .07$. Follow-up within-group pairwise t tests revealed no significant difference in speed between trained and untrained items for monolinguals ($M_{\text{diff}} = -63.84$ ms, $SE = 65.09$, $t(24) = -0.98$, $p = .336$), but a marginal training effect for both Spanish-L1 ($M_{\text{diff}} = 89.93$ ms, $SE = 46.55$, $t(27) = 1.93$, $p = .064$) and English-L1 bilinguals ($M_{\text{diff}} = 90.26$ ms, $SE = 49.38$, $t(18) = 1.83$, $p = .084$), who exhibited slower RTs for untrained items than for trained items. Follow-up one-way ANOVAs to examine the effect of group separately for trained and untrained items revealed a marginal effect of group on RTs for trained items, $F(2, 69) = 2.91$, $p = .061$, $\eta_p^2 = .08$, but not for untrained items, $F(2, 69) = 0.32$, $p = .726$, $\eta_p^2 = .01$. The marginal effect of group for the trained items was localized to the contrast between Spanish-L1 bilinguals ($M = 2068$ ms, $SD = 431$) and monolinguals ($M = 2326$ ms, $SD = 355$), $p = .062$. See Figure 3 for a visual depiction of these different patterns for the effect of training on RTs for the monolinguals and the two bilingual groups.

Because the two bilingual groups resembled each other so closely in their RT patterns, an additional ANOVA was conducted in which the bilinguals were considered as a

Figure 2. Sensitivity to novel morpheme for trained and untrained items. A' sensitivity values are calculated after excluding no-response trials. An A' value of .5 indicates chance responding. All groups exhibited sensitivity significantly greater than .5 in both conditions with no significant effect of group and no significant effect of condition. Error bars show 1 SE.

Figure 3. Response speed for trained and untrained items, including p values from paired t tests. Error bars show 1 SE .

single group. In this analysis, there continued to be no significant effect of group, $F(1, 70) = 2.10$, $p = .152$, $\eta_p^2 = .03$, and no significant effect of training, $F(1, 70) = 0.16$, $p = .693$, $\eta_p^2 = .002$, but there was a significant interaction between group and training, $F(1, 70) = 5.40$, $p = .023$, $\eta_p^2 = .07$. A follow-up within-group pairwise t test for the combined bilingual group revealed significantly slower RTs on untrained trials ($M = 2189$ ms, $SD = 481$) than on trained trials ($M = 2099$ ms, $SD = 411$), $M_{diff} = 90.06$ ms, $SE = 33.81$, $t(46) = 2.66$, $p = .011$, while the pairwise t test for the monolinguals had revealed comparable RTs for trained ($M = 2326$ ms, $SD = 355$) and untrained trials ($M = 2262$ ms, $SD = 482$). Follow-up independent samples t tests revealed a significant difference in RT between monolinguals and bilinguals for trained items, $t(70) = 2.34$, $p = .022$, but not for untrained items, $t(70) = 0.613$, $p = .542$.

Factors That Contribute to Learning

Monolinguals

Model 1 revealed that age ($B = 0.169$, $SE = 0.084$, $p = .058$) was a marginally significant predictor, with older children showing greater sensitivity to correct use of the novel morpheme. As a whole, Model 1 accounted for 28% of the variance in sensitivity, $F(3, 21) = 2.67$, $p = .074$. Adding English receptive language skills in Model 2 did not explain any additional variance in sensitivity, $\Delta F < 0.001$, $p = .977$. Full information from these regression analyses can be found in Table 3.

Bilinguals

Model 1 revealed that parent education level ($B = 0.086$, $SE = 0.025$, $p = .001$) was a significant predictor, with children from higher socioeconomic backgrounds showing greater sensitivity to correct use of the novel morpheme. As a whole, Model 1 accounted for 30% of the variance in sensitivity, $F(3, 41) = 5.81$, $p = .002$.

Table 3. Sensitivity regression table for monolinguals: No effect of English receptive language skills on sensitivity to new morpheme.

Predictor	Model 1 (B)	Model 2 (B)
Age (centered)	0.168*	0.169 [†]
Primary caregiver education (levels 1–5, z scored) ^a	–0.010	–0.010
Nonverbal IQ (centered)	0.002	0.002
English Receptive Language (centered) ^b		0.0002
R^2	.276	.276
F	2.67 [†]	1.91
ΔR^2		< .001
ΔF		< 0.001

^aIndexed by the highest level of education completed by the child's primary caregiver, where 1 = less than high school; 2 = high school or General Educational Development (GED); 3 = some college; 4 = college; 5 = at least some graduate school. ^bStandard scores from the Clinical Evaluation of Language Fundamentals–Fourth Edition.

[†] $p < .08$. * $p < .05$.

English predictors. Adding current weekly English exposure in Model 2 explained only an additional 3.9% of the variance and did not significantly improve over Model 1, $\Delta F = 2.35$, $p = .133$. Adding English receptive language skills and the interaction with group in Model 3 explained only an additional 2.27% of the variance and did not significantly improve over Model 2, $\Delta F = 0.44$, $p = .729$. Full information from these regression analyses can be found in Table 4.

Spanish predictors. Adding current weekly Spanish exposure in Model 2 explained only an additional 3.9% of the variance and did not significantly improve over Model 1, $\Delta F = 2.33$, $p = .135$. Adding Spanish receptive language skills and the interaction with group in Model 3 explained only an additional 0.21% of the variance and did not significantly improve over Model 2, $\Delta F = 0.04$, $p = .989$. Full information from these regression analyses can be found in Table 5.

Discussion

The findings of the present study indicate highly comparable levels of performance on the novel derivational morpheme learning task in three groups of typically developing children characterized by distinct language acquisition histories: monolingual English-speaking children, Spanish-L1 bilingual children, and English-L1 bilingual children. The children in all three groups not only successfully learned the novel derivational morpheme marking the part-whole distinction, but they also successfully generalized the use of this morpheme to nouns they never heard in association with the novel morpheme. Furthermore, only limited relationships were observed between background characteristics and children's performance on the morpheme-learning task. Most notably, for the bilingual children, neither language exposure nor language skills contributed to morpheme-learning

Table 4. Sensitivity regression table for bilinguals: No effect of English exposure, nor English receptive language skills, on sensitivity to new morpheme.

Predictor	Model 1 (B)	Model 2 (B)	Model 3 (B)
Age (centered)	0.083	0.098	0.100
Primary caregiver education level (Level 1–5, z scored) ^a	0.086**	0.105***	0.088*
Nonverbal IQ (centered)	0.002	0.001	0.001
Current English Exposure (centered)		–0.003	–0.003
English Receptive Language (centered)			0.003
Group (Spanish-L1 vs. English-L1) ^b			<0.001
English Receptive Language × Group (Spanish-L1 vs. English-L1)			0.004
R ²	.298	.338	.360
F	5.81**	5.10**	2.98*
ΔR ²		.039	.023
ΔF		2.35	0.44

^aIndexed by the highest level of education completed by the child's primary caregiver, where 1 = *less than high school*; 2 = *high school or General Educational Development (GED)*; 3 = *some college*; 4 = *college*; 5 = *at least some graduate school*. ^bGroup was coded as –0.5 (Spanish-L1) and 0.5 (English-L1), so that the coefficient for English receptive language skills represents the main effect of English ability, collapsed across both types of bilinguals.

* $p < .05$. ** $p < .01$. *** $p \leq .001$.

performance. Together, these findings offer promise for the utility of this particular version of the novel morpheme learning task in clinical practice.

Novel Morpheme Learning in Bilingual Children

The morpheme-learning task implemented in the present study elicited highly similar levels of learning in three groups of children characterized by vast differences in language acquisition histories and current levels of language exposure and ability. We believe that three aspects of the present study have been instrumental to the findings of comparable learning levels across the three groups of children:

the particular morpheme taught, the comprehension measure utilized to index learning, and children's relatively high levels of English language ability.

The Structure of the Novel Morpheme

The phonological structure of the novel morpheme appears to matter a great deal in learning outcomes, such that learning is facilitated when the novel morpheme fits with the phonological and the syllabic structure of the target language. In a number of studies that involved designing a novel morpheme for use with speakers of Spanish, the structure of the morpheme in relation to the structure of Spanish was carefully considered. In all such studies, the

Table 5. Sensitivity regression table for bilinguals: No effect of Spanish exposure, nor Spanish receptive language skills, on sensitivity to new morpheme.

Predictor	Model 1 (B)	Model 2 (B)	Model 3 (B)
Age (centered)	0.083	0.098	0.095
Primary caregiver education level (Level 1–5, z scored) ^a	0.086**	0.105***	0.102**
Nonverbal IQ (centered)	0.002	0.001	0.001
Current Spanish Exposure (centered)		0.003	0.003
Spanish Receptive Language (centered) ^b			0.001
Group (SpanL1 vs. EngL1) ^b			0.005
Spanish Receptive Language × Group (Spanish-L1 vs. English-L1)			<0.001
R ²	.298	.338	.340
F	5.81**	5.10**	2.72*
ΔR ²		.039	.002
ΔF		2.33	0.04

^aIndexed by the highest level of education completed by the child's primary caregiver, where 1 = *less than high school*; 2 = *high school or General Educational Development (GED)*; 3 = *some college*; 4 = *college*; 5 = *at least some graduate school*. ^bGroup was coded as –0.5 (Spanish-L1) and 0.5 (English-L1), so that the coefficient for Spanish receptive language skills represents the main effect of Spanish ability, collapsed across both types of bilinguals.

* $p < .05$. ** $p < .01$. *** $p \leq .001$.

original morpheme /ə/ used by Connell (1987) to mark the part-whole distinction was deemed incongruent with the structure of Spanish. Instead, the novel morpheme took the form of a CV syllable (Anderson, 2001; Boyer & Martin, 2012; Havas et al., 2015; Kohnert & Danahy, 2007), such as /be/.

There is sound reasoning behind the need to design a morpheme that would not challenge the structural constraints of the languages known to the learners. However, the implementation of distinct morphemes in the context of different linguistic environments poses methodological and interpretational challenges because such an approach conflates the effects of language experience and the effects of morpheme structure. Our approach to designing a language-neutral morpheme that would be equally viable within the structure of English and the structure of Spanish may be an important methodological step forward in the search for a morpheme-learning task that would not be sensitive to fluctuations in the typical language experiences of bilingual children who speak English and Spanish.

The Use of a Comprehension Measure to Index Learning

The second factor that likely was crucial to our finding comparable levels of morpheme-learning performance across the three groups of children was our choice of a receptive rather than an expressive measure to index learning. Receptive measures of morpheme-learning performance have yielded ceiling effects in prior studies with bilingual children (Hwa-Froelich & Matsuo, 2005; Restrepo, 1998) and have not been effective at distinguishing monolingual children with SLI (e.g., Roseberry & Connell, 1991). In fact, the studies that have examined derivational processes in monolingual children with SLI have interpreted the findings to suggest that children with SLI do *not* have difficulty with acquiring derivational rules of their language per se, but rather have difficulty *producing* derivational morphemes under increased task demands (Dohmas, Lohmann, Moritz, & Kauschke, 2012; Marshall & Van der Lely, 2007; Windsor & Hwang, 1999a, 1999b). Therefore, on the surface it would seem that expressive rather than receptive testing measures should be prioritized when designing a morpheme-learning task that would index the typicality of the language system in bilingual children. However, the use of expressive testing measures may in fact be counterindicated if the goal is to design a morpheme-learning task that, when delivered in bilinguals' weaker language, would still capture their typical language learning capacity. This is because in prior studies of typically developing bilingual children's morpheme-learning performance, expressive testing measures delivered in the children's weaker second language yielded floor effects (Hwa-Froelich & Matsuo, 2005; Kohnert & Danahy, 2007). This reduces the usefulness of such expressive testing measures to the efforts of distinguishing bilingual children with SLI from bilingual children with typical language skills. In our study, we therefore targeted comprehension of the newly learned derivational morpheme rather than production.

In prior studies, comprehension was tested by providing a child with two pictures of the same object, one of

which represented the part-object, and the child was required to point to the part-object upon hearing the "word-novel morpheme" (e.g., Connell, 1987; Hwa-Froelich & Matsuo, 2005). In our study, children were presented with pictures of whole- and part-objects one by one and heard names that did or did not contain the novel morpheme. The task therefore did not allow the children to compare the pictures of the whole- and the part-object side by side, unlike the comprehension measures implemented in prior studies. This, we believe, rendered the task difficult enough that the children did not ceiling on the task despite its receptive nature, although they did demonstrate successful (i.e., well above chance) levels of performance.

Levels of Target-Language Ability

It is tempting to interpret the finding that children in the bilingual groups performed similarly to the monolingual children on the novel morpheme learning task to suggest that the task is impermeable to fluctuations in target-language ability within the population of children with typical language. However, the third factor that likely contributed to our finding similar levels of sensitivity to the novel morpheme across the three groups of children was children's relatively high level of English language abilities. That is, despite the fact that the monolingual children outperformed the children in the two bilingual groups on the standardized measure of English language, on average the children in each group scored within normal limits on this measure. It is possible, then, that children in all three groups have attained sufficient skills and experience with English to demonstrate successful learning on a task that was administered in English.

This raises the possibility that children whose English language scores would fall below the mean on standardized measures (and thus be lower than those attained by the children tested here) would in fact struggle with our version of the morpheme-learning task, despite our careful attention to the structure of the novel morpheme and our use of comprehension measures. Indeed, the Spanish-English bilingual children in the Kohnert and Danahy (2007) study who struggled with the morpheme-learning task when it was administered in English were characterized by only 12 months of English experience in the Head Start classroom and likely by quite low English language abilities. In our own data, we also find confirmation for this supposition, considering that the 15 children across the three groups who demonstrated a lack of sensitivity to the novel morpheme were characterized by lower receptive language abilities in English than the children who were sensitive to the novel morpheme. Thus, one immediate direction for future research is testing our task with a group of Spanish-L1 bilingual children in the earlier stages of acquisition of English and with lower English language scores than the children tested here. In the meantime, we think it noteworthy that, in the present study, children characterized by typical, yet relatively weaker, English language skills attained similar levels of learning and generalization performance on the novel morpheme learning task as did the children characterized by stronger English language skills.

Morpheme Learning in the Context of Language Structure and Language Knowledge

There is evidence both from more naturalistic (Arajas-Trejo et al., 2014) and more experimental work (Havas et al., 2015) indicating that experience with a more consistent and dense morphological system is associated with more agile morpheme learning. Because the Spanish noun-final morphological system is more dense, regular, and redundant than the English morphological system, one may expect experience with Spanish to facilitate novel morpheme-learning performance. We hypothesized that the benefits would be especially strong for English-L1 bilingual children, who have the advantage of knowing Spanish and being tested in their native language. However, the sensitivity rates for English-L1 bilingual children were highly comparable to those observed for the monolingual and the Spanish-L1 bilingual children, indicating that experience with Spanish, even when coupled with a native-level ability in English, did not influence performance on this version of the morpheme-learning task. The analyses relating language exposure and abilities to bilingual children's morpheme-learning performance confirm this interpretation, in that neither the degree of exposure to English nor the strength of the English language system as captured by standardized measures contributed to the bilingual children's morpheme-learning outcomes.³

One caveat to this conclusion is that our measure of language exposure was based entirely on parent report, and thus, it is possible that the lack of the relationship observed between exposure to English (vs. Spanish) and children's performance on the morpheme-learning task may have been the result of inexact exposure estimates. Relatedly, it is important to note that the English-L1 bilingual children tested in the present study experienced, on average, only 19 months of exposure to Spanish. It may be hypothesized that such an amount may have been insufficient to yield an effect of Spanish knowledge, and that higher levels of experience with Spanish may confer a benefit upon children's performance on the morpheme-learning task. We would point out, however, that despite this relatively limited experience with Spanish, the children in the English-L1 bilingual group performed rather well on the standardized measures of Spanish language ability and, in fact, performed similarly to the Spanish-L1 bilingual children on the measure of receptive Spanish language skills. Therefore, we interpret the finding that the English-L1 bilingual children were similarly sensitive to the novel derivational morpheme as the other two groups of children to indicate that experience with Spanish had only a limited effect on morpheme-learning

performance, at least as implemented in the present study, and at least for the sensitivity scores.

Interestingly, although the sensitivity scores indicated generally similar levels of performance on the morpheme-learning task in the three groups of children, the RT data suggested subtle facilitation effects associated with Spanish experience in the bilingual children. That is, the bilingual children in the present study were faster to recognize the correctly derived nouns than were the monolingual children, although this was only true for the derived nouns that had been presented during the teaching phase. A particularly notable aspect of the RT results is that this facilitation effect was observed in both groups of the bilingual children—those who spoke Spanish as L1 and those who spoke Spanish as L2. Therefore, the RT results indicate that experience with Spanish may enhance children's ability to efficiently retrieve newly learned morphological information, perhaps because Spanish presents children with more numerous opportunities to retrieve noun-based morphology.

Summary and Conclusion

In summary, the findings of the present study indicate that when the novel derivational morpheme is constructed such that it overlaps with both English and Spanish in structural properties, typically developing children characterized by significant variability in English and Spanish skills and experience can successfully learn such a morpheme in the context of an English-only learning task. The high degree of similarity in learning outcomes across the three groups of children, as well as the resistance of learning measures to individual differences in language characteristics within groups, indicate that this particular derivational morpheme-learning task may be suitable for further work that would examine its sensitivity to language impairment.

We believe that two design features have likely been instrumental to the findings in the present study: the use of a carefully constructed novel morpheme that mapped similarly onto both the English and the Spanish linguistic systems and the receptive modality of testing. However, future studies with typically developing children in this area would need to carefully consider issues related to target-language proficiency and the structure of the words selected for the morpheme-learning task. With respect to target-language proficiency, it is crucial that morpheme-learning tasks like the one implemented in the present study be tested in typically developing bilingual children characterized by only a limited amount of experience with English. The clinical utility of the task would be undermined if children with low levels of English language ability, who are nevertheless typically developing, fail to demonstrate sensitivity to the novel morpheme.

With respect to the words selected to teach and test novel bound morpheme learning, it is possible that for children with relatively low levels of target-language proficiency, the structure of the words (i.e., their phonological complexity, the presence of language-specific phonemes and syllable stress patterns, etc.) would influence children's

³SES did contribute significantly to bilingual children's morpheme-learning performance. This finding is consistent with the broad effects of SES on cognitive and language outcomes in children (e.g., Hoff, 2003; Mezzacappa, 2004). The pattern whereby the relationship between learning performance and SES was stronger in the bilingual than in the monolingual children is likely driven by the wider distribution of SES levels in the bilingual sample.

ability to learn the novel morphemes. This hypothesis must be empirically tested before the usefulness of the morpheme-learning task is examined in the context of language impairment—the final step for this line of research. In the meantime, we conclude that a novel derivational morpheme /ku/, when taught in combination with English nouns, can be successfully learned (at least receptively) by typically developing children who speak English and Spanish with fluctuating levels of English and Spanish experience and knowledge. This, then, suggests significant potential for such a task in clinical practice, considering that a diagnostic tool that would be appropriate for use with bilingual children should yield comparable levels of performance in age-matched typically developing children, bilingual and monolingual.

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