Research Article

Influences of Phonological Context on Tense Marking in Spanish–English Dual Language Learners

Philip N. Combiths,^{a,b} Jessica A. Barlow,^a Irina Potapova,^{a,b} and Sonja Pruitt-Lord^a

Purpose: The emergence of tense-morpheme marking during language acquisition is highly variable, which confounds the use of tense marking as a diagnostic indicator of language impairment in linguistically diverse populations. In this study, we seek to better understand tense-marking patterns in young bilingual children by comparing phonological influences on marking of 2 word-final tense morphemes.

Method: In spontaneous connected speech samples from 10 Spanish–English dual language learners aged 56–66 months ($M = 61.7$, $SD = 3.4$), we examined marking rates of past tense *-ed* and third person singular *-s* morphemes in different environments, using multiple measures of phonological context.

Results: Both morphemes were found to exhibit notably contrastive marking patterns in some contexts. Each was most sensitive to a different combination of phonological influences in the verb stem and the following word.

Conclusions: These findings extend existing evidence from monolingual speakers for the influence of word-final phonological context on morpheme production to a bilingual population. Further, novel findings not yet attested in previous research support an expanded consideration of phonological context in clinical decision making and future research related to word-final morphology.

Children's acquisition of grammatical morphemes can be characterized as an initial absence of the morpheme that is followed by a period of inconsistent use, during which the morpheme is considered to be emerging. Mastery of the morpheme occurs once the morpheme is used correctly and consistently, with common benchmarks for achievement of mastery falling between 80% and 95% accuracy (e.g., Brown, 1973). Children with typical development from all linguistic backgrounds can be expected to move reliably from absence to mastery; however, the mechanisms underlying this trajectory are not well understood.

This study is concerned with the emerging stage of morpheme acquisition. Because this stage is highly variable and can appear differently across populations, including in children with language impairment (LI; e.g., Gutiérrez-Clellen, Simon-Cerejido, & Wagner, 2008; Paradis, 2005;

Paradis & Crago, 2000; Rice, Tomblin, Hoffman, Richman, & Marquis, 2004), there is considerable motivation to understand the factors that affect morpheme production during this period. Understanding patterns of influence in different population groups is of scientific interest because it contributes to the growing body of typological evidence for factors that interact with morpheme production. Further, influences on morpheme production are of clinical interest for their diagnostic potential, particularly in differentiating nonclinical language differences, such as characteristics of a nonmainstream dialect or multilingual speaker, from a language disorder (Paradis, 2005).

Word-Final Tense Morphology in Linguistically Diverse Populations

In English, regular tense marking is mostly restricted to two suffixes that attach to the right edge of the verb stem (i.e., word-final morphemes): past tense (PT; e.g., *-ed* in *walked*) and third person singular present tense (3s; e.g., *-s* in *plays*). In particular, children with LI demonstrate distinct error patterns and protracted emergence of PT and 3s morphemes, resulting in an extended period of lower marking rates when compared with age- or language-matched peers (for an overview, see Leonard, 2014). Children's

^aSan Diego State University, CA

^bUniversity of California, San Diego

Correspondence to Philip N. Combiths: pcombiths@sdsu.edu

Editor: Sean Redmond

Associate Editor: Emma Hayiou-Thomas

Received October 19, 2016

Revision received February 3, 2017

Accepted March 10, 2017

https://doi.org/10.1044/2017_JSLHR-L-16-0402

Disclosure: The authors have declared that no competing interests existed at the time of publication.

productive use of tense morphology, such as PT and 3s, has therefore emerged as a particularly salient indicator of LI in monolingual English speakers (e.g., Bedore & Leonard, 1998; Rice & Wexler, 1996).

Although the diagnostic value of tense marking has been established for monolingual English speakers, the validity of its use among bilingual speakers, particularly young dual language learners (DLLs), has been called into question. These DLLs are developing two languages at potentially incongruous stages of linguistic development. This is particularly true for sequentially bilingual children exposed first to their native language and later to a second language (for further discussion of this terminology, see Barlow & Enríquez, 2007; Hammer, Miccio, & Rodriguez, 2004). When the later-acquired second language is English, performance on measures of English is highly variable across individuals and may be lower than that of their same-age monolingual peers (Iglesias & Rojas, 2012).

This performance variability also extends to tense-morpheme marking, which is especially relevant in that several studies have shown tense-morpheme marking rates among bilingual DLLs without LI to be similar to or even lower than rates for age-matched monolingual speakers with LI (e.g., Gutiérrez-Clellen et al., 2008; Paradis & Crago, 2000; Paradis, Rice, Crago, & Marquis, 2008). However, this potentially confounding overlap has been identified as a result of comparing bilingual groups to monolingual speakers with LI (i.e., across linguistic populations). When compared within a bilingual group matched by dual-language profile, tense-morpheme use has been shown to differentiate children with and without LI (Blom & Paradis, 2013; Gutiérrez-Clellen et al., 2008; Jacobson & Schwartz, 2005).

In short, comparing morpheme marking rates across monolingual and bilingual populations can result in under- or overidentification of LI (Paradis, 2005). However, the feasibility of using tense-morpheme marking to identify LI within bilingual and monolingual groups suggests that tense morphology is related to LI in both, and identification of LI using morpheme-marking differences is still plausible, even within linguistically diverse populations. Though comparison of tense-morpheme use across linguistic groups is currently problematic, this may be due to the broad lens with which we have so far examined morpheme marking rates. It could be that examining other linguistic influences on morpheme marking would allow us to identify patterns in LI groups that are sufficiently robust to identify LI not only within but also across linguistically diverse populations.

Influences on Tense-Morpheme Production

In order to make use of the differentiating power of tense-morpheme marking in other populations, such as DLLs, a more complete understanding of the factors that affect marking of these morphemes is needed. Morpheme production, as with other areas of language, does not exist in isolation from other influences. To date, multiple factors related to the context in which the morpheme occurs have

been shown to influence emerging PT and 3s marking rates. These include nonlinguistic influences, such as task type (Barlow, Pruitt-Lord, & Combiths, 2015; Oetting et al., 2012); supralexical linguistic influences, such as utterance position (Barlow & Pruitt-Lord, 2014; Dalal & Loeb, 2005; Song, Sundara, & Demuth, 2009; Sundara, Demuth, & Kuhl, 2011); and lexical influences, such as the frequency with which verbs are inflected for tense marking (Blom & Paradis, 2013; Blom, Paradis, & Duncan, 2012; Marchman, 1997; Marchman, Wulfeck, & Weismer, 1999; Oetting & Horohov, 1997).

In this study, we explored sublexical influences on morpheme production, particularly the influence of phonological context. There is precedent for the influence of phonology—particularly of the preceding segment in the verb stem—on morpheme marking in acquisition and dialect patterns. Phonological context has been shown to affect regular PT and 3s marking rates across studies of groups both with and without impairment, spanning linguistic populations and task types (e.g., Barlow & Pruitt-Lord, 2014; Johnson & Morris, 2007). However, indices used to measure phonological-context effects have been inconsistent, and findings even appear contradictory in some cases. See Table 1 for a summary of previous findings, which will be discussed later.

PT Marking and Word-Final Phonological Context

In terms of PT marking, consideration of phonological context has mostly been localized to the end of the root verb, particularly the root-final segment, which immediately precedes the morpheme segment (e.g., the root-final segment /p/ in *drop* immediately precedes [-t] in *dropped*). Initial studies of the influence of phonological context on morpheme marking rates directly examined the influence of preceding phonological contexts that result in either monosegmental or syllabic allomorphs (i.e., [-t] or [-d], as in *popped* /papt/ or *filled* /fild/, vs. syllabic [-ɪd], as in *started* /statɪd/), converging in their findings that PT is marked more frequently in contexts that elicit the monosegmental allomorph than those that elicit the syllabic form (Berko, 1958; Blom & Paradis, 2013; Marchman, 1997; Marchman et al., 1999).

Sequential complexity. The heterogeneity with which phonological context has been operationalized in previous research complicates a cohesive discussion of previous findings. In the interest of a unified discussion of phonological context, we appeal to the construct of phonological complexity, which provides a useful framework for contextualizing various aspects of phonology. The relative simplicity or complexity of a phonological unit or sequence is based on many factors, including universal preferences for certain structures across the world's languages (Jakobson, 1968), order of acquisition in languages that contain these structures, and simplification patterns in developing or disordered speech (Barlow & Gierut, 1999; Hawkins, 1987). For instance, the sequential arrangement of speech sound types contributes to the relative complexity of a word or phrase. To be specific, adjacent consonants, also known as consonant clusters (CC or CCC), are more complex (i.e.,

Table 1. Abbreviated findings for word-final phonological-context effects on regular marking of past tense and third person singular.

Study	LI/TD	Linguistic population	Phonological context	Task	Observed effect ^a
Past tense					
Berko (1958)	TD	MAE	Allomorphic	Elicitation	Segmental > syllabic
Oetting & Horohov (1997)	Both	MAE	Son vs. obs	Elicitation	Son > obs
Marchman (1997)	TD	MAE	Allomorphic/probability	Elicitation	Segmental > syllabic/high > low prob
Marchman et al. (1999)	Both	MAE	Allomorphic	Elicitation	Segmental > syllabic
Johnson & Morris (2007)	Both	MAE	Son vs. obs	Imitation	Son > obs
Marshall & van der Lely (2007)	LI	MAE	Complex vs. simple coda	Elicitation	Simple > complex
Leonard et al. (2007)	Both	MAE	Probability	Elicitation	High > low prob (LI only)
Stemberger (2007)	TD	MAE	Probability	LS	High > low prob
Pruitt & Oetting (2009)	TD	AAE	C vs. V	Elicitation	V > C
Blom & Paradis (2013)	Both	MAE/bilingual	Allomorphic	Elicitation	Segmental > syllabic
Riches (2015)	TD	MAE	Sonority slope	Imitation	Falling > level
Owen Van Horne & Green Fager (2015)	Both	MAE	Son vs. obs/alveo	Elicitation	Son > obs/nonalveo > alveo
Third person singular					
Song et al. (2009)	TD	MAE	C vs. V	LS	V > C
Blom et al. (2012)	TD	Bilingual	Allomorphic	LS	[-z] > [-s] > syllabic
Barlow & Pruitt-Lord (2014)	TD	MAE/AAE	C vs. V/son vs. obs	LS	C > V/son > obs (MAE only)

Note. Only significant findings ($p < .05$) for regular forms are listed; LI = group with language impairment; TD = group with typical development; MAE = (mainstream) monolingual American English; Allomorphic = syllabic form versus monosegmental form; Son vs. obs = sonorant versus obstruent; Probability (prob) = phonotactic probability/frequency; LS = language sample; AAE = African American English; C vs. V = consonant versus vowel; Alveo = alveolar versus nonalveolar place of articulation.

^aContext of higher marking rate > context of lower marking rate.

less frequent across languages or more difficult to acquire or produce) than vowel-consonant sequences (VC or VCVC; e.g., Greenberg, 1978).

In the case of monosegmental PT or 3s inflection, marking of the morpheme will always result in the addition of a consonant to the word-final sequence. When the verb root ends with a consonant, this creates a word-final consonant cluster (e.g., *step* /step/ → /stept/) and, therefore, a more complex sequence than when the verb root ends with a vowel, which creates a final VC sequence (e.g., *fly* /flaɪ/ → /flaɪz/). Thus, in terms of sequential complexity, we would expect higher morpheme marking rates when preceded by a vowel (less complex) than when preceded by a consonant (more complex). In fact, PT marking has been found in previous studies to be higher in preceding-vowel contexts (Marshall & van der Lely, 2007; Pruitt & Oetting, 2009).

Structural complexity. Sequential phonological context alone does not fully capture phonological structure. We must also consider the syllable, a hierarchical arrangement that organizes sequential speech segments into naturally parsable groups (e.g., Blevins, 1995; Zec, 2007). Syllable structure is often illustrated using a schematic known as a syllable tree, shown in the first row of Figure 1. For our purposes, it is most important to note that each syllable contains a nucleus, which is usually a vowel, and that most consonants occupy positions outside of the nucleus. Consonants generally occur in the onset if at the front (e.g., /m/ in *met*) and the coda if at the end (e.g., /t/ in *met*) of the syllable. Consonant clusters within any part of the syllable create branches in the syllable structure, which are considered

more complex. Thus, in order of increasing complexity, *me* < *met* < *melt*, as shown in Figures 1A–1C.

There are of course exceptions to the prototypical arrangement of syllable structure, with one notable example being word-final consonants that may exist outside of the syllable in the appendix position, as shown in Figure 1D. What is especially relevant for the morphophonologically inclined is that the appendix position has been, at least in part, proposed in explanation of the peculiar behavior of English word-final morphemes within syllables (e.g., Borowsky, 1989; Goldsmith, 2011; Nathan, 2008; Selkirk, 1982). The complexity of the appendix structure is not yet clear. Though three adjacent word-final consonants are sequentially complex, how and if the appendix segment contributes to syllable-structure complexity still merits investigation. Despite these questions, syllable structure is likely an aspect of phonological complexity at play in the formation of words and phrases (e.g., Zec, 2007). In particular, the exceptional nature of word-final morphemes, whatever position they may occupy, suggests that these segments might interact with the preceding syllable structure in ways that might differ from final phonemes that are not morphemes. Thus, the findings for PT by Pruitt and Oetting (2009) and Marshall and van der Lely (2007) can also be attributed to syllable-structure complexity, because a word-final VC sequence denotes a simple coda (as in Figure 1B) and a word-final CC sequence likely requires a complex, branching coda (as in Figure 1C) or an appendix (as in Figure 1D).

Transitional complexity. Phonological complexity also extends to sonority transitions within a syllable. Sonority

Figure 1. Syllable structure (A–D), sonority distance (E–G), and resyllabification (H–I) in contexts of varied word-final complexity.

refers to the relative acoustic energy of a sound segment, often arranged in a hierarchy that ranks each phoneme in a given language from most to least sonorous: vowel > glide > liquid > nasal > voiced fricative > voiceless fricative > voiced stop > voiceless stop (Clements, 1990). Sonority and the difference in sonority rank between adjacent segments have been shown to play an important role in syllable organization and reduction patterns during language acquisition (for a review, see Barlow, 2016). This is due in large part to a cross-linguistic preference for syllables that transition from a low-sonority initial segment to a high-sonority nucleus (an upward sonority slope) and end with a segment that either falls in sonority or remains level (sonority sequencing principle; Clements, 1990). This preferred configuration of sonority slopes is thus considered less complex, whereas sonority transitions that do not adhere to this pattern within a syllable are considered more complex.

The second row in Figure 1 illustrates sonority transitions at the end of a syllable. *Feels* /fɪlz/ demonstrates a falling sonority slope, and *popped* /pɒpt/ presents a level word-final slope. Both demonstrate preferred sonority configurations. Word-final morphemes are known to deviate from the preferred form in that they can form an upward sonority slope when a level or falling slope would be expected according to the sonority sequencing principle, as shown in Figure 1G. In *sits*, the sonority transition from the penultimate segment /t/ to the morpheme segment [-s] creates

an upward word-final sonority slope. This violation of syllable-internal transitional properties is also cited as evidence in support of the syllable-external appendix status of English word-final morphemes (Clements, 1990; Fujimura & Lovins, 1978; Halle & Vergnaud, 1980). A number of studies have examined PT marking according to sonority-based influences, consistently identifying marking rates that increase in the context of falling sonority slopes, and therefore phonologically simpler environments (Johnson & Morris, 2007; Oetting & Horohov, 1997; Owen Van Horne & Green Fager, 2015; Riches, 2015).

Probabilities and frequencies. More recent studies have used measures of probability or frequency to describe phonological context, examining the influence of neighborhood density, inflectional frequency, and phonotactic probability on PT marking rate (Leonard, Davis, & Deevy, 2007; Marchman, 1997; Stemberger, 2007). Unlike the aspects of phonological context discussed thus far, these measures all relate to the frequency with which all or part of the tense-inflected verb occurs in speech. In brief, neighborhood density is a measure of the frequency of words that have a similar form, inflectional frequency refers to the number of occurrences of the inflected form of a given verb, and phonotactic probability is derived from the frequency of occurrence of sounds or sequences in a given word position. In these studies examining PT marking, these different measures were used to capture the frequency of occurrence

of the inflected form in some fashion. The findings are similar in that they demonstrate higher PT marking rates in more phonotactically probable or frequently inflected contexts. These results on the basis of probability and frequency also suggest that PT is marked more frequently in less phonologically complex environments, given that more frequently occurring or probable contexts might also be considered less complex.

3s Marking and Expansion of Phonological Context

Whereas word-final phonological complexity has shown a relatively consistent pattern of influence on PT marking rates across studies, the few existing studies examining 3s marking and phonological context appear to present conflicting results. Blom et al. (2012) found that bilingual children marked monosegmental [-z] allomorphs more often than [-s], and both more than syllabic [-ɹz] forms—a finding suggestive of the influence of preceding context. In a more direct examination of preceding phonological context in mainstream monolingual English-speaking children, Song et al. (2009) identified higher 3s marking rates in preceding-vowel contexts. On the converse, Barlow and Pruitt-Lord (2014) examined a cross-section from the same corpus used in the longitudinal study of Song et al. and found 3s marking rates to be lower in preceding-vowel contexts. These later findings are unexpected, not only because they differ from a study sampling the same population, but also because they appear contrary to patterns that are expected on the basis of word-final phonological complexity.

Barlow and Pruitt-Lord suggested that differences in control of following context may have contributed to their results that differed from those of Song et al. To date, few studies have examined the effect of the following phonological context on morpheme production (tense or otherwise), even though many have appealed to complexity in syllable structure (e.g., Marshall & van der Lely, 2007; Polite, 2011; Riches, 2015; Song et al., 2009). Excepting utterance-final (UF) productions, we can expect—given resyllabification processes that occur during production of connected speech (Cholin, Schiller, & Levelt, 2004; W. J. M. Levelt, Roelofs, & Meyer, 1999)—that syllable formation will occur across word boundaries in some instances, such as when the preceding word ends with a consonant (as is the case with an inflected regular verb) and the following word begins with a vowel. This tendency, motivated by a universal preference for simple syllables that begin with a consonant and a preference against branching rhymes with a coda (e.g., Barlow & Gierut, 1999), is sometimes referred to as the onset maximization principle (e.g., Selkirk, 1981). For example, it is argued that this principle motivates the occurrence of allomorphy for the *alan* definite article in English. However, this process does not apply equally across languages (Cholin et al., 2004). For instance, this principle is considered highly robust in Spanish (e.g., production of *las alas* /las alas/, “the wings,” as [la.salas]), perhaps more so than in English (Colina, 2009; Martínez-Gil, 2000).

The third row in Figure 1 illustrates two examples of following-vowel environments where such resyllabification might occur with PT and 3s morphemes. For simplicity, the PT and 3s morphemes are both presented in the appendix position. Note, however, that evidence for this position is more robust in the presence of an already-complex coda, as in Figure 1I, than in Figure 1H, where the PT morpheme [-d] could also legally occupy a coda position (Selkirk, 1982). Despite disagreement as to whether and how such resyllabification occurs in connected speech¹ (e.g., Jensen, 2000; Szigetvári, 2001), it is reasonable to also consider the following phonological environment, because the morpheme segment may be produced in the onset of the following syllable in some cases.

Some studies have examined the role of following phonological context on morpheme marking rate (plural -s: Barlow & Pruitt-Lord, 2014; Polite, 2011; 3s: Barlow & Pruitt-Lord, 2014). These studies failed to identify an effect of following context (consonant vs. vowel) for plural -s; however, in comparing 3s and plural -s marking rates, the effect of a following vowel was shown to be contrastive. To be specific, 3s marking rate increased when followed by a vowel, yet plural -s marking rate decreased in the same context (Barlow & Pruitt-Lord, 2014), suggesting that the influence of following context might differ for 3s and plural -s. It is curious that no published studies of following context are available for PT. Nevertheless, given that PT is also likely subject to resyllabification processes, it would be appropriate to expand examination of its phonological context to the following environment as well. In addition, given differences in the influence of following context for 3s and plural -s morphemes, examination of following context might reveal differences or similarities between PT and 3s marking patterns.

The Current Study

An overview of the existing research pertaining to the influence of phonological context on tense-marking rates generates questions about differing sensitivity to phonological context across morphemes and populations and the role of resyllabification and following context. In the interest of addressing some of these gaps and questions in an exploratory fashion, we examine phonological influences on both PT and 3s morphemes that include multiple aspects of word-final phonology in naturalistic connected speech samples. We also expand the scope of context to examine phonological influences that might interact with the following word. Further, we contribute to the emerging typology of morphophonological interactions in tense marking by examining these effects in a population of young Spanish-English DLLs.

¹For instance, Kahn (1976) provides phonetic evidence from the realization of /t/ allophones for the occurrence of ambisyllabic consonants (i.e., those which straddle two syllables) in lieu of resyllabification in some contexts (for a discussion, see Treiman & Zukowski, 1990).

We seek to answer the following questions:

1. Do aspects of phonological context affect the marking rate of PT and 3s morphemes in Spanish–English DLLs with typical development?
2. Does syllable constituency or resyllabification across the word boundary contribute to the influence of phonological context?
3. Which measure or combination of measures of phonological context best predicts morpheme marking rates?
4. Beyond marking rate alone, do the influences of phonological context differ for PT and 3s morpheme productions? Further, are these differences attributable to the phonological form of these morphemes?

On the basis of existing research in other populations, we predict that, across measures, phonological context will affect marking rates for both morphemes. Further, given consistent findings for PT word-final influences, we expect this effect to follow patterns that are based on phonological complexity (i.e., higher marking in less complex contexts), at least for PT. Given inconsistent findings for the 3s morpheme in prior studies, we expect that phonological context will affect PT and 3s morpheme productions differently. And last, we expect resyllabification and following context to affect marking rate, given the notable influence of resyllabification processes in Spanish, the first language of our sampled population.

Method

Participants

Ten Spanish–English bilingual children, aged 56–66 months ($M = 61.7$, $SD = 3.4$) and enrolled in a Southern California public preschool, participated in this study as part of a larger community-based intervention project. All participants accessed the same curriculum in one of two classrooms where a teacher, a teacher's aide, and at least one speech-language pathology student volunteer were present 5 days a week.

Participants were all identified as Spanish–English DLLs with typical development by their caregivers. In written questionnaires, caregivers described their own education level and language use at home. Maternal and paternal education did not exceed a high school diploma. All children were described by caregivers as native speakers of Spanish, and language use at home was further described as percent spoken (output) and percent heard (input) in Spanish and English (e.g., Fabiano-Smith & Goldstein, 2010). At the time of this study, all participants had Spanish input and output at least 30% and 45% of the time at home, respectively (Pearson, Fernandez, Lewedeg, & Oller, 1997). Enrollment in an English-language preschool program denoted consistent English exposure for at least one academic year. Thus, the children in this study present with the profile of a sequential bilingual child (e.g., Hammer et al., 2004), with immersion

in their first language, Spanish, from birth and immersion in their second language, English, occurring later in school (starting at age 3–4 years). At this stage, both languages are in development, hence the children's DLL status. However, their second language, English, is in a particularly early stage of development that is highly variable across individuals (Iglesias & Rojas, 2012). Though mastery of PT and 3s morphemes is common in monolingual English learners with typical development by age 4–5 years (Brown, 1973), marking rates for these morphemes in same-age sequential bilingual children are much more variable—ranging anywhere from complete absence to mastery—as attested across studies of young bilingual children (e.g., Bland-Stewart & Fitzgerald, 2001; Gutiérrez-Clellen et al., 2008; Marinis & Chondrogianni, 2010; Padilla, 1978).

Caregivers, with teacher support, also completed the Ages and Stages Questionnaire (Squires & Bricker, 2009) as an indicator of each child's overall development. All scores on this measure exceeded the cutoff for typical development. All children demonstrated nonverbal IQ within the normal range on the Figure Ground and Form Completion subtests of the Leiter International Performance Scale–Revised (Roid & Miller, 1997). In addition, teachers and the lead certified speech-language pathologist working on a community-based intervention in the classrooms identified these children as developing language typically. Thus, in addition to standardized measures of development, typical language development was determined by reports from caregiver, teacher, and speech-language pathologist, which have been shown to provide reliable measures of language development in bilingual populations, for whom norms of many standardized language assessments are inappropriate (Gutiérrez-Clellen & Kreiter, 2003; Paradis, Emmerzael, & Duncan, 2010).

Caregiver questionnaires and nonverbal-intelligence measures were administered at the beginning of the school year, and language samples were collected at the end of the same school year. Standardized testing and language sampling were conducted by speech-language pathology graduate students as part of the larger community-based intervention project.

Procedure

Language-Sample Measures

Spontaneous language samples were the sole source of grammatical-morpheme production measurements in this study. Samples were collected for all children following a play-based elicitation protocol. This protocol included conversation and play with people figures, a gas station, cars, a doll family, toy food, and a picnic set, followed by story retell using three Apricot pictures (Arwood, 1985). Though obligatory 3s and PT contexts occurred throughout the samples, 3s occurred most frequently during the play portion and PT most frequently during story retell. Language samples from 10 participants were orthographically transcribed and analyzed for broad language measures using the Systematic Analysis of Language Transcripts (SALT)

software and guidelines (Miller & Iglesias, 2004) as part of the larger community intervention project. Average sample length was 15 min., for a total of 1,993 complete and intelligible utterances ($M = 199.3$, $SD = 84.48$). Mean length of utterance in morphemes was 3.61 ($SD = 0.41$).

Phonological Transcription

A protocol for phonemic transcription and coding of word-final grammatical-morpheme production was developed using Phon (Rose & Hedlund, 2016), a free and open-source software for phonological transcription and analysis. All child-produced utterances were transcribed in their entirety for each language sample in the International Phonetic Alphabet (IPA) using broad phonemic transcription. Target forms were also transcribed to reflect the correct, adultlike form of each utterance. For the purposes of this study, the target form was transcribed to match the child's production except for any errors in the child's production. In other words, the target transcription reflected acceptable idiosyncratic speech variation and dialectal influences, such as flapping of intervocalic alveolar stops, substitution of tense vowels for diphthongs, and dental production of alveolar obstruents.

Utterances were segmented such that any pause in connected speech, as determined by auditory perception and visual interpretation of the waveform and spectrogram, indicated the start of a new utterance. This operationalization of utterance boundaries is phonetic rather than syntactic in nature and is paramount to our analyses of connected speech. For example, *he melts it* /hi mɛlts ɪt/ would be transcribed as a single utterance only if there were no pauses between all three words. Given connected speech (Cholin et al., 2004; W. J. M. Levelt et al., 1999) and onset maximization principles (Clements, 1990; Selkirk, 1981; Zec, 2007), resyllabification could occur across word boundaries in this instance, as shown in Figure 1.

Morpheme Marking

During the transcription process, each utterance was also coded for PT and 3s morphemes in an additional tier within Phon. In this study, only monosegmental regular forms of these morphemes were analyzed (i.e., [-s, -z, -t, -d]), because the VC structure of [-ɪd, -ɪz] allomorphs adds an additional syllable to any word to which they are suffixed. Irregular forms were similarly excluded, because they can vary greatly in terms of which phoneme segments differ between the inflected and bare forms (e.g., *go* → *went*, *be* → *is*).

PT and 3s morphemes were coded at each obligatory context, irrespective of the child's production of the morpheme. In other words, transcriptions were initially coded only for the presence of obligatory contexts of PT and 3s morphemes. From these transcriptions, an obligatory context was considered marked if the morpheme was identifiable in the child's production. Thus, there are contexts in which a child's errant or idiosyncratic production may be coded as marked (see Table 2 for examples). For instance, in one child's production of *he needs to drink*, the inflected verb was produced as [nis]. Though the final consonant of the

verb stem was deleted, and the morpheme segment itself was devoiced, the morpheme segment was still phonologically present; thus, this token was coded as marked. In these samples, distortions of the morpheme segment were limited to devoicing or dentalization. On the converse, any obligatory context in which no morpheme segment was identified in the child's production was considered unmarked. Other morpheme-production error types, such as commission or overregularization, were not included in the analyses.

Phonemic transcription and morpheme coding were completed independently of the aforementioned SALT transcriptions by a separate group of graduate and upper-division undergraduate research assistants. Each phonemic transcriber demonstrated consistent and reliable transcription of child speech and identification of word-final morphemes before beginning the project. Transcribers were also trained in the use of Phon, interpretation of spectrograms and waveforms, and allophonic patterns of English and Spanish. Transcribers used both auditory interpretation of the child's speech and visual interpretation of spectrograms and waveforms to guide their transcriptions. Each language sample was transcribed and coded twice by separate transcribers, unaware of each other's coding and transcriptions. Reliability was calculated for 56% of the obligatory marking contexts. Each context included the bare verb stem, the final morpheme segment, and the following word (excepting UF forms). Reliability for IPA transcription of the child productions was 91%; reliability for identification of obligatory 3s and PT contexts was 99%; and reliability for transcription of the PT or 3s morpheme segment (i.e., marked versus unmarked tokens) was 88%. Disagreements were resolved by consensus after both transcriptions were complete. When consensus could not be reached due to noise or poor intelligibility, the item was marked as unintelligible and excluded from the analyses.

Phonological Predictor Variables

In order to examine multiple aspects of phonological context, including those which might extend across the word boundary, we used four different measures of phonological context: one measure of surrounding sequential complexity, two measures specific to preceding (i.e., word-final) phonological context, and one probabilistic measure of morpheme resyllabification into the following word. Using multiple measures of phonological context allowed for better comparison to the results of previous research, given the variability of measures used in those studies (see Table 1), and exploration of the phonological influences beyond preceding context. Furthermore, analyses of multiple measures allowed for comparison of their power to predict morpheme marking.

Number of surrounding consonants. This is the broadest measure, incorporating both preceding and following phonological contexts. This integer variable is a discrete count of the consonants in the coda of the verb stem and the consonants in the onset of the following word. For

Table 2. Contextual examples of past tense and third person singular tokens coded as marked or unmarked.

Orthography	International Phonetic Alphabet (IPA) target	IPA actual	Target → actual	Marked
<i>He needs to go</i>	/hi nidz tu gōʊ/	[hi nid tu gōʊ]	/z/ → Ø	No
<i>They dropped all the</i>	/ðeɪ dɹɑpt əl ðə/	[dʒə dɹɑp əl ðə]	/d/ → Ø	No
<i>He needs to drink</i>	/hi nidz tu dɪŋk/	[hi nis tu dɪŋk]	/dz/ → [s]	Yes
<i>Daddy comes to the</i>	/dædi kʌmz tu ðə/	[dædi kʌms tu ðə]	/z/ → [s]	Yes
<i>I fixed it</i>	/aɪ fɪkst ɪt/	[aɪ fɪkst ɪt]	/t/ → [t]	Yes

example, in *jumps by* /dʒʌmps baɪ/, the final morpheme [-s] is surrounded by three consonants: preceding /m/ and /p/ and following /b/. Because sequences of adjacent consonants are more sequentially complex than fewer consonants or alternating VC sequences, this measure is indicative of surrounding sequential complexity.

Preceding consonant or vowel (C/V) context. Preceding C/V context labels the final segment of the verb stem (i.e., the preceding segment) as a consonant or vowel. For example, in *jumped off* /dʒʌmpt əf/, the preceding segment is /p/, and thus the preceding C/V context is C. This measure captures preceding structural complexity in that words with branching coda structures (i.e., multiple word-final consonants) are more complex than words with a simple coda or appendix (i.e., only a single word-final consonant).

Preceding sonority distance. This variable takes into account the difference in sonority level of adjacent segments, also referred to as a sonority slope. Sonority values were coded using the sonority hierarchy for all preceding and morpheme segments to calculate the sonority distance between them. To illustrate, in the example *picked me* /pɪkt mi/, [-t] is the PT morpheme segment and /k/ is the preceding segment. Preceding sonority distance² is derived by subtracting the sonority rank (vowel [8] > glide [7] > liquid [6] > nasal [5] > voiced fricative [4] > voiceless fricative [3] > voiced stop [2] > voiceless stop [1]; Clements, 1990) of the morpheme segment from the preceding segment. In our example, the rank of /t/, a voiceless stop, is subtracted from the rank of /k/, also a voiceless stop (1 – 1 = 0). Because there is no change in sonority rank here, the preceding sonority distance is zero. Marking trends identified by this variable reflect transitional complexity, in that a falling word-final sonority slope is simpler than one that remains level or transitions from low to high (Clements, 1990).

Morpheme resyllabification. A final predictor variable addresses the role that resyllabification may play in mediating other phonological influences (i.e., interactions with other predictor variables). This measure is derived from the phonotactic probability of the phoneme sequence that would result if the morpheme segment were to resyllabify into the onset of the following word. Herein, we will refer

to this novel measure simply as *morpheme resyllabification*. For this study, all phonotactic-probability measures were calculated using average biphone frequencies from a calculator by Storkel and Hoover (2010), which derives frequencies from a combined corpus of American English speech productions of kindergarten and first-grade children (Kolson, 1960; Moe, Hopkins, & Rush, 1982).

To illustrate, consider the phrase *wants to* /wʌnts tu/. The phonotactic probability of the sequence /stu-/ at the beginning of a word is relatively high because this forms a phonotactically legal sequence, which also occurs at the beginning of many English words. On the other hand, in the phrase *picks the* /pɪks ðə/, the phonotactic probability of the sequence /sðə-/ at the beginning of a word is very low; in fact, it is zero because it does not occur in the onset of any words in the corpus of child speech from which the probability was derived. Further, this sequence is illegal according to English phonotactic constraints (Pitt, 1998; Treiman & Zukowski, 1990). Therefore, contexts where morpheme resyllabification is more probable are presumed to be instances where the morpheme is more likely to be associated with the beginning of the following word, as in *wants to* /wʌnts tu/ but not *picks the* /pɪks ðə/. This is because in these contexts, the morpheme segment could feasibly occupy a position in the following syllable. On the converse, a zero or low morpheme-resyllabification value, as in *picks the*, suggests that the morpheme segment is unlikely to occupy a position in the syllable at the start of the following word because this sequence is either uncommon or nonexistent at the start of words in English.

This measure was selected in consideration of the young DLL population examined in this study. In young children, emerging syllable structure might look very different than in adults (e.g., C. C. Levelt, Schiller, & Levelt, 2000; McLeod, van Doorn, & Reed, 2001), and constraints on syllable structure vary greatly across languages (e.g., Lleó & Prinz, 1996). Not only are the children in this study developing rules for syllable formation, but they are doing so for two languages with differing constraints on syllable structure (e.g., Blevins, 1995). Thus, we used a probability-based measure that does not require overt assumptions about underlying syllable structure or categorical distinctions on the basis of English phonotactics. This measure is derived solely from the relative frequency of occurrence of a resyllabified sequence, as observed in child speech.

²This measure would be most accurately described as word-final sonority distance. However, we at times refer to it as preceding sonority distance to differentiate it from other more global measures of context that extend across the word boundary.

Lexical and Sublexical Control Variables

Lexical frequency and phonotactic probability of the bare verb or inflected verb have been shown in previous studies to influence morpheme marking (e.g., Blom et al., 2012; Leonard et al., 2007; Marchman, 1997; Stemberger, 2007). In this study, these properties were not manipulated during data collection, because the language sampling procedure did not include stimulus words; rather, the children were free to produce (or avoid) verbs of their choosing. To address potentially confounding factors related to verb properties, we included word-final phonotactic probability and lexical frequency of the verb stem as control variables.

Word-final phonotactic probability. To control for the phonotactic properties of the final sound sequence of the inflected verb, phonotactic probability was calculated for the vowel of the final syllable, any coda consonants, and the final morpheme (e.g., /aps/ in *stops him* /staps him/). These phonotactic-probability values were derived using the same corpus and procedures as were used for the morpheme-resyllabification predictor variable.

Verb-stem frequency. This lexical property is a measure of the frequency of occurrence of a word in a given language or population. For this study, lexical frequency of the bare verb stem was collected from the ChildFreq calculator (Bååth, 2010), which draws from approximately 3,500,000 child productions of English words in the North American and UK English corpora of the CHILDES database (for more information on this freely available database of child language, see MacWhinney, 2000). Drawing from the CHILDES database allowed for collection of frequency counts from a large and heterogeneous corpus of English-speaking child productions and, importantly, permitted restriction to an age range matched to the participants in this study.

ChildFreq analyzes lexical frequency in child output only, and thus is not a measure of child-directed speech input. Frequency values from this calculator were derived from the number of occurrences per 1,000,000 words in all English-speaking children between 54 and 71 months of age from the aforementioned CHILDES corpora. Lexical frequency of the verb root (as opposed to the inflected form) was used, because this database did not distinguish between homophonous inflected forms (e.g., *3s he walks* vs. plural *such long walks*).

Coding Procedures

Marking rate, the dependent variable in this study, is defined as the proportion derived from the number of marked contexts (i.e., where the morpheme segment is present in the child’s production) out of the total number of obligatory contexts for a given morpheme. Verb-stem frequency values were collected, unchanged, from the ChildFreq calculator. Phonotactic-probability measures were calculated as the average of the positional biphone frequencies collected from the Storkel and Hoover (2010) calculator. Codes for the remaining variables were generated automatically in Phon or with spreadsheet formulas directly from IPA transcriptions of the target productions

for each obligatory PT or 3s morpheme context. Reliability for 25% of the PT and 3s items on the lexical-frequency measure was 100%. Reliability for 25% of the 3s items on two phonotactic-probability measures was 98%. All phonotactic-probability measures for PT were calculated twice because three errors were identified during reliability testing. All errors (four in total) were corrected and confirmed by a third party.

Statistical Analyses

To identify the effect of phonological context on marking rate for two morphemes, examine differences between them should they exist, and identify which phonological influences are most predictive in each case, we compared several families of mixed logistic regression models. A summary of the variables in these analyses is given in Table 3. For each morpheme, a separate family of model comparisons was conducted for each main phonological predictor (number of surrounding consonants, preceding C/V context, and preceding sonority distance). In other words, each main predictor was examined independently. Within each family, morpheme resyllabification was examined as an interacting predictor variable and both word-final phonotactic probability and verb-stem frequency were included as fixed control factors in the initial model. Because morpheme resyllabification is dependent on the following phonological context, all analyses that included this variable excluded UF forms. To account for differences across individuals, participant was included as a random factor in each model. Given repeated observations from each child, standard error was clustered by participant to obtain robust variance estimates (Rogers, 1993). Model variables were not orthogonalized; rather, collinear predictors were examined in a separate model (see Wurm & Fisi­caro, 2014).

Because we are interested in identifying the most predictive (or most predictive combination) of these various measures of phonological context, several model comparisons and diagnostic techniques were implemented. Each family of examinations began with the most complex model, including both control factors and the interaction between the main phonological predictor for that family and morpheme resyllabification. Interactions and control factors that were not significant ($p \geq 0.05$), did not contribute to goodness of fit as determined by Akaike’s information criteria (Akaike, 1974; Sakamoto, Ishiguro, & Kitagawa,

Table 3. Regression variables.

Predictor
Number of Surrounding Consonants × Morpheme Resyllabification
Preceding C/V Context × Morpheme Resyllabification
Preceding Sonority Distance × Morpheme Resyllabification
Control
Word-final phonotactic probability
Verb-stem frequency
Participant (random factor)

1986), and/or led to poor specification (as determined by a model-specification link test³) were removed. The results reported for each family of comparisons therefore reflect the most parsimonious model, and thus the most predictive and nonredundant configuration available for each measure of phonological context.

Results

Marking of PT and 3s morphemes was sufficiently variable for observation of phonological influences on marking rates, though data sampling from spontaneous connected speech resulted in nearly twice the number of obligatory contexts for 3s ($n = 92$) than for PT ($n = 54$). Average marking rate for PT was 27.8% ($SD = 45.2\%$), with large variation across participants ($SD = 33.1\%$). Marking rate for 3s was higher at 47.8% ($SD = 50.0\%$), also with considerable variation across participants ($SD = 29.0\%$). These findings are congruent with highly variable word-final morpheme marking rates in other studies of Spanish–English DLLs (Bland-Stewart & Fitzgerald, 2001; Gutiérrez-Clellen et al., 2008; Marinis & Chondrogianni, 2010; Padilla, 1978). Four participants did not produce PT in any obligatory contexts, though they evidenced multiple productions in PT probes and other standardized language measures, demonstrating some knowledge of the morpheme and ability to produce it; thus, unmarked contexts for these participants were included in the PT analyses. Two participants did not produce 3s in any obligatory contexts, and no data were available to otherwise demonstrate their ability to produce the morpheme; thus these participants were excluded from the 3s analyses. Results for each family of comparisons, for each morpheme, are displayed in Figure 2.

Number of Surrounding Consonants

There was a significant negative effect of number of surrounding consonants on PT marking rate, $z(1, 54) = -2.47, p = .01$, and no interaction with morpheme resyllabification. PT marking was at 100% (of five instances) in the simplest phonological context of no surrounding consonants (preceded by a vowel and in UF position). Note that a PT morpheme surrounded by a preceding and a following vowel (V_V) would also constitute a context with no surrounding consonants; however, this context did not occur in these samples. Marking rates for more complex contexts of one or two surrounding consonants were much lower, and all (four) instances of PT surrounded by three consonants were unmarked. Though the most parsimonious model

available⁴ was used, a significant specification link test (see Table 4) suggests that variables in this model may have been poorly specified. This could be related to few vowel-final PT verb stems and the absence of V_V context in these samples or the influence of UF position.⁵ Thus, this result should be interpreted with caution because the predictive power of this measure might be affected by sampling limitations or unidentified context effects.

Overall, number of surrounding consonants had a significant positive effect on 3s marking rate, $z(1, 78) = 4.73, p < .01$, and this influence was modulated by the probability of morpheme resyllabification—that is, a significant Number of Surrounding Consonants $\times$ Morpheme Resyllabification interaction, $z(1, 78) = -3.46, p < .01$ —as determined by the most parsimonious model.⁶ The simple main effect of morpheme resyllabification was also significant, $z(1, 78) = 2.57, p = .01$.

Examination of the interaction between surrounding consonants and morpheme resyllabification reveals that the total number of surrounding consonants does influence 3s marking rate, but this influence depends on the probability of morpheme resyllabification into the following word. In contexts with low morpheme resyllabification, a greater number of surrounding consonants results in higher 3s marking rates (an unexpected pattern on the basis of sequential complexity). In high-resyllabification contexts, increasing surrounding consonants results in lower 3s marking (the expected pattern also observed for PT).

Preceding C/V Context

Preceding C/V context significantly influenced PT marking rate, $z(1, 54) = 5.62, p = .02$, and did not interact with morpheme resyllabification, as determined by the most parsimonious model.⁷ PT marking rate increased when preceded by a vowel (i.e., in a simple coda) and decreased when preceded by a consonant.

Preceding C/V context also significantly influenced 3s marking rate, $z(1, 78) = 5.88, p = .02$, and, once again, this effect was mediated by morpheme resyllabification, $z(1, 78) = 11.52, p < .01$, as determined by the most parsimonious model.⁸ The simple main effect of morpheme resyllabification

³A model-specification link test is used to confirm that a given model is both predictive and unlikely to exclude other significant predictors, interactions, or polynomial transformations. This test generates a model with only two variables: one from the predictions of the model we are examining, and a second that is an exponential transformation of the predictions. Should the exponential transformation reach a level of significance, this would indicate misspecification, such as missing variables and interactions or incorrect formatting of existing variables (Pregibon, 1980).

⁴Independent predictor: number of surrounding consonants. Controls: verb-stem frequency, word-final phonotactic probability. Wald $\chi^2(3, 54) = 7.64, p = .05$.

⁵Two follow-up examinations tested this model with UF items excluded and, alternatively, with UF position included as a predictor variable. Exclusion reduced specification error ($p = .60$), though UF position was not a significant predictor ($p = .96$).

⁶Interacting predictors: Number of Surrounding Consonants $\times$ Morpheme Resyllabification. Control: verb-stem frequency. Wald $\chi^2(4, 78) = 45.03, p < .01$.

⁷Independent predictor: preceding C/V context. Controls: verb-stem frequency, word-final phonotactic probability. Wald $\chi^2(3, 54) = 12.65, p = .01$.

⁸Interacting predictors: Preceding C/V Context $\times$ Morpheme Resyllabification. Controls: verb-stem frequency, word-final phonotactic probability. Wald $\chi^2(6, 78) = 78.30, p < .01$.

Figure 2. Findings for marking rates of past tense and third person singular. For number of surrounding consonants and word-final sonority distance, low resyllabification = morpheme resyllabification at 0.00, and high resyllabification = morpheme resyllabification at 0.01. For preceding consonant/vowel (C/V) context, Low resyllab. and High resyllab. groups represent a median split of the morpheme-resyllabification values (Low resyllab. ≤ 0.0005 , High resyllab. > 0.0005). Error bars indicate 95% confidence intervals.

was not significant, $z(1, 78) = -1.77, p = .08$. Overall 3s marking rate was higher when preceded by a consonant than by a vowel. However, this effect differed according to probability of morpheme resyllabification. In contexts with low probability of morpheme resyllabification, 3s marking increased with a preceding consonant. In contexts with high probability of resyllabification, 3s marking rate favored a preceding vowel.

Preceding Sonority Distance

As with number of surrounding consonants and preceding C/V context, preceding sonority distance also significantly influenced PT marking rate, $z(1, 54) = 3.01, p < .01$. Unlike with previous families of observations, no control factors contributed to the most parsimonious model.⁹ When the PT morpheme created larger word-final sonority slopes, marking rate increased. Out of 20 obligatory contexts for PT marking where the verb stem ended in a stop consonant (e.g., *stop[-t]*), thus creating a level sonority slope, it is notable that no participant produced the morpheme segment. In contexts with a slight-to-moderate sonority slope of 2 to 4 (verbs ending with a fricative or nasal; e.g., *clean[-d]*), the PT morpheme was marked in 33% of obligatory contexts. When preceded by a vowel (e.g., *tief[-d]*), which creates a steep sonority slope, PT marking rate was 86%.

Preceding sonority distance also significantly affected 3s marking rate, $z(1, 78) = -2.03, p = .04$, and this influence

interacted with morpheme resyllabification, $z(1, 78) = 3.86, p < .01$, as determined by the most parsimonious model.¹⁰ The simple main effect of morpheme resyllabification was also significant, $z(1, 78) = -2.61, p = .01$. Thus, word-final sonority transitions affect 3s marking rate, and this influence is dependent on the probability of resyllabification into the following word.

As with each phonological predictor of 3s marking, two opposing patterns emerged. When resyllabification into the following word was less probable, more steeply falling (and thus, preferred) sonority slopes reduced 3s marking rate. In other words, in these environments the influence of word-final sonority distance is contrary to expectations that are based on transitional phonological complexity. When resyllabification into the following word is more probable, however, more steeply falling sonority slopes increased 3s marking rate, which is the expected pattern on the basis of transitional phonological complexity. This is also, incidentally, the pattern observed for PT.

Phonological Predictors of Tense-Morpheme Marking

Number of surrounding consonants, preceding C/V context, and preceding sonority distance each emerged as significant predictors of tense-morpheme marking rate. In order to identify which measurement of phonological

⁹Wald $\chi^2(1, 54) = 9.08, p < .01$.

¹⁰Interacting predictors: Preceding Sonority Distance $\times$ Morpheme Resyllabification. Controls: verb-stem frequency, word-final phonotactic probability. Wald $\chi^2(5, 78) = 22.29, p < .01$.

Table 4. Model comparisons for measures of phonological context.

Phonological context	AIC ^a	BIC ^a	LT pred. ^b	LT error ^c
Past tense				
Surrounding consonants	64.88	74.82	> .01	.01 ^d
Preceding C/V	60.05	69.99	> .01	.63
Preceding sonority distance	51.49	57.46	> .01	.74
Third person singular				
Surrounding Consonants × Morpheme Resyllabification	98.70	112.84	> .01	.74
Preceding C/V × Morpheme Resyllabification	100.03	116.53	> .01	.52
Preceding Sonority Distance × Morpheme Resyllabification	102.47	118.97	> .01	.80

Note. Best-fit models are in boldface; AIC = Akaike's information criterion; BIC = Bayesian information criterion; LT = link test; C/V = consonant/vowel.

^aLower value = better fit. ^bLink test: significance of model prediction ($p \leq .05$ = significant model prediction). ^cLink test: specification error ($p \leq .05$ = significant specification error). ^dSignificant model-specification link test indicating specification error.

context is most predictive for each morpheme, we repeated the same model comparison and diagnostic techniques used in each family of examinations for the most parsimonious model from each set. The results of these comparisons for each morpheme are listed in Table 4. For PT, word-final sonority distance—alone—emerged as the most salient phonological predictor of PT marking rate. For 3s, total number of surrounding consonants and its interaction with probability of morpheme resyllabification were the most predictive aspects of phonological context.

Differentiating Patterns of Tense-Morpheme Marking

Given differences in PT and 3s marking patterns across phonological contexts, an additional analysis was conducted to determine if these differences might be attributable to phonological features of the morphemes themselves. For this comparison, we examined nonmorphemic word-final homophones of both morphemes (e.g., the /d/ in *slide* as compared to the PT [-d] in *cried*; the /s/ in *axe* as compared to the 3s [-s] in *packs*). A randomly selected subset of 78 nonmorphemic final /s/ and /z/ fricatives and 54 nonmorphemic final /d/ and /t/ stops were extracted from the participants' language samples¹¹ and analyzed for the influence of preceding C/V context following the same procedures as for the word-final morphemes. No frequency or probability data were collected for nonmorphemic segments, and variables derived from these values (morpheme resyllabification and both control factors) were not used in this analysis.

The effect of preceding C/V context on nonmorphemic final-consonant marking rate is compared to the effects observed for PT and 3s in Figure 3. Preceding C/V context did not have a significant influence on the production of nonmorphemic final consonants /s/, /z/, /t/, and /d/, regardless

of type, $z(1, 132) = 0.80, p = .43$. Similar marking patterns for nonmorphemic final consonants (i.e., /t/ and /d/ do not pattern differently from /s/ and /z/), $z(1, 132) = 0.85, p = .40$, suggest that the observed differences in PT and 3s marking patterns cannot be explained by differences between stop (/t/ and /d/) and fricative (/s/ and /z/) sound types.

Discussion

In this study, the influence of phonological context on tense-morpheme marking was examined in a group of preschool-age Spanish-English DLLs. Results are summarized in Table 5. For both PT and 3s morphemes, phonological influence was most strongly identified at the end of the verb stem to which the morpheme attaches. This phonological influence was confirmed by both C/V distinction and word-final sonority configuration—a reassuring finding because it aligns with, and therefore supports, word-final context being the focus for most prior research. We thus extend evidence demonstrating the influence of preceding phonological context on tense-morpheme marking rate to a population of young Spanish-English DLLs.

In addition to the influence of preceding context, the influences of following and surrounding context were also considered, and patterns were compared across PT and 3s morphemes. Upon comparison, PT and 3s morphemes diverge tremendously in the marking patterns that emerged on the basis of their sensitivity to contextual phonological influences. The marking pattern observed for PT supports previous findings in populations of monolingual English speakers. The rate of PT marking increased when preceded by a vowel, when surrounded by fewer consonants, and when forming a steeper word-final sonority slope. Other than the influence of total surrounding consonants, following phonological context was not found to significantly affect PT marking rate. Of all phonological measures examined, word-final sonority slope was the most powerful predictor of PT marking rate.

Examination of phonologically influenced marking patterns for the 3s morpheme yielded notably different results. When considering only preceding phonological context, 3s

¹¹Items were sampled to match the frequency of analyzed PT and 3s morphemes. Because all 3s analyses included a significant interaction with morpheme resyllabification (a measure that does not apply to UF forms), UF forms were also excluded from the nonmorphemic homophone analysis of /z/ and /s/.

Figure 3. Marking rate by preceding consonant/vowel (C/V) context for past tense (PT) and third person singular (3s) morphemes and their corresponding nonmorphemic homophones (/d/, /t/; /z/, /s/) in word-final position. Error bars indicate 95% confidence intervals.

marking rate appeared to decrease in the same contexts where PT marking rate was shown to increase. That is, 3s overall marking rate was reduced in the context of preceding vowels, fewer surrounding consonants, and when forming steeper word-final sonority slopes. These findings are compatible with those reported by Barlow and Pruitt-Lord

(2014) for younger monolingual English-speaking children but appear in contrast to the findings of Song et al. (2009), where 3s marking rate was shown to increase in the context of a preceding vowel. However, these different findings may be explained by the role of following and surrounding context, which significantly affected 3s marking rate in the

Table 5. Summary of findings for phonological influences on marking rates for past tense and third person singular.

Measure of preceding or surrounding context	Morpheme resyllabification ^a	Simple	Complex
Past tense			
Surrounding consonants	High	✓	
	Low	✓	
Preceding C/V context	High	✓	
	Low	✓	
Preceding sonority distance	High	✓	
	Low	✓	
Third person singular			
Surrounding consonants	High	✓	
	Low		✓
Preceding C/V context	High	✓	
	Low		✓
Preceding sonority distance	High	✓	
	Low		✓

Note. Check mark indicates context (in terms of relative phonological complexity) with the highest marking rate. Simplest contexts for each measure (in descending order): zero surrounding consonants, preceding vowel, and large word-final sonority distance; C/V = consonant/vowel.

^aMorpheme resyllabification indicates phonotactic probability of resyllabification into the following word. This variable did not interact with other measures for past tense; there were significant interactions with each predictor variable for third person singular ($p < .05$).

current study. Marking of 3s was sensitive to the number of surrounding consonants and syllable-level phonotactic effects across the word boundary. In fact, the most powerful predictor of 3s marking rate was number of surrounding consonants, but only when the probability of resyllabification into the following word was also taken into account. To be specific, two patterns emerged in juxtaposition. When resyllabification of the 3s morpheme into the following syllable was improbable (as determined by phonotactic probability), marking rate increased in complex phonological contexts; in contrast, for PT the marking rate was consistently lower in complex contexts. When resyllabification was more probable, however, 3s marking rate favored simpler phonological contexts in much the same way as PT-marking trends.

The emergence of two distinct patterns of 3s marking in the same preceding contexts suggests that examination of preceding context alone might result in variable patterns across studies if following phonological context (specifically, syllable-level phonotactics) is not taken into account. This could contribute to the different findings for preceding context by Barlow and Pruitt-Lord and by Song et al. In fact, because these studies differed in how they restricted following context, perhaps one finding is not contrary to the other. It may be that they reveal complementary patterns of influence due to sampling different surrounding contexts.

The PT and 3s morphemes have many similarities, such as analogous allomorphic alternations, similar periods of acquisition (in monolingual individuals: Brown, 1973; in Spanish-English bilingual individuals: Bland-Stewart & Fitzgerald, 2001), and Level 2 morpheme status (i.e., monosegmental morphemes that suffix at the word level; e.g., Goldsmith, 2011), and both are tense markers used as diagnostic indicators of LI. These similarities make the observed dissimilar influence of phonological context on their marking rates all the more unexpected. Because the monosegmental forms examined in this study are composed of different sets of phonemes, each with different phonological properties, phonological influences on each morpheme were also compared with influences on their nonmorphemic word-final homophone counterparts. All four nonmorphemic word-final consonants showed the same pattern in favor of simpler phonological contexts. Thus, the differences observed for PT and 3s cannot be attributed only to differences in the types of phonemes these morphemes contain.

Modulating Word-Final Complexity

In this study, word-final phonological context was examined using multiple measures, many of which have appeared in previous studies (see Table 1). Across measures, two types of patterns emerged that can be characterized by preceding and surrounding phonological complexity. For PT and for 3s (though only in the context of high morpheme resyllabification), marking rate increased in phonologically simpler environments. A second, contrastive pattern emerged, but only for 3s in contexts of low morpheme resyllabification. In these environments, 3s not only appeared resistant

to the negative influence of phonological complexity but in fact was more frequently marked.

It is argued that word-level morphemes, such as PT and 3s, can occupy an extrasyllabic appendix position, particularly in more complex preceding contexts (Selkirk, 1982). A consideration of extrasyllabic constituency can provide an explanation of these disparate 3s marking patterns. When the morpheme segment is situated outside of the syllable (i.e., appendix position), syllable-internal complexity constraints may not apply to it (Clements, 1990; Selkirk, 1982), effectively fortifying the morpheme against the inhibitory influence of preceding complexity. If the extrasyllabic appendix position fortifies marking in complex contexts, it stands to reason that resyllabification out of this position into the following word would have an impact on this effect.

On the other hand, in simple preceding contexts there is less linguistic motivation for the morpheme to occupy an appendix position, if only because the morpheme segment is unlikely to violate word-final phonotactic constraints in a simple coda (e.g., Selkirk, 1982; Zec, 2007). Therefore, we might not expect the same fortifying effect of extrasyllabic constituency in simpler contexts. Indeed, when neither option results in appendix occupancy, preference (in the form of higher marking rate) is given to the morpheme in onset position over coda position. This is not surprising, given a widely attested cross-linguistic preference for syllables with a consonant onset and a preference against syllable codas (e.g., McCarthy & Prince, 1995). Thus, marking patterns related to the occupancy or vacancy of an appendix position might be involved in the findings for 3s presented here. It is interesting that like 3s, the PT morpheme is also allowed to occur in an extrasyllabic appendix position, though it could be argued that evidence for 3s appendix occupancy is more robust than for PT, given that only 3s can create negative word-final sonority slopes that violate the sonority sequencing principle. Related or not, no such influence of morpheme resyllabification was observed for PT. This description on the basis of appendix constituency is thus only extended to 3s, but a more substantial explanation related to syllabic constituency would need to accommodate observations for both morphemes.

Limitations and Future Directions

In this exploratory study, data were drawn from spontaneous connected speech to minimize a task-related influence and observe naturalistic connected speech patterns. This sampling method, however, was a source of methodological limitation due to the small sample size and the lack of controlled stimulus items. Given the sample size, there may be influences that did not reach significance but still contributed to marking rate, particularly for PT. Further, many potentially illuminating analyses of phonological context were not conducted due to the lack of multiple target productions in each desired condition. The entire surrounding phonological context was suspected to influence marking rates, and indeed, this was confirmed in

the form of a morpheme-resyllabification measure for 3s. However, measures of following context that paralleled measures of preceding context (e.g., following C/V context or following sonority distance) were not analyzed because identification of an interaction between preceding and following contexts would require more observations than were available in these data. For instance, preceding and following sonority distance each contain up to eight levels, and a complete examination of their interaction would require observations in as many as 64 conditions. This limitation is particularly true for PT, where vowel-final regular forms (e.g., *cried*; $n = 7$) were especially sparse, and even with evenly distributed UF productions and following consonants and vowels, there would be a maximum of only one or two observations in each combination of C/V context (V_V, V_C, C_UF, etc.).

For this same reason, a probability-based measure of following context (i.e., morpheme resyllabification) was especially useful for detecting influences that transcend the limitations of somewhat arbitrary categorical linguistic distinctions, such as consonant versus vowel. This continuous variable allowed for trend-like interactions that did not require observations in each combination of levels, as is the case for categorical interactions. Nonetheless, limited observations severely restricted analyses of surrounding context. It is possible, if not likely, that following context exhibits a demonstrable impact on tense-marking rate that could be identified with linguistic measures other than morpheme resyllabification.

Elicitation or imitation probes might allow for better control and inclusion of multiple observations in each condition. However, children have been shown to perform differently in probes and spontaneous language samples (Oetting et al., 2012). Moreover, prior identification of a task effect that interacted with the influence of preceding phonological context on PT marking (Barlow et al., 2015) suggests that this difference in performance may also extend to the influence of phonological environment, complicating the use of probes in research of this nature. Future research might systematically examine the effect of task type on morphological sensitivity to phonological context in order to guide data-collection methods in future morphophonological studies.

The influence of a probabilistic measure of resyllabification into the following onset adds to the growing body of research suggesting that lexical and sublexical frequency and probability measures do affect morpheme production (e.g., Hoover & Storkel, 2013; Leonard et al., 2007; Marchman, 1997; Stemberger, 2007). Further, it extends this effect to the word-final morpheme in combination with the initial sequence of the following word. Nonetheless, this measure of resyllabification probability is novel, and thus has yet to be validated. It is important that in a given production, such as *picks it* [piks.it], the high phonotactic probability of an onset sequence /sɪ-/ derived from the morpheme-resyllabification measure, may suggest that resyllabification is plausible (as in *pik sit* [pɪk.sɪt]), but it certainly does not indicate if such a syllable formation did in fact occur in that

particular production. This measure is essentially a calculation of phonotactic probability, and its extension to online syllable formation is currently only suggestive. Future research could identify the relationship between such a probability measure and syllable formation, for example, in a productive syllable-manipulation task.

This study draws from the connected speech productions of preschool-age Spanish–English DLLs. This is useful in that it expands our typological understanding of morphophonological interactions; however, it limits comparison of these findings to other studies until further research is conducted on young bilingual and monolingual comparison groups. It is not yet clear if these results are particular to the sampled population of Spanish–English bilingual children or generalizable to other bilingual or monolingual populations.

There is reason to consider the linguistic profile of this population, because dual-language interaction in these young learners could ostensibly affect PT and 3s marking patterns differently, especially across word boundaries. Nonpeninsular dialects of Spanish, for example, do not contain word-final grammatical morphemes similar in form to PT /-d/, but they do contain such morphemes similar to 3s /-z/, such as plural /-s/ (e.g., *casas*, “houses”) and present tense second person singular /-es/, /-as/, or /-is/ (e.g., *corres* /kores/, “(you) run”). If Spanish morphology has any influence on these children’s English productions, it might then be expected to surface in similar /s/-type morphemes, such as 3s, but not PT.

Spanish syllables are also highly restricted in their allowance of syllable codas, with an especially strong preference for open CV syllables, both of which contribute to robust resyllabification across word boundaries in Spanish (e.g., Colina, 2009; Martínez-Gil, 2000). In addition, /s/ is subject to Spanish-specific phonotactic constraints, such as impermissibility in onset clusters, which further govern its behavior during resyllabification (e.g., Lipski, 1999). It might then be that resyllabification influences identified for English 3s but not PT are related to particularly stringent constraints against /s/-initial clusters in Spanish. Indeed, Spanish–English bilingual individuals have been shown to activate Spanish-specific phonotactic constraints even when accessing English words (Freeman, Blumenfeld, & Marian, 2016). Future research might isolate and compare the influence of following context on the morpheme productions of Spanish–English bilingual speakers against the productions of English monolingual speakers.

Different findings for PT and 3s sensitivity to phonological context could be attributable to a number of factors and are likely a combination of many. Perhaps this cross-sectional examination is revealing each morpheme in a different state of emergence (note that overall marking rate was higher for 3s than PT in this sample), or perhaps there is some categorical difference in the underlying representation of these morphemes that has yet to be identified. If these morphemes are indeed sensitive to different phonological influences, this knowledge might be used to develop more sensitive diagnostic measures for identification of LI using

tense-marking patterns (rather than marking rate alone), especially in linguistically diverse populations. Given that both morphemes were more frequently marked in some phonological contexts and less marked in others, there is reason to further consider the role of phonology in the development and interpretation of diagnostic tools that examine morpheme production. For instance, it may be worthwhile to provide opportunities for word-final morpheme production in a variety of surrounding phonological contexts to provide a more complete demonstration of the child's language use patterns.

Many studies have demonstrated the efficacy of treating complex word-initial sequences for speech sound disorders (e.g., Gierut, 2007). However, there is a poverty of such research for word-final sequences, which is perhaps more outstanding given the frequent co-occurrence of speech sound disorders and LI (e.g., Shriberg & Austin, 1998). Given the sensitivity of word-final tense marking to phonological environment, treatment of word-final sequences could be a promising avenue for future research related to efficacious and even simultaneous treatment of speech sound production and morphosyntax. The findings presented here suggest that multiple phonological factors, including aspects of the following word, influence morpheme marking in a bilingual population. The presence of these influences may have implications for the development and administration of diagnostic tools for identification of LI and for morphophonological treatment approaches, such that future research should consider a broader scope of phonological influence in other linguistically diverse populations, including children with LI.

To conclude, aspects of phonological context and complexity surrounding PT and 3s tense morphemes were examined for their influence on marking rate in young sequential Spanish-English bilingual children. Marking of both morphemes was sensitive to word-final phonological context, though they differed in the nature of this sensitivity. Marking of 3s in particular was also influenced by aspects of following phonological context. We suggest that resyllabification and positioning of the morpheme in syllable structure may contribute to different sensitivities to phonological context. Further research is needed to understand the differences observed for PT and 3s morphemes and the role of a dual-language profile in sensitivity to phonological influences on morpheme production.

Acknowledgments

Philip N. Combiths and Irina Potapova were supported by National Institutes of Health Training Grant T32 DC007361. Additional funding was provided by National Institute on Deafness and Other Communication Disorders RO3 Grant DC012141 and a Price Philanthropies research grant, awarded to Sonja Pruitt-Lord.

The authors would like to thank our young participants and research assistants in the Phonological Typologies Lab and the Child Language Development, Disorders, and Disparities Lab at San Diego State University for their integral role in the completion of this project. We thank Jörg Matt for statistical consultation and Yvan Rose and Greg Hedlund for technical assistance and

their role in the development of Phon, as well as attendees of the 2016 International Child Phonology Conference and the 2016 Symposium on Research in Child Language Disorders for valuable feedback on preliminary data. We also thank Sam Engel for contributions to the initial stages of this investigation.

References

- Akaike, H. (1974). A new look at the statistical model identification. *IEEE Transactions on Automatic Control*, 19, 716–723.
- Arwood, E. (1985). *Apricot I Kit*. Tigard, OR: Apricot.
- Bååth, R. (2010). ChildFreq: An online tool to explore word frequencies in child language [Technical report]. *LUCS Minor*, 16, 1–6.
- Barlow, J. (2016). Sonority in acquisition: A review. In M. J. Ball & N. Müller (Eds.), *Challenging sonority: Cross-linguistic evidence* (pp. 295–336). Sheffield, United Kingdom: Equinox.
- Barlow, J. A., & Enriquez, M. (2007). Theoretical perspectives on speech sound disorders in bilingual children. *Perspectives on Communication Disorders and Sciences in Culturally and Linguistically Diverse Populations*, 14(2), 3–10. <https://doi.org/10.1044/cds14.2.3>
- Barlow, J. A., & Gierut, J. A. (1999). Optimality theory in phonological acquisition. *Journal of Speech, Language, and Hearing Research*, 42, 1482–1498.
- Barlow, J. A., & Pruitt-Lord, S. (2014). The role of phonological context in children's overt marking of 's' in two dialects of American English. In A. W. Farris-Trimble & J. A. Barlow (Eds.), *Perspectives on phonological theory and acquisition: In honor of Daniel A. Dinnsen* (pp. 133–154). Philadelphia, PA: Benjamins.
- Barlow, J. A., Pruitt-Lord, S. L., & Combiths, P. (2015, June). *Context and task effects on English past-tense marking: The case of bilinguals*. Paper presented at the International Child Phonology Conference, St. John's, Newfoundland, Canada.
- Bedore, L. M., & Leonard, L. B. (1998). Specific language impairment and grammatical morphology: A discriminant function analysis. *Journal of Speech, Language, and Hearing Research*, 41, 1185–1192.
- Berko, J. (1958). The child's learning of English morphology. *Word*, 14, 150–177. <https://doi.org/10.1080/00437956.1958.11659661>
- Bland-Stewart, L. M., & Fitzgerald, S. M. (2001). Use of Brown's 14 grammatical morphemes by bilingual Hispanic preschoolers: A pilot study. *Communication Disorders Quarterly*, 22, 171–186. <https://doi.org/10.1177/152574010102200403>
- Blevins, J. (1995). The syllable in phonological theory. In J. A. Goldsmith (Ed.), *The handbook of phonological theory* (pp. 206–244). Oxford, United Kingdom: Blackwell.
- Blom, E., & Paradis, J. (2013). Past tense production by English second language learners with and without language impairment. *Journal of Speech, Language, and Hearing Research*, 56, 281–294. [https://doi.org/10.1044/1092-4388\(2012/11-0112\)](https://doi.org/10.1044/1092-4388(2012/11-0112))
- Blom, E., Paradis, J., & Duncan, T. S. (2012). Effects of input properties, vocabulary size, and L1 on the development of third person singular -s in child L2 English. *Language Learning*, 62, 965–994. <https://doi.org/10.1111/j.1467-9922.2012.00715.x>
- Borowsky, T. (1989). Structure preservation and the syllable coda in English. *Natural Language & Linguistic Theory*, 7, 145–166.
- Brown, R. (1973). *A first language: The early stages*. Cambridge, MA: Harvard University Press.
- Cholin, J., Schiller, N. O., & Levelt, W. J. M. (2004). The preparation of syllables in speech production. *Journal of Memory and Language*, 50, 47–61. <https://doi.org/10.1016/j.jml.2003.08.003>
- Clements, G. N. (1990). The role of the sonority cycle in core syllabification. In J. Kingston & M. E. Beckman (Eds.), *Papers*

- in laboratory phonology I: Between the grammar and physics of speech (pp. 283–333). Cambridge, United Kingdom: Cambridge University Press.
- Colina, S.** (2009). *Spanish phonology: A syllabic perspective*. Washington, DC: Georgetown University Press.
- Dalal, R. H., & Loeb, D. F.** (2005). Imitative production of regular past tense -ed by English-speaking children with specific language impairment. *International Journal of Language & Communication Disorders*, 40, 67–82. <https://doi.org/10.1080/13682820410001734163>
- Fabiano-Smith, L., & Goldstein, B. A.** (2010). Phonological acquisition in bilingual Spanish–English speaking children. *Journal of Speech, Language, and Hearing Research*, 53, 160–178. [https://doi.org/10.1044/1092-4388\(2009/07-0064\)](https://doi.org/10.1044/1092-4388(2009/07-0064))
- Freeman, M. R., Blumenfeld, H. K., & Marian, V.** (2016). Phonotactic constraints are activated across languages in bilinguals. *Frontiers in Psychology*, 7, 702. <https://doi.org/10.3389/fpsyg.2016.00702>
- Fujimura, O., & Lovins, J.** (1978). Syllables as concatenative phonetic units. In A. Bell & J. B. Hooper (Eds.), *Syllables and segments* (pp. 107–120). New York, NY: North-Holland.
- Gierut, J. A.** (2007). Phonological complexity and language learnability. *American Journal of Speech-Language Pathology*, 16, 6–17.
- Goldsmith, J.** (2011). The syllable. In J. Goldsmith, J. Riggle, & A. C. L. Yu (Eds.), *The handbook of phonological theory* (2nd ed., pp. 164–196). Oxford, United Kingdom: Wiley-Blackwell.
- Greenberg, J. H.** (1978). Some generalizations concerning initial and final consonant clusters. In J. H. Greenberg, C. A. Ferguson, & E. A. Moravcsik (Eds.), *Universals of human language*, Vol. 2: *Phonology* (pp. 243–279). Stanford, CA: Stanford University Press.
- Gutiérrez-Clellen, V. F., & Kreiter, J.** (2003). Understanding child bilingual acquisition using parent and teacher reports. *Applied Psycholinguistics*, 24, 267–288. <https://doi.org/10.1017/S0142716403000158>
- Gutiérrez-Clellen, V. F., Simon-Cereijido, G., & Wagner, C.** (2008). Bilingual children with language impairment: A comparison with monolinguals and second language learners. *Applied Psycholinguistics*, 29, 3–19. <https://doi.org/10.1017/S0142716408080016>
- Halle, M., & Vergnaud, J.-R.** (1980). Three dimensional phonology. *Journal of Linguistic Research*, 1, 83–105.
- Hammer, C. S., Miccio, A. W., & Rodriguez, B. L.** (2004). Bilingual language acquisition and the child socialization process. In B. A. Goldstein (Ed.), *Bilingual language development and disorders in Spanish-English speakers* (pp. 21–50). Baltimore, MD: Brookes.
- Hawkins, J. A.** (1987). Implicational universals as predictors of language acquisition. *Linguistics*, 25, 453–473.
- Hoover, J. R., & Storkel, H. L.** (2013). Grammatical treatment and specific language impairment: Neighbourhood density & third person singular -s. *Clinical Linguistics & Phonetics*, 27, 661–680. <https://doi.org/10.3109/02699206.2013.789928>
- Iglesias, A., & Rojas, R.** (2012). Bilingual language development of English language learners: Modeling the growth of two languages. In B. A. Goldstein (Ed.), *Bilingual language development and disorders in Spanish-English speakers* (2nd ed., pp. 1–30). Baltimore, MD: Brookes.
- Jacobson, P. F., & Schwartz, R. G.** (2005). English past tense use in bilingual children with language impairment. *American Journal of Speech-Language Pathology*, 14, 313–323.
- Jakobson, R.** (1968). *Child language, aphasia and phonological universals* (A. R. Keiler, Trans.). The Hague, the Netherlands: Mouton.
- Jensen, J. T.** (2000). Against ambisyllabicity. *Phonology*, 17, 187–235.
- Johnson, B. W., & Morris, S. R.** (2007). Clinical implications of the effects of lexical aspect and phonology on children's production of the regular past tense. *Child Language Teaching and Therapy*, 23, 287–306. <https://doi.org/10.1177/0265659007080682>
- Kahn, D.** (1976). *Syllable-based generalizations in English phonology* (Doctoral thesis, Massachusetts Institute of Technology). Retrieved from <https://hdl.handle.net/1721.1/16397>
- Kolson, C.** (1960). *The vocabulary of kindergarten children* (Unpublished doctoral dissertation), University of Pittsburgh, Pittsburgh, PA.
- Leonard, L. B.** (2014). *Children with specific language impairment* (2nd ed.). Cambridge, MA: MIT Press.
- Leonard, L. B., Davis, J., & Deevy, P.** (2007). Phonotactic probability and past tense use by children with specific language impairment and their typically developing peers. *Clinical Linguistics & Phonetics*, 21, 747–758. <https://doi.org/10.1080/02699200701495473>
- Levelt, C. C., Schiller, N. O., & Levelt, W. J.** (2000). The acquisition of syllable types. *Language Acquisition*, 8, 237–264.
- Levelt, W. J. M., Roelofs, A., & Meyer, A. S.** (1999). A theory of lexical access in speech production. *Behavioral and Brain Sciences*, 22, 1–38. <https://doi.org/10.1017/S0140525X99001776>
- Lipski, J. M.** (1999). The many faces of Spanish /s/-weakening: (Re)alignment and ambisyllabicity. In J. Gutiérrez-Rexach & F. Martínez-Gil (Eds.), *Advances in Hispanic linguistics* (pp. 198–213). Somerville, MA: Cascadia Press.
- Lleó, C., & Prinz, M.** (1996). Consonant clusters in child phonology and the directionality of syllable structure assignment. *Journal of Child Language*, 23, 31–56.
- MacWhinney, B.** (2000). *The CHILDES project: Tools for Analyzing Talk* (3rd ed., Vol. II). Mahwah, NJ: Erlbaum.
- Marchman, V. A.** (1997). Children's productivity in the English past tense: The role of frequency, phonology, and neighborhood structure. *Cognitive Science*, 21, 283–304. https://doi.org/10.1207/s15516709cog2103_2
- Marchman, V. A., Wulfeck, B., & Weismer, S. E.** (1999). Morphological productivity in children with normal language and SLI: A study of the English past tense. *Journal of Speech, Language, and Hearing Research*, 42, 206–219. <https://doi.org/10.1044/jslhr.4201.206>
- Marinis, T., & Chondrogianni, V.** (2010). Production of tense marking in successive bilingual children: When do they converge with their monolingual peers? *International Journal of Speech-Language Pathology*, 12, 19–28.
- Marshall, C. R., & van der Lely, H. K. J.** (2007). The impact of phonological complexity on past tense inflection in children with Grammatical-SLI. *Advances in Speech Language Pathology*, 9, 191–203.
- Martínez-Gil, F.** (2000). La estructura prosódica y la especificación vocálica en español: El problema de la sinalefa en ciertas variedades de la lengua coloquial contemporánea [Prosodic structure and vowel specification in Spanish: The problem of synaloepha in certain varieties of contemporary colloquial language]. In J. G. Fernández (Ed.), *Panorama de la fonología española actual* (pp. 511–560). Madrid, Spain: Arco Libros.
- McCarthy, J. J., & Prince, A. S.** (1995). Faithfulness and reduplicative identity. In J. Beckman, L. W. Dickey, & S. Urbanczyk (Eds.), *University of Massachusetts occasional papers in linguistics 18: Papers in optimal theory* (pp. 249–384). Amherst, MA: Graduate Linguistic Students' Association, University of Massachusetts.
- McLeod, S., van Doorn, J., & Reed, V. A.** (2001). Normal acquisition of consonant clusters. *American Journal of Speech-Language*

- Pathology*, 10, 99–110. [https://doi.org/10.1044/1058-0360\(2001/011\)](https://doi.org/10.1044/1058-0360(2001/011))
- Miller, J. F., & Iglesias, A.** (2004). Systematic Analysis of Language Transcripts (Version 8), English & Spanish [Computer software]. Madison, WI: Language Analysis Lab, University of Wisconsin.
- Moe, A. J., Hopkins, C. J., & Rush, R. T.** (1982). *The vocabulary of first-grade children*. Springfield, IL: Charles C Thomas.
- Nathan, G. S.** (2008). *Phonology: A cognitive grammar introduction*. Amsterdam, the Netherlands: John Benjamins.
- Oetting, J. B., & Horohov, J. E.** (1997). Past-tense marking by children with and without specific language impairment. *Journal of Speech, Language, and Hearing Research*, 40, 62–74. <https://doi.org/10.1044/jslhr.4001.62>
- Oetting, J. B., Riviere, A., Lee, R., Richardson, J., Hegarty, M., & McDonald, J.** (2012, June). Structure specific differences in nonmainstream dialects of English across tasks. Paper presented at the Symposium on Research in Child Language Disorders, Madison, WI.
- Owen Van Horne, A. J., & Green Fager, M.** (2015). Quantifying the relative contributions of lexical and phonological factors to regular past tense accuracy. *International Journal of Speech-Language Pathology*, 17, 605–616. <https://doi.org/10.3109/17549507.2015.1034174>
- Padilla, A. M.** (1978). The acquisition of fourteen English grammatical morphemes in the speech of bilingual children. *Bilingual Review/La Revista Bilingüe*, 5, 163–168.
- Paradis, J.** (2005). Grammatical morphology in children learning English as a second language. *Language, Speech, and Hearing Services in Schools*, 36, 172–187. [https://doi.org/10.1044/0161-1461\(2005/019\)](https://doi.org/10.1044/0161-1461(2005/019))
- Paradis, J., & Crago, M.** (2000). Tense and temporality: A comparison between children learning a second language and children with SLI. *Journal of Speech, Language, and Hearing Research*, 43, 834–847. <https://doi.org/10.1044/jslhr.4304.834>
- Paradis, J., Emmerzael, K., & Duncan, T. S.** (2010). Assessment of English language learners: Using parent report on first language development. *Journal of Communication Disorders*, 43, 474–497. <https://doi.org/10.1016/j.jcomdis.2010.01.002>
- Paradis, J., Rice, M. L., Crago, M., & Marquis, J.** (2008). The acquisition of tense in English: Distinguishing child second language from first language and specific language impairment. *Applied Psycholinguistics*, 29, 689–722. <https://doi.org/10.1017/S0142716408080296>
- Pearson, B. Z., Fernandez, S. C., Lewedeg, V., & Oller, D. K.** (1997). The relation of input factors to lexical learning by bilingual infants. *Applied Psycholinguistics*, 18, 41–58. <https://doi.org/10.1017/S0142716400009863>
- Pitt, M. A.** (1998). Phonological processes and the perception of phonotactically illegal consonant clusters. *Perception & Psychophysics*, 60, 941–951. <https://doi.org/10.3758/bf03211930>
- Polite, E. J.** (2011). The contribution of part-word phonological factors to the production of regular noun plural -s by children with and without specific language impairment. *First Language*, 31, 425–441. <https://doi.org/10.1177/0142723711406431>
- Pregibon, D.** (1980). Goodness of link tests for generalized linear models. *Journal of the Royal Statistical Society, Series C: Applied Statistics*, 29, 15–23. <https://doi.org/10.2307/2346405>
- Pruitt, S., & Oetting, J.** (2009). Past tense marking by African American English-speaking children reared in poverty. *Journal of Speech, Language, and Hearing Research*, 52, 2–15.
- Rice, M. L., Tomblin, J. B., Hoffman, L., Richman, W. A., & Marquis, J.** (2004). Grammatical tense deficits in children with SLI and nonspecific language impairment. *Journal of Speech, Language, and Hearing Research*, 47, 816–834. [https://doi.org/10.1044/1092-4388\(2004/061\)](https://doi.org/10.1044/1092-4388(2004/061))
- Rice, M. L., & Wexler, K.** (1996). Toward tense as a clinical marker of specific language impairment in English-speaking children. *Journal of Speech and Hearing Research*, 39, 1239–1257. <https://doi.org/10.1044/jshr.3906.1239>
- Riches, N.** (2015). Past tense -ed omissions by children with specific language impairment: The role of sonority and phonotactics. *Clinical Linguistics & Phonetics*, 29, 482–497. <https://doi.org/10.3109/02699206.2015.1027832>
- Rogers, W.** (1993). Regression standard errors in clustered samples. *Stata Technical Bulletin*, 13, 19–23.
- Roid, G. H., & Miller, L. J.** (1997). *Leiter International Performance Scale-Revised (Leiter-R) manual*. Wood Dale, IL: Stoelting.
- Rose, Y., & Hedlund, G.** (2016). Phon (Version 2.1) [Computer software]. Retrieved from <https://www.phon.ca/phontrac>
- Sakamoto, Y., Ishiguro, M., & Kitagawa, G.** (1986). *Akaike information criterion statistics*. Dordrecht, the Netherlands: D. Reidel.
- Selkirk, E. O.** (1981). English compounding and the theory of word structure. In M. Moortgat, H. van der Hulst, & T. Hoekstra (Eds.), *The scope of lexical rules* (pp. 229–277). Dordrecht, the Netherlands: Foris.
- Selkirk, E. O.** (1982). The syllable. In H. van der Hulst & N. Smith (Eds.), *The structure of phonological representations* (Vol. 2, pp. 337–383). Dordrecht, the Netherlands: Foris.
- Shriberg, L. D., & Austin, D.** (1998). Comorbidity of speech-language disorders: Implications for a phenotype marker for speech delay. In R. Paul (Ed.), *The speech-language connection* (pp. 73–117). Baltimore, MD: Brookes.
- Song, J. Y., Sundara, M., & Demuth, K.** (2009). Phonological constraints on children's production of English third person singular -s. *Journal of Speech, Language, and Hearing Research*, 52, 623–642.
- Squires, J., & Bricker, D.** (2009). *Ages & Stages Questionnaires: A parent-completed, child-monitoring system* (3rd ed.). Baltimore, MD: Brookes.
- Stemberger, J. P.** (2007). Children's overtensing errors: Phonological and lexical effects on syntax. *Journal of Memory and Language*, 57, 49–64.
- Storkel, H. L., & Hoover, J. R.** (2010). An online calculator to compute phonotactic probability and neighborhood density on the basis of child corpora of spoken American English. *Behavior Research Methods*, 42, 497–506. <https://doi.org/10.3758/BRM.42.2.497>
- Sundara, M., Demuth, K., & Kuhl, P. K.** (2011). Sentence-position effects on children's perception and production of English third person singular -s. *Journal of Speech, Language, and Hearing Research*, 54, 55–71. [https://doi.org/10.1044/1092-4388\(2010/10-0056\)](https://doi.org/10.1044/1092-4388(2010/10-0056))
- Szigetvári, P.** (2001). Dismantling syllable structure. *Acta Linguistica Hungarica*, 48, 155–181.
- Treiman, R., & Zukowski, A.** (1990). Toward an understanding of English syllabification. *Journal of Memory and Language*, 29, 66–85. [https://doi.org/10.1016/0749-596x\(90\)90010-w](https://doi.org/10.1016/0749-596x(90)90010-w)
- Wurm, L. H., & Fisičaro, S. A.** (2014). What residualizing predictors in regression analyses does (and what it does not do). *Journal of Memory and Language*, 72, 37–48.
- Zec, D.** (2007). The syllable. In P. de Lacy (Ed.), *The Cambridge handbook of phonology* (pp. 161–194). Cambridge, United Kingdom: Cambridge University Press.