Phonological spell-out of word internal code-switching by early Spanish/English bilinguals

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Abstract

This paper examines phonological spell-out of Spanish/English word-internal code-switching. Specifically, we empirically test the claim that a code-switched word cannot contain phonological elements from two languages (MacSwan & Colina, 2014; Rao & DenDikken, 2014). In this pilot study we examine production of English /z/ (not part of the Spanish phonological inventory) in morphologically switched nonce verbs with an English root and Spanish affixes. Data from an elicited production task administered in English/Spanish code-switching and monolingual Spanish conditions indicate that the early Spanish/English bilinguals tested do not maintain English phonology ([z]) in the English root of the switched verb. Instead, Spanish phonology is applied to the entire word, which provides preliminary support for the posited ban on word-internal phonological switches.
Phonological Spell-out of intra-word code-switching by early Spanish/English bilinguals

Code-switching (CS) at the word level is different than CS at the sentence or discourse level in that a distinction needs to be made between morphology and phonology. At the sentence/discourse level, it is generally considered that the language of the morphology matches the language of the phonology of the constituents.¹ For example, take a typical case of intrasentential CS as shown in (1).

(1) Tell Larry que se calle la boca (Poplack, 1980)
   ‘Tell Larry to shut his mouth’

The words ‘tell Larry’ are English morphological elements and possess English phonology whereas the words que se calle la boca are Spanish morphological elements and possess Spanish phonology. This overlap between morphology and phonology does not seem to be the case when code-switching occurs within a word. Consider the morphologically switched word (i.e., a word made up of morphological elements from two languages, in this case Spanish and German) in (2).

(2) Utilisieren (taken from González-Vilbazo & López, 2011)
   ‘we use’

The word in (2) is made up of the Spanish root utiliz² from the verb utilizar ‘to use’ and the German derivational and inflectional affixes –ier and –en, respectively. German/Spanish

¹ See MacSwan and Colina (2014) for a discussion and González-Vilbazo and López (2012) for an example in which segmental level phonology matches the language of the morphology but suprasegmental phonology does not.
² We are aware of the orthographic difference between the ‘z’ in utilizar and the ‘s’ in the code-switched word utilisieren. We have taken the orthography directly from González-Vilbazo and López (2011) whose first author is a German/Spanish bilingual.
bilinguals accept the word in (2) as long as it is produced with German phonology (3) (K. González-Vilbazo, personal communication, November 22, 2016).

(3) [ʔɔtʰli:zi:ʁn]

However, German/Spanish bilinguals reject (2) if it is produced as a phonologically switched word (i.e., a word made up of elements from two phonologies, or which has undergone phonological processes from two different phonological systems).

(4) *[u̯tilisi:ʁn]

In (4) the morphology of the elements matches the phonology of the elements in the same manner as (1) and this overlap between the two is rejected by German/Spanish bilinguals.³ It has also been determined that the switch in (2) is only acceptable if the phonetic form matches the language of the affixes (i.e., German); (2) is rejected by German/Spanish bilinguals if Spanish phonology applies to the root and affixes (5).

(5) *[u̯tilisjerɛn]

This distinction between morphology and phonology when examining word-internal CS has not been made explicit within the CS literature. Moreover, the phonology of these morphologically switched words has yet to be empirically examined. This paper begins to address these gaps by providing an acoustic analysis of the production of morphologically switched words in order to determine whether words comprised of morphological elements from two languages can be produced with phonological elements from both languages.

³ German/Spanish CS judgments are provided by a German/Spanish bilingual consultant.
Background

*Code-switching and the bilingual’s linguistic system*

Before we move further, it is necessary to define our view of CS and clarify our assumptions about the phenomenon. CS can be defined as “the use of two languages within the same discourse, sentence or constituent” (Poplack, 1980, p. 583). In this chapter we focus on CS as the use of two languages within a single word (see (2), repeated as (6)).

(6) *Utilisieren*  
’we use’

We take CS to be an expression of the bilinguals’ I-language (see Badiola, Delgado, Sande & Stefanich, 2017; González-Vilbazo, Bartlett, Downey, Ebert, Heil, Hoot & Ramos, 2013; González-Vilbazo & López, 2011 among others). I-language as defined by Chomsky (1986) is the mentally represented linguistic knowledge of a native speaker reflected in their competence. Thus, bilingual speakers have intuitions about and reflect competence in CS in the same way that monolingual speakers have intuitions about and reflect competence in their language.

Further, we assume that CS can be accounted for in the same way as monolingual speech (e.g., MacSwan, 1999). Bilinguals take lexical items from Language A and Language B and merge them into a single syntactic derivation. The features of these lexical items are checked in the same manner as in a monolingual derivation. As long as there is no feature mismatch, the code-switched structure will be sent to spell-out, where, among other things, it will receive its phonological form. We subscribe to MacSwan’s (2000) view of the bilingual linguistic system in which a bilingual has one computational syntax and one Phonological Component (PF) with two separate phonologies (i.e., phonological systems). Thus, a bilingual producing the code-switched
word in (6) will take the lexical items from their lexica and merge them into the syntactic derivation. In syntax, the lexical items are combined via a process of head movement/incorporation giving rise to a single complex morphosyntactic head. When this structure is sent to spell-out, there are two potentially available phonological systems from which it can receive its phonological form, in this case, Spanish or German. Receiving a phonological form from either the Spanish or German phonological systems would give rise to a morphologically switched word (i.e., morphological elements from two languages but phonological elements from one language) but not a phonologically switched word. Another possibility is that the structure can receive elements of its phonological form from both phonological systems. This would give rise to a code-switched structure along the lines of (1) in which there are both morphological and phonological elements from two languages. In this paper we investigate which of these three options (Phonology A only, Phonology B only, or Phonology A and Phonology B) might apply at PF.

CS theory

Within the CS literature there are no studies to our knowledge that look specifically at the phonology of word-internal switches. However, scattered throughout the CS literature are various examples and theoretical accounts pertaining to word-internal CS more generally. What follows is a synthesis of these accounts and an interpretation of how they can be applied to word-internal switches when focusing specifically on phonology.

Rao and DenDikken (2014)

In their examination of Telugu/English CS, Rao and DenDikken (2014) noticed an interesting asymmetry. Telugu/English bilinguals were able to produce and accept sentences such as (7)
with a Telugu root and English verbal morphology but rejected sentences such as (8) with an English root and Telugu verbal morphology.

(7) my sister kalp-ified the curry kalp ‘stir’ [taken from Rao & DenDikken, 2014]

(8) *vaaDu nanni love-inc-EEDu
    He-NOM me-ACC love-do-PST-AGR

Rao and DenDikken ask why there should be a difference between (7) and (8) since both examples demonstrate a switch between little v and VP. They argue that the difference lies with the use of *ify and inc as little light verbs whereby inc incorporates with its host (‘love’ in this case) in the syntax and *ify does not. Using this difference as a base they posit the following restriction:

(9) Code-switching within phonological words that are morphosyntactic heads (X⁰s) is illicit.

Following a “late spell-out” analysis within Distributed Morphology (e.g., Halle & Marantz, 1993; Marantz, 1997), when the structure created in syntax is handed over to the PF at spell-out, phonology “forgets” (Chomsky, 2001) the earlier stages of the derivation. This means that complex X⁰’s of the type in (8) become single words which will be analyzed as a single unit and therefore cannot be realized as a mixture of morpholexical material from two different languages. In other words, (7) is acceptable because ‘kalp’ and ‘ified’ do not incorporate to a single X⁰ in the syntax. Instead, they are put together at PF and can therefore give rise to a phonological word that contains morpholexical material from two different languages. However, (8) is rejected because ‘love’ and ‘inc-eedu’ do in fact incorporate to a single X⁰ in the syntax and therefore are viewed as a single unit by PF. Thus, (8) can only evince morpholexical material from one language.
Rao & DenDikken (2014) do not consider a separation between morphology and phonology in their analysis. They do not provide corresponding phonetic or phonemic transcriptions and posit a constraint against phonological switches within a word on the basis that (8) is unacceptable. Thus, we must assume that their analysis is based upon the structure in (8) looking like the structure in (1), i.e., having matching phonology and morphology. Now, consider the case that (8), while comprised of morphological elements from two different languages, were to demonstrate the phonology of only one of the two languages (Telugu or English). That is, the word comprises morphological elements from two different languages but phonetic material from one language. Would bilinguals prefer or even accept (8) if this were the case? We return to this question in our discussion of González-Vilbazo and López (2011), as this separation is the basis for their argument for acceptance of morphological word-internal CS in Spanish/German bilinguals.

*MacSwan and Colina (2014)*

Working from an Optimality Theoretic perspective, MacSwan and Colina (2014) come to a conclusion that parallels that of Rao and DenDikken (2014). They posit the *PF Interface Condition* (Colina & MacSwan, 2005; MacSwan, 2013; MacSwan & Colina, 2007) as the theoretical rationale for why word-internal CS is not viable.

(10) *PF Interface Condition*

i. Phonological input is mapped to the output in one step with no intermediate representations.

ii. Each set of internally ranked constraints is a constraint dominance hierarchy, and a language-particular phonology is a set of constraint dominance hierarchies.

iii. Bilinguals have a separately encapsulated phonological system for each language in their repertoire in order to avoid *ranking paradoxes*, which result from the availability of distinct constraint dominance hierarchies with conflicting priorities.
iv. Every syntactic head must be phonologically parsed at spell-Out. Therefore, the boundary between heads (words) represents the minimal opportunity for code-switching.

The consequences of the PF Interface Condition are the same as those implied by the restriction in (9); phonological CS in a word that is made up of a single syntactic head, simple or complex, is impossible due to the requirements of PF. PF does not allow for a word that has been formed in syntax to go through a process that consists of being separated back into its individual morphological elements so that each element can undergo the phonological processes of its original phonological system and then being reformed into the original word. PF demands that once formed in syntax, a word must undergo phonological processes from one and only one phonological system, preventing word-internal phonological CS.

MacSwan and Colina (2014), assuming the consequences of the PF Interface Condition, test the phonological effects of CS across word boundaries in Spanish/English bilinguals as measured by Spanish spirantization and /s/ voicing assimilation. With regards to spirantization, Spanish and English show a contrast in phonological processes. In English the voiced plosives /b d g/ are realized as plosives [b d g] in postvocalic context, whereas in postvocalic context in Spanish they are realized as approximants [β̝ ð̝ γ̝]. Further, in Spanish, the unvoiced alveolar fricative /s/ can be realized as voiced [z] when followed by a voiced consonant. In English, /s/ and /z/ maintain a phonemic contrast and /s/ is not subject to voicing assimilation in this context. MacSwan and Colina (2014) tested CS utterances as in (11) and (12) to examine the effects of spirantization and /s/ voicing assimilation, respectively.

(11) Hablamos de mi book yesterday.

‘We talked about my book yesterday’

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4 With the exception of unstressed/d/, which is realized as [ɾ] in unstressed position
In examining CS utterances such as (11) they found that even though the context for Spanish spirantization was present for the initial voiced plosive /b/ in English (‘book’ in (11)), the plosive was not spirantized. In other words, the Spanish process “was not triggered on English words” (p. 201). The results of CS utterances akin to (12) showed that an English word-initial voiced consonant (/g/ in (12)) can and did trigger voicing assimilation of Spanish /s/. That is, the Spanish phonological process of regressive voicing assimilation was triggered by an English consonant. The results of MacSwan and Colina (2014) indicate that phonological processes can occur across the boundary of words from two languages but only if the word undergoing the process belongs to the language in which the phonological process is operational. That is, Spanish phonological processes cannot be applied to English words and English phonological processes cannot be applied to Spanish words, although an English word can serve as the context source needed for a Spanish phonological process to apply. These results fall in line with the predictions made by the PF Interface Condition, as we do not see evidence of two phonologies being applied to a single word.

While MacSwan and Colina (2014) did not explicitly examine word-internal switches, they hint at a possible distinction between morphology and phonology by making a point of reference towards Sankoff and Poplack (1981). Sankoff and Poplack (1981) noted that in instances such as (13) where a word is comprised of morphological elements from two languages, phonological integration plays an important role.

(13) Juan está parqueando su coche

‘Juan is parking his car’
In the word in question (‘parqueando’) the English stem ‘park’ is phonologically integrated into the language of the affixes (i.e., Spanish) and does not result in ill-formedness. Instances such as (13) are often thought of as borrowings (MacSwan & Colina, 2014; Poplack, 1980; Sankoff & Poplack, 1981, among others) and are considered separately from CS. However, González-Vilbazo & López (2011) offer a preliminary account of CS at the word level that on the surface looks very similar to borrowing but whose mechanisms differ.5

González-Vilbazo and López (2011)

González-Vilbazo & López (2011) propose that word-internal switches in German/Spanish CS are possible but are sharply limited with respect to directionality and phonological form. They provide a preliminary sketch of what a separation between morphology and phonology at the word level would look like. Consider the following German/Spanish word-internal CS presented in González-Vilbazo and López (2011), where the roots (represented in italics) are Spanish and the affixes are German.

(14) cosieren ‘we sew’

(15) jodieren ‘we annoy’

The words in (14)-(15) are formed via incorporation or head movement in syntax similarly to (8) in Rao and DenDikken (2014). The key difference between the words in (14)-(15) and (8) is that (14)-(15) are accepted and attested by bilingual speakers of the two relevant languages, while (8) is not.

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5 The purpose of this paper is not to offer an account of the differences between borrowing and CS at the word level, nor to offer a method for distinguishing between the two, but rather to examine what happens when a word arrives at PF with underlying features from two languages.
In order to account for this acceptability González-Vilbazo and López (2011) propose that a root can incorporate with its affixes and that this incorporated form “gives rise to an endocentric structure in which all and only the features of the [morphosyntactic] head project to the newly created term” (p. 840). Returning to our examples in (14)-(15) (as well as (6)), if we take the derivational affix (-ier in this case) to be the morphosyntactic head,\(^6\) then it will project its features (in this case, German features) to the whole word. At spell-out, PF sees the German features and German phonology is applied. We propose that the derivational affix is a good candidate for the morphosyntactic head of the word as it also plays a role in monolingual grammars. For instance, in English the category of the word (which is determined by the highest derivational affix) plays a role in stress assignment, e.g. ‘cóntent’ vs ‘contént’ (Roca & Johnson, 1999). From this we can infer that phonology minimally has access to the derivational affix and that certain phonological processes are applied based upon its features (in this case stress assignment based upon its category feature, i.e. little n or little a). Thus we see González-Vilbazo and López making a preliminary distinction between the phonology and morphology of word-internal switches. The examples in (14) and (15) are made up of morphological elements from two different languages (a morphological switch) but maintain only one phonology (no phonological switch). Following this account, the prediction is made that a morphologically switched word will always evince the phonology of the language of the affixes because the derivational affix (i.e., the morphological head of the word) will always project its features to the whole word. For the purposes of this paper we follow the preliminary account given by González-Vilbazo and López (2011) and assume that if it is the case that a morphologically switched word will always evince the phonology of the language of the affixes because the derivational affix (i.e., the morphological head of the word) will always project its features to the whole word.

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\(^6\) This follows González-Vilbazo and López (2011), who state that “we take it that little v is the base for verbal inflectional morphology (Oltra-Massuet and Arregi, 2005). This is visible in German; the suffix -ier attaches to a bare root and the verbal morphology attaches to the resulting base. Thus, -ier- can be taken to be a spell-out of little v” (p. 838).
switched word can exhibit only one phonology, that it is the features of the affixes that get projected to the whole word and thus the language of the phonology will match the language of the affixes.

We test the prediction that the phonology of a code-switched word will match the language of the affixes by looking at Spanish/English CS, examining morphologically switched words where the root is English and the affixes are Spanish.7

(16) *mopeando* ‘mopping’

\[[mop]_{\text{Eng}}\text{-eando}]_{\text{Spn}}\]

In order to determine if English phonology, Spanish phonology, or both apply to the word it is necessary for the English root to contain phonemes that are not part of the Spanish phonemic inventory. In this paper we present a subset of data from an ongoing study; we report speech production data from an examination of English roots that contain the voiced alveolar fricative phoneme /z/ in onset position.8 In English, the voiced alveolar fricative /z/ and the voiceless alveolar fricative /s/ maintain a phonemic contrast as shown in (17).

(17) /sip/ ‘sip’ /zip/ ‘zip’

In contrast to English, /z/ does not have phonemic status in Spanish. However, the voiceless alveolar fricative /s/ can be realized as [z] when followed by a voiced consonant, e.g. *desde*

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7 González-Vilbazo and López (2011) and Rao and DenDikken (2014) have noted an asymmetry in CS with morphologically switched words in which bilinguals can switch in one direction but not the other. Following data from Spanish/English bilingual consultants we are only testing words composed of English roots and Spanish affixes, as preliminarily it does not seem possible for Spanish/English bilinguals to switch in the other direction (i.e., Spanish root and English affixes). The intuitions of our bilingual consultants were confirmed by participants’ responses to a debriefing questionnaire in which they stated they were unable to form code-switched words comprised of Spanish roots and English verbal morphology. We leave the issue of this asymmetry open to future research.

8 /z/ is one of four English phonemes that we examine in our ongoing study. The others include /v/, /θ/, and /ʃ/, none of which have phonemic status in Mexican Spanish.
/desde/ [dεzðe] ‘since’ (e.g., Schmidt & Willis, 2011), but only in coda position. Moreover, word-internal regressive voicing assimilation in American English is limited to devoicing (e.g., ‘lose’ [lu:z] ~ ‘lost,’ [lɔst]).

Bearing our discussion in the previous section in mind, we propose the following exploratory research question:

Which phonological system(s) does a Spanish/English bilingual employ when producing words comprised of English roots and Spanish verbal affixes?

Based upon the work of González-Vilbazo and López (2011) we hypothesize that Spanish/English bilinguals will employ Spanish phonology when producing words with English roots and Spanish affixes. In this situation the morphological head of the word (i.e. the highest derivational affix) will be Spanish and will therefore project “Spanish” features to the whole word prompting the use of the Spanish phonological system. We predict that these Spanish/English bilinguals will not produce [z] in an English root since the segment a) is not part of the Spanish phonemic inventory and b) is not generated as an allophone of Spanish /s/ in onset position. Instead, we predict that the speakers will produce the closest equivalent sound that is a part of the Spanish inventory, namely the voiceless alveolar fricative [s]. If it is the case that Spanish/English bilinguals produce [s] then this will provide preliminary evidence for the proposed ban on word internal phonological switches.

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9 While /s/ voicing has also been reported in intervocalic position in certain varieties of Spanish (see García, 2013, for a review), to our knowledge observation of intervocalic /s/ voicing in Mexican Spanish is limited to an impressionistic account of voicing in word-final position by Obaid (1973).
10 We use “Spanish” in this sense as a purely descriptive label for ease of explanation and do not assume that language tag features exist within the linguistic system.
Methods

Participants

Five early Spanish/English bilinguals participated in this pilot study, four females and one male. At the time of the study all participants were living in the Chicagoland area and were undergraduate (n = 4) or graduate (n = 1) students. Participants ranged in age from 21-30 ($M = 22.8, SD = 4.02$). All participants reported learning Spanish since birth and English before the age of 8 (average age of English acquisition was 4.2 years, $SD = 3.03$) and all grew up in bilingual households. The participants were all born in the United States to Mexican parents and all reported using primarily Spanish at home with their parents.

Participants were asked to self-rate their proficiency in English and in Spanish on a scale of 1 ‘not well at all’ to 6 ‘very well’ in reading, writing, speaking, and understanding as part of a larger background questionnaire. Their self-ratings are provided in Table 1.

Table 1

<table>
<thead>
<tr>
<th></th>
<th>Spanish</th>
<th>English</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$M$</td>
<td>$SD$</td>
</tr>
<tr>
<td>Reading</td>
<td>4.80</td>
<td>1.10</td>
</tr>
<tr>
<td>Writing</td>
<td>4.60</td>
<td>1.14</td>
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<tr>
<td>Speaking</td>
<td>5.00</td>
<td>1.22</td>
</tr>
<tr>
<td>Understanding</td>
<td>5.40</td>
<td>0.55</td>
</tr>
</tbody>
</table>
In addition to providing proficiency ratings, participants also completed the Bilingual Language Profile (BLP, Birdsong, Gertken, & Amengual, 2012). The BLP provided a calculation of language dominance based on self-reported information on Spanish and English acquisition and usage. Based on participants’ responses, the BLP calculates language dominance on a scale of -218 to 218 with values closer to 0 representing more ‘balanced’ bilinguals. Our participants were found to be mildly English dominant with a range of scores from 6 to 53 ($M = 29.62, SD=18.19$).

All participants are self-reported code-switchers and indicated that they have various people in their lives with whom they use both Spanish and English in a single conversation. Further, they all reported using both Spanish and English in a single sentence and were able to provide examples. Lastly, participants demonstrated positive attitudes towards CS as based upon their answers to an attitudes questionnaire (Badiola et al., 2016).

**Materials**

The experiment consisted of two elicited productions tasks, one in a baseline monolingual Spanish mode and one in an English/Spanish bilingual CS mode. While we have since developed a separate baseline monolingual English production task for the next phase of this project, our English monolingual baseline data in this pilot study come from monolingual English productions in the bilingual CS task (see task trial description for details). In each task participants were presented with a total of 40-60 nonce verbs, 10 of which contained /s/ or /z/ depending on the language(s) of the task (Table 2). In both tasks, /s/ and /z/ were in word onset.
position with the exception of the Spanish voicing assimilation context, in which case /s/ was in word-medial syllable-final position.

Table 2

*Phonemic transcriptions of stimuli by task.*

<table>
<thead>
<tr>
<th>Spanish task</th>
<th>/s/ (onset)</th>
<th>/s/ (coda + heterosyllabic voiced consonant)</th>
<th>Bilingual CS task</th>
</tr>
</thead>
<tbody>
<tr>
<td>sistear</td>
<td>/sisteər/</td>
<td>lismeər /lismeər/</td>
<td>zimp /zɪmp/</td>
</tr>
<tr>
<td>siltsear</td>
<td>/siltseər/</td>
<td>teismeər /teismeər/</td>
<td>zilp /zɪlp/</td>
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<td>/sultseər/</td>
<td>misbeər /misbeər/</td>
<td>zarp /zəp/</td>
</tr>
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<td>/saperər/</td>
<td>dusmeər /dusmeər/</td>
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<tr>
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<td>/surteər/</td>
<td>disdeər /disdeər/</td>
<td>zilt /zɪlt/</td>
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<td>/selteər/</td>
<td>mesgeər /mesgeər/</td>
<td>zerb /zəb/</td>
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<td>pesbeər /pesbeər/</td>
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<td>/sompeər/</td>
<td>disguər /disguər/</td>
<td>zalk /zɑlk/</td>
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<tr>
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<td>/sinteər/</td>
<td>desbeər /desbeər/</td>
<td>zert /zɜ-t/</td>
</tr>
<tr>
<td>silear</td>
<td>/sileər/</td>
<td>pumeər /pumeər/</td>
<td>zant /zænt/</td>
</tr>
</tbody>
</table>

We used nonce words to control for phonetic factors, cognate effects, and frequency effects. The monolingual Spanish items consisted of phonotactically legal nonce verbs with /s/ in word-onset position (e.g. *sinteər*) as well as nonce verbs with an /s/ in coda position followed by a voiced consonant (e.g. *tesmeər*). As /s/ voicing in Spanish has been shown to be variable in nature rather than categorical (e.g., Schmidt & Willis, 2011) this allowed a baseline to be established so that
each participant could be used as his/her own control. For example, if we find that a participant produces the voiced alveolar fricative \([z]\) in their monolingual Spanish, then the production of \([z]\) in a code-switched word might not signal a phonological switch given that the \([z]\) is a part of the participant’s Spanish system (albeit the outcome of a phonological process applied in a different context). We return to this potential scenario and its implications in the discussion. The bilingual CS items consisted of phonotactically legal monosyllabic nonce verbs with /z/ in onset position (e.g., ‘zimp’).

Tasks

Trials in both tasks were administered using E-prime 2.0 (Psychology Software Tools, Inc.) stimuli presentation software. All stimuli were presented auditorily to avoid orthographic effects. In the Spanish monolingual production task participants were presented with nonce verbs under the guise that these were new words that would be added to the Spanish dictionary within the next 10 years. Each trial consisted of the following: Participants heard the infinitive form of the nonce verb and were asked to repeat it out loud. They then heard a definition of the verb followed by an example of the verb used in a sentence. Simultaneously, they were presented with an image of a person (or persons) performing the action associated with the verb. After the presentation, participants were asked ¿Qué está(n) haciendo en la foto? ‘What is/are he/she/they doing in the picture?’ to prompt them to answer using the nonce word as a verbal root with progressive morphology. For example, the Spanish nonce word *sistear* was defined as *bailar en la lluvia* ‘to dance in the rain’. The participants heard the word *sistear*, were asked to repeat it, and then they heard the following definition and example: *sistear es bailar en la lluvia*.

*Margarita vive en Argentina y ella sistea cada vez que llueve. ¿Qué está haciendo en la foto?* ‘sistear is to dance in the rain. Margarita lives in Argentina and she ‘sistea’ every time it rains.'
What is she doing in the picture?’ In order to ensure that participants answered using progressive verbal morphology, Está(n) __________ was presented on the screen.

Trials in the bilingual CS production task were structured in the same way as those in the monolingual production task with the difference being that participants heard CS throughout. Participants were presented auditorily with English nonce verbs under the guise that these were new words and we wanted them to teach us how to use them in ‘Spanglish’ (i.e., CS). Each trial consisted of the following: Participants heard the English nonce verb and were asked to repeat it out loud. They then heard a definition of the verb followed by an example of the verb used in a sentence. Both the definitions and the examples were code-switched. Simultaneously they were presented with an image of a person (or persons) performing the action associated with the verb. After the presentation, participants were asked Qué está(n) haciendo en la foto? ‘What is/are he/she/they doing in the picture?’ The question prompt was always in Spanish in order to prompt the participants into responding using the nonce word and to prime them for a switch into Spanish. As with the monolingual production task, Está(n) __________ was presented on the screen to promote the use of Spanish progressive verbal morphology. For example, the nonce word ‘zerb’ was defined as “to paint a picture of a flower on a canvas”. After participants repeated the ‘English’ word ‘zerb’, they heard “To zerb is to paint a picture of a flower on a canvas. Emeralda es una artista and she zerbs at least once a week. Qué está haciendo en la foto?” The expected response for this trial was “está [s/z]erbeando” thus giving us an English root combined with Spanish affixes.  

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11 This is the repetition that was used to establish a voicing baseline for English [z].  
12 As participants were prompted only with “Está __________”, participants could potentially utilize English progressive verbal morphology (i.e. ‘-ing’) instead of Spanish (i.e. ‘-endo’). If this was case, during the practice trials, the research assistant asked the participant if he/she knew of another way of answering the question (i.e. “Qué
Procedure

Participants were tested on two separate days. Sessions were separated by language mode and were completed first in Bilingual mode (CS) and then in monolingual Spanish mode. In Bilingual mode, a 10-15 minute interview in CS Spanish and English was conducted with a Spanish/English bilingual research assistant to move participants into the relevant mode. The research assistant is a natural code-switcher and a member of the same bilingual community as the participants. The participants were then given instructions for the production task in CS. They completed the bilingual elicited production task in a sound-attenuated booth, speaking into a Shure SM81 condenser microphone. Speech production was recorded directly to disk using a MOTU Ultralite external interface. The production task was followed by the English-Spanish BLP. In addition to the BLP, participants were asked to answer questions about the linguistic background of the participants’ parents or guardians and the participants’ use of and attitudes towards CS. As a final step, participants were asked the following questions in a debriefing interview:

1) What did you think about the experiment?

2) When you code-switch in real life do you ever mix English and Spanish together in a single word?

3) Can you give us any examples?

4) Can you mix in the other direction? That is, with a Spanish verb and English endings?

5) If so, any examples?
The Spanish session was conducted exclusively in Spanish with the same bilingual research assistant. After a 10-15 minute interview, participants completed the production task.

Analysis

For each of the five participants, all /s/ and /z/ tokens (10 per condition) were extracted from the speech samples elicited in the elicited production tasks. As the acoustic difference between [s] and [z] lies primarily with voicing, we measured percentage of voicing as the dependent variable. Following Schmidt and Willis (2011), percentage of voicing was calculated by dividing the duration of voiced sibilance for each segment by the total duration of the segment. Using Praat software (Boersma & Weenink, 2014) for acoustic analysis and following Schmidt and Willis (2011), onset and offset of segments were defined by the visual presence in the spectrogram of strong high-frequency frication around 8000 to 9000 hertz (Hz). Voicing was determined by 1) the presence of visible regular glottal pulses in the voice bar and 2) regular periodic patterns in the waveform. Following Schmidt (2014), tokens were then categorized into five voicing categories: 0% (no voicing), 1-33% (initial voicing), 34-66% (partial voicing), 67-99% (majority voicing) and 100% (total voicing).

Given the sample size of this pilot study, we present individual data instead of addressing aggregate means. For each individual the dependent variable (percentage of voicing) is presented as continuous (on a scale of 0 to 100) as well as categorical (following the voicing categories described in the above paragraph). Following Plonsky (2015), we use a combination of descriptive statistics including means, standard deviations, confidence intervals, and effect sizes instead of inferential statistics given the low power as a result of the small sample size (p. 30). We report within-subjects effect sizes via Hedges’ g, which corrects for bias yielded by small sample size. Small, medium and large effect sizes correspond to values of .60, 1.00, and 1.40,
respectively (Plonsky & Oswald, 2014). We also present 95% confidence intervals for means; a difference between two means is considered significant when one mean does not fall within the other’s confidence interval and vice versa (Plonsky, 2015, p. 40).

**Results**

Our research question asked which phonological system(s) Spanish/English bilinguals employ when producing words that are comprised of an English root with /z/ and Spanish verbal affixes. In order to answer this question, it was first necessary to establish a baseline for each participant’s /s/ production in Spanish and /z/ in English. This baseline is then used in comparison with the CS percent voicing data from the /z/ in the English root to determine if the CS data pattern with that of the speakers’ monolingual Spanish or English baseline. While the Spanish baseline was established via data from the Spanish monolingual production task, the English baseline was established via the initial repetitions of the infinitive form of the English nonce verbs in the CS task. Table 3 shows the mean percent voicing for each participant in each condition (Spanish, English, and CS).

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13 We acknowledge the evidence in the code-switching literature that phonetic realizations of comparable utterances can differ in monolingual versus bilingual modes (e.g., Balukas & Koops, 2015; Piccinini & Arviniti, 2015, but cf. González López, 2012; Grosjean & Miller, 1994). However, as the data will show, there are no cases of intermediate voicing percentages in which it is unclear whether the CS /z/ more closely resembles English /z/ or Spanish /s/.
Table 3

*Mean percent voicing and categorization by participant and condition*

<table>
<thead>
<tr>
<th>Condition</th>
<th>Participant</th>
<th>1001</th>
<th>1002</th>
<th>1003</th>
<th>1004</th>
<th>1006</th>
</tr>
</thead>
<tbody>
<tr>
<td>English</td>
<td>/z/</td>
<td>$M\ (SD)$</td>
<td>.79 (.24)</td>
<td>.67 (.19)</td>
<td>.50 (.33)</td>
<td>.85 (.25)</td>
</tr>
<tr>
<td>Voicing Category</td>
<td>Majority</td>
<td>Majority</td>
<td>Partial</td>
<td>Majority</td>
<td>Majority</td>
<td></td>
</tr>
<tr>
<td>Spanish</td>
<td>/s/ (word-initial)</td>
<td>$M\ (SD)$</td>
<td>.04 (.03)</td>
<td>.02 (.03)</td>
<td>.05 (.08)</td>
<td>.17 (.21)</td>
</tr>
<tr>
<td>Voicing Category</td>
<td>Initial</td>
<td>Initial</td>
<td>Initial</td>
<td>Initial</td>
<td>Initial</td>
<td></td>
</tr>
<tr>
<td>Spanish</td>
<td>/s/ (voicing assimilation context)</td>
<td>$M\ (SD)$</td>
<td>.70 (.48)</td>
<td>.26 (.29)</td>
<td>.18 (.30)</td>
<td>.71 (.31)</td>
</tr>
<tr>
<td>Voicing Category</td>
<td>Majority</td>
<td>Initial</td>
<td>Initial</td>
<td>Majority</td>
<td>Majority</td>
<td></td>
</tr>
<tr>
<td>CS</td>
<td>Root+eando</td>
<td>$M\ (SD)$</td>
<td>.70 (.24)</td>
<td>.02 (.03)</td>
<td>.01 (.02)</td>
<td>.83 (.28)</td>
</tr>
<tr>
<td>Voicing Category</td>
<td>Majority</td>
<td>Initial</td>
<td>Initial</td>
<td>Majority</td>
<td>Initial</td>
<td></td>
</tr>
<tr>
<td>CS</td>
<td>Root+ing</td>
<td>$M\ (SD)$</td>
<td>.55 (.19)</td>
<td>.70 (.22)</td>
<td>.22 (.01)</td>
<td>n/a</td>
</tr>
<tr>
<td>Voicing Category</td>
<td>Partial</td>
<td>Majority</td>
<td>Initial</td>
<td>n/a</td>
<td>n/a</td>
<td></td>
</tr>
</tbody>
</table>

Table 3 reveals that all five participants produced higher percentages of voicing for English /z/ than for Spanish /s/ in onset. English /z/ was produced with mostly majority voicing (4/5 participants) while Spanish /s/ was produced with initial voicing (5/5 participants). Three of the 5 participants (Participants 1001, 1004, and 1006) produced majority voicing assimilation (i.e. >66%) in Spanish.
A pairwise comparison of confidence intervals and effect sizes (Table 4) confirms that for all five participants English /z/ was significantly more voiced than Spanish /s/ in onset position. In addition, for participants 1001, 1004, and 1006, the productions of Spanish /s/ in the voicing assimilation context were significantly different from those of Spanish /s/ in word-initial position but were not significantly different than the productions of English /z/. In all cases where a significant difference was found, effect sizes were greater than 1.40 (a large effect according to Plonsky & Oswald, 2014). In all cases of non-significance, effect sizes were smaller than .60, or what Plonsky and Oswald denote as a small effect, which indicates very low practical significance in the difference between these means.

Table 4

Comparison of confidence intervals and effect sizes by participant and condition

<table>
<thead>
<tr>
<th>Participant</th>
<th>Condition</th>
<th>English /z/</th>
<th>Spanish /s/</th>
<th>Spanish /s/ VA</th>
<th>CS [root+ eando]</th>
<th>CS [root+ ing]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1001</td>
<td>English /z/</td>
<td>.79 [.61-.96]</td>
<td>* (g=4.20)</td>
<td>n.s (g=.23)</td>
<td>n.s (g=.36)</td>
<td>n.s (g=.96)</td>
</tr>
<tr>
<td></td>
<td>Spanish /s/</td>
<td>.04 [.01-.06]</td>
<td>* (g=4.20)</td>
<td>* (g=1.91)</td>
<td>* (g=4.08)</td>
<td>* (g=5.55)</td>
</tr>
<tr>
<td></td>
<td>Spanish /s/ VA</td>
<td>.70 [.40-.99]</td>
<td>n.s (g=.23)</td>
<td>* (g=1.91)</td>
<td>n.s (g=.00)</td>
<td>n.s (g=.32)</td>
</tr>
<tr>
<td></td>
<td>CS (-eando)</td>
<td>.70 [.44-.96]</td>
<td>n.s (g=.36)</td>
<td>n.s (g=0)</td>
<td>n.s (g=.59)</td>
<td>n.s (g=.59)</td>
</tr>
<tr>
<td></td>
<td>CS (-ing)</td>
<td>.55 [.06-1.00]</td>
<td>* (g=.96)</td>
<td>n.s (g=.32)</td>
<td>n.s (g=.59)</td>
<td>n.s (g=.59)</td>
</tr>
<tr>
<td>1002</td>
<td>English /z/</td>
<td>.67 [.54-.80]</td>
<td>* (g=3.38)</td>
<td>* (g=1.62)</td>
<td>n.s (g=4.58)</td>
<td>n.s (g=.14)</td>
</tr>
<tr>
<td></td>
<td>Spanish /s/</td>
<td>.02 [.01-.05]</td>
<td>* (g=3.38)</td>
<td>* (g=1.15)</td>
<td>n.s (g=.00)</td>
<td>* (g=4.15)</td>
</tr>
<tr>
<td></td>
<td>Spanish /s/ VA</td>
<td>.26 [.04-.49]</td>
<td>* (g=1.62)</td>
<td>* (g=1.15)</td>
<td>* (g=1.15)</td>
<td>* (g=1.65)</td>
</tr>
<tr>
<td></td>
<td>CS (-eando)</td>
<td>.02 [.00-.04]</td>
<td>* (g=4.58)</td>
<td>n.s (g=0)</td>
<td>* (g=1.15)</td>
<td>* (g=4.15)</td>
</tr>
<tr>
<td></td>
<td>CS (-ing)</td>
<td>.70 [.54-.85]</td>
<td>n.s (g=.14)</td>
<td>* (g=4.15)</td>
<td>* (g=1.65)</td>
<td>* (g=4.15)</td>
</tr>
<tr>
<td>Page</td>
<td>English /z/</td>
<td>Spanish /s/</td>
<td>Spanish /s/ VA</td>
<td>CS (-endo)</td>
<td>CS (-ing)</td>
<td></td>
</tr>
<tr>
<td>------</td>
<td>-------------</td>
<td>-------------</td>
<td>----------------</td>
<td>------------</td>
<td>-----------</td>
<td></td>
</tr>
<tr>
<td>1003</td>
<td>.50 [.25-.74]</td>
<td>.05 [.00-.10]</td>
<td>.18 [.00-.39]</td>
<td>.01 [.00-.02]</td>
<td>.22 [.14-.30]</td>
<td></td>
</tr>
<tr>
<td></td>
<td>* (g=1.79)</td>
<td>* (g=1.97)</td>
<td>n.s (g=.57)</td>
<td>n.s (g=.62)</td>
<td>n.s (g=2.07)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>* (g=1.88)</td>
<td>* (g=1.88)</td>
<td>n.s (g=.72)</td>
<td>(g=9.96)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Page</th>
<th>English /z/</th>
<th>Spanish /s/</th>
<th>Spanish /s/ VA</th>
<th>CS (-endo)</th>
<th>CS (-ing)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1004</td>
<td>.85 [.67-1.00]</td>
<td>.17 [.01-.34]</td>
<td>.71 [.49-.94]</td>
<td>.83 [.63-1.00]</td>
<td></td>
</tr>
<tr>
<td></td>
<td>* (g=2.67)</td>
<td>* (g=1.96)</td>
<td>n.s (g=.39)</td>
<td>n.s (g=.39)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>* (g=1.96)</td>
<td>n.s (g=.39)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Page</th>
<th>English /z/</th>
<th>Spanish /s/</th>
<th>Spanish /s/ VA</th>
<th>CS (-endo)</th>
<th>CS (-ing)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1006</td>
<td>.71 [.51-.91]</td>
<td>.06 [.02-.09]</td>
<td>.90 [.66-1.00]</td>
<td>.18 [.00-.39]</td>
<td></td>
</tr>
<tr>
<td></td>
<td>* (g=3.21)</td>
<td>* (g=3.72)</td>
<td>* (g=2.30)</td>
<td>(g=1.81)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>n.s (g=.63)</td>
<td>n.s (g=2.53)</td>
<td>* (g=1.81)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

aSpanish [s] VA is the voicing assimilation context
Significance (as determined by means not falling within comparison mean CIs) is represented with an asterisk.

Having established a voicing baseline for English /z/ and Spanish /s/ we can compare the English and Spanish productions to those in the CS task. The last two rows for each participant in Table 3 illustrate the voicing percentages from the CS task. As three of the five participants produced tokens with English progressive verbal morphology (i.e. ‘-ing’) in addition to Spanish (i.e. ‘-eando’), during this task, data from these tokens were extracted and are also listed in Table 3.

In general, for the tokens that were produced with Spanish verbal inflection (i.e. ‘-eando’), three of the five participants produced the alveolar fricative with little to no voicing (i.e. <19%). The other two participants produced segments with majority voicing (i.e. > 66%). Three
participants also produced tokens with English verbal inflection (i.e., ‘-ing’). Two of these three participants produced /z/ with partial to majority voicing while the third participant produced initial (i.e., left-edge) voicing. A visual comparison of percent voicing between the CS and monolingual data is presented in Figure 1.

![Percent Voicing by Condition and Participant]

Figure 1. Percent voicing for all participants by condition

A within-subjects pairwise comparison of confidence intervals between conditions revealed a significant difference for participants 1002, 1003, and 1006 between /z/ in the CS condition with Spanish morphology (i.e. –eando) and the English alveolar fricative such that monolingual English /z/ was significantly more voiced than /z/ in the code-switched items. For participants 1001 and 1004 the reverse held true; the English monolingual /z/ was not significantly more voiced than the code-switched English /z/ nor the monolingual Spanish /s/ in voicing assimilation context. Instead, the monolingual Spanish /s/ in word-initial position was significantly less voiced than the code-switched English /z/.

**Discussion**
Our research investigates the phonological productions of code-switched verbs by Spanish/English bilinguals. More specifically, we investigate whether Spanish/English bilinguals evidence Spanish phonology when producing words comprised of an English root and Spanish verbal inflection. Here we determine the application of Spanish phonology based upon the production of /z/ in the English root of code-switched words with Spanish affixes. Principally, if participants apply Spanish phonology, they are expected to produce a Spanish-like [s] in the onset of the English root. If they do not, a more English-like [z] is expected.

The results indicate that three of the five participants (i.e. 1002, 1003, 1006) produced a Spanish-like [s] in the CS condition. That is, when producing a code-switched word with an English root and Spanish affixes, they produced /z/ as they would produce /s/ in Spanish in onset position. We take this as a preliminary indicator of the application of Spanish phonology at the word level. This finding falls in line with the CS accounts that motivate this study (i.e., González-Vilbazo & López, 2011; MacSwan & Colina; 2014; Rao & DenDikken, 2014), which suppose that phonological switches at the word level are not possible. However, the other two participants’ productions of /z/ in the CS condition pattern with their productions of monolingual English /z/. This should a priori indicate maintenance of English phonology in the root and the possibility of producing a phonologically switched word in the CS condition. This could potentially serve as counterevidence towards the aforementioned accounts.

However, a closer look at the data reveal a pattern that requires further consideration. Specifically, the two participants (i.e. 1001, 1004) who produced /z/ in the CS condition with majority voicing produced segments with majority voicing in the assimilation context in the monolingual Spanish condition. It is worth noting that the productions of /z/ in the CS condition and /s/ in the monolingual Spanish condition occurred in different contexts (word-initial onset
and word-medial coda, respectively). Productions of /s/ in onset position in the monolingual Spanish condition had only initial voicing. Thus it begs the question, is Spanish or English phonology the source of productions of /z/ in CS context? If we consider that [z] is a part of the inventory of Spanish speakers who produce /s/ as [z] when followed by a voiced consonant, the participants who produce /z/ in the English root of the code-switched word with majority voicing are producing a segment that is also a part of their Spanish system, even if the context in which it surfaces in Spanish is different than the context in which it surfaces in these English roots. With that in mind, it could be the case that these participants are redeploying the voiced segment [z] to onset position. The distinct production patterns between the participants that do not assimilate /s/ in Spanish (CS English /z/ productions with initial voicing) and those that do (two produce /z/ in the English root in CS items with majority voicing, one does not), lend strong support to the possibility that the participants applied Spanish phonology to the entire word. We further note that impressionistic analysis of the code-switched verbs as a whole does not indicate a presence of aspects of English phonology (e.g., vowel quality) elsewhere in the root or affixes. These patterns align with the hypothesis that only one phonology can be applied to morphologically code-switched words.

These data follow the predictions of González-Vilbazo and López (2011), who posit that the phonology that is applied will match the language of the affixes (in this case, Spanish), because the (Spanish) morphological head determines the phonology at spell-out. Support for the application of Spanish and not English is highlighted by the CS data from participant 1002. For each token, the participant produced words with Spanish progressive verbal morphology (i.e. ‘-eando’) and with English progressive verbal morphology (i.e. ‘-ing’). For the code-switched

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14 The impressionistic evidence will be verified with acoustic data in a future phase of this study.
words with English affixes (e.g., *está zerting*) she produced the alveolar fricative with majority voicing ($M = 69.85\%$), although she produced Spanish /s/ in the voicing assimilation context with only 26.4% voicing. The majority voicing produced in the words with English affixes is a striking contrast to the 1.5% voicing in the code-switched words with Spanish affixes (e.g., *está zerteando*). Thus, it appears that when the affixes were Spanish, she applied Spanish phonology to the switched word, but when the affixes were English she applied English phonology to the word. Since [z] is not part of her Spanish inventory, [z] is not available and she produces an unvoiced segment in the code-switched words with Spanish affixes.

We also note a third emerging pattern within the data. Participant 1006, like participants 1001 and 1004, produced /s/ with majority voicing in the Spanish voicing assimilation context. However, unlike participants 1001 and 1004, participant 1006 produced /z/ in the English root in the CS context with only 18% voicing. Anecdotally, this participant produced multiple instantiations of each word in the CS condition. The first instantiation was always coded for analysis, which was consistently produced with initial voicing. However, impressionistically the additional productions sounded voiced. We take this as additional potential evidence that the bilingual participants who produce /s/ in the assimilation context in Spanish with majority voicing have the option to produce voiceless or voiced segments in the root of the CS items since both are part of their Spanish system.

In light of the individual variation in the data set with respect to the relationship between production in the Spanish voicing assimilation context and English /z/ in CS context, a summary of possible and attested production patterns is provided in Table 5.

Table 5
Production patterns between Spanish /s/ in voicing assimilation context and English /z/ in CS items

<table>
<thead>
<tr>
<th>Pattern supports a ban on phonological switches</th>
<th>[s] – [s]</th>
<th>[z] – [s]</th>
<th>[z] – [z]</th>
<th>[s] – [z]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pattern is attested in the data</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>X</td>
</tr>
</tbody>
</table>

Of the possible four production patterns, three were attested in the data. As we have discussed, these three patterns provide preliminary evidence that Spanish phonology has been applied to code-switched words comprised of an English root and Spanish affixes, thus supporting a ban on word internal phonological switches. Crucially, the fourth pattern, which would be evidence against a ban on word internal phonological switches, was not found. That is, there were no cases in which participants produced /s/ in a Spanish voicing assimilation context with zero or initial voicing but produce /z/ in CS as they do English monolingual /z/ (in this case, with majority voicing).

As the results of this study come from pilot data, there are several limitations that will be addressed in the next stage of this project. The most substantial limitation is the sample size; we anticipate a sample size of 30 Spanish/English bilinguals in the full study, which will allow us to analyze data via mixed modeling and generalize the results to the larger Mexican Spanish/English bilingual population. The other methodological limitation of note is the lack of an English monolingual production condition, which we have now developed for the next stage of this project. In this study, our monolingual English data come from the repetition of the English nonce verb in the CS production task. Use of the English monolingual production condition will provide a baseline equivalent to the Spanish monolingual baseline. Lastly, we
recognize that production data is limited in terms of what it can tell us about the I-language and competence of our bilingual participants. Production data tells us what bilinguals produce in a CS context, but just because something is not produced does not mean that it cannot be produced. To address this, the next phase of this project will include the elicitation of auditory acceptability judgments of Spanish/English bilinguals. This step is needed in order to lend insight into whether phonologically switched words are acceptable to bilingual speakers and the consequences this has for the architecture of the bilingual linguistic system.

This study provides preliminary acoustic evidence in support of a ban on phonological switches at the word level, as participants did not produce segments in the CS condition that were not a part of their Spanish inventory. This pattern leads us to question what participants would produce if the relevant phoneme in the English root of a code-switched word with Spanish affixes has no allophonic equivalent in Spanish. For example, if the English root contains the voiceless interdental fricative /θ/ or the lax high back vowel /u/ in a code-switched word with Spanish affixes, we predict that these sounds will not be produced in the English root since they are not part of the Mexican Spanish system. The next stage of this study will examine these scenarios to determine whether this is the case.
References


*Lingua, 121*(5), 832-850.


