Cross-linguistic interaction: A retrospective and prospective view

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Abstract. This paper provides a critical review of research on cross-linguistic interaction in the phonetic and phonological development of young bilingual children. After presenting some examples of cross-linguistic interaction (acceleration, delay, transfer) in German-Spanish bilingual children tested in Hamburg (i.e. Hamburg study), it examines whether other investigators have documented the same results as the Hamburg study. It investigates studies which have tested similar contact situations or which have looked at similar predictive factors such as frequency, complexity, structural ambiguity, or dominance. This survey indicates that very few generalizations can be gleaned across studies. The paper then explores possible reasons for the lack of generalizations, which include methodological limitations and the lack of an appropriate research model. Certain suggestions are made to improve the research model, which involve taking into account themes from both first and second language acquisition. Incorporating additional interaction patterns into the current framework, as well as considering the developing speech-motor and lexical abilities of young children might lead to a better explanatory model of phonological interaction in early bilingualism. The paper ends with an examination of new perspectives in studying cross-linguistic interaction.

Keywords: bilingual children, cross-linguistic interaction, phonetic and phonological acquisition, acceleration, delay, transfer

Introduction

During the last two to three decades, there has been considerable research investigating the phonetic and phonological abilities of young bilingual children. One of the research's main goals has been to determine whether the speech of bilingual children differ in qualitative and quantitative ways from the speech of monolingual children. The presence of systematic differences between monolingual and bilingual speech suggests that there is interaction between the two linguistic systems of the bilingual, a phenomena referred to as cross-linguistic interaction. The aim of the current article is to examine the findings on cross-linguistic interaction in the area of phonetic and phonological development. This study takes a "retro-" and "prospective" view because it looks back on what we have found out in past studies and looks forward to what we should find out in future studies. Indeed, we have collected a great deal of information on the speech of young bilinguals, but not all of it forms a coherent picture or is easily generalizable. Thus, this study aims to find coherency and generalizations by systematically examining similar contact situations across bilingual children and by looking at the effects of the same predictive factors across a range of studies. Referring to the English expression "I can't see the woods for the trees" whereby someone has difficulty seeing a situation clearly because they are viewing only the details, this article strives to "see the woods".

This article focuses on young bilinguals, who are either simultaneous bilinguals (acquiring two languages from birth) or early sequential bilinguals (acquiring a second language after the first language but before the age of five years). We do not distinguish between the two groups in this early period because several authors suggest that simultaneous and early sequential bilinguals display similar, although not identical, patterns of acquisition (Fabiano-Smith & Goldstein, 2010a, b; Splendido, 2014, in press). The article is divided into two main parts: retrospective and prospective. The retrospective part includes an overview and historical perspective of phonetic and phonological research in early bilingualism, followed by a closer examination of cross-linguistic interaction. It then attempts to seek generalizations across studies by examining similar contact situations and by testing similar predictive factors. The prospective part starts with a critical look at current research and the research model, and moves on to a presentation of new perspectives.

Retrospective

Overview and historical perspective

The field of early bilingualism is situated between the more prominent fields of first and second language acquisition and it shares with them many commonalities. Both first language acquisition and early bilingualism are concerned with children who are in the process of developing their phonological representations, articulatory, acoustic-perceptual, and higher-level, as well as their speech-motor control. Even if children are acquiring their second-language slightly later than at birth, they still have not obtained adult-like perceptual and articulatory knowledge of the sounds in their first language (Munson, 2004; Munson, Edwards, & Beckman, 2005; Nittrouer, 1992). Early bilingualism and second language acquisition deal in both cases with language contact within an individual, and as such similar outcomes that arise from this contact may be anticipated.

If we examine speech production studies in early bilingualism from a historical perspective, two important landmarks can be discerned. The first is the idea promoted by Volterra and Taeschner (1978) that bilingual children speak a mixed sort of language at the beginning. The second is the notion of cross-linguistic interaction introduced by Paradis and Genesee (1996) who argue that bilingual children operate with two systems from the beginning but with the possibility of interaction between the two systems. Since this time, we have not seen any major change in the orientation of the research, although some recent studies suggest new developments, notably a study by Lleó and Cortes (2013) which attempts to model cross-linguistic interaction and one by Vihman (2015), which takes a more critical stance towards the Paradis and Genesee (1996) position, arguing that it is "more programmatic than empirically testable". Given an emergent view of phonology, Vihman (2015) points out that the question of whether there is one or two systems need not be asked.

This section does not focus on the first landmark since the view of a single system as proposed by Volterra and Taeschner (1978) has been severely criticized both empirically and methodologically (De Houwer, 1990; Genesee, 1989; Meisel, 1989). There is evidence that two-year-old children pragmatically separate their languages (they speak the language of their interlocutor most of the time), which presupposes that they also differentiate their language at other levels (Paradis & Genesee, 1996). In retrospect, we may wonder whether we have been too hasty in discarding certain aspects of a unitary system proposal, not the one proposed by Volterra and Taeschner (1978), but one of a more differentiated nature. Certain findings in phonology are consistent with this. Studies based on whole-word proximity show that bilingual children maintain the same distance between the target form and their own production in both of their languages (Bunta, Davidovich, & Ingram, 2006; Bunta, Fabiano-Smith, Goldstein, & Ingram, 2009), which Bunta et al. (2006) argue is consistent with an "underlying unitary hypothesis". That is, the child's two languages share the same underlying phonological properties but differ in terms of surface manifestations. Later, in this article we will present findings which indicate that, in many cases, the phonological systems of bilingual children resemble each other more than do those of their monolingual counterparts. These "merging" patterns may reflect a pooling of phonetic and phonological resources, rather than a lack of differentiation between the two phonetic systems. Finally, Vihman (2015) questions how separate the linguistic systems of older bilinguals are and provides both experimental and anecdotal evidence for non-selective language use and processing by older bilinguals. In short, the possibility of a unitary system at a certain level may reflect integrated and efficient language systems rather than a state of confusion.

This section focuses instead on the program of research stimulated by Paradis and Genesee's (1996) article, in which the possibility of both separation and interaction was entertained. Over the last two decades, studies of both a clinical or linguistic nature have compared the phonetic and phonological abilities of monolingual and bilingual children. By "clinical", I refer to those studies which have measured general aspects of phonological acquisition such as percentage consonants correct (PCC), whole-word proximity, phonetic inventory, and phonological processes (Holm & Dodd, 1999; Fabiano-Smith & Goldstein, 2010b; Gildersleeve-Neumann & Wright, 2010; Goldstein & Washington, 2001; Goldstein, Fabiano, & Washington, 2005; Grech & Dodd, 2008). These studies

have examined whether bilingual children differ from monolingual children in terms of rate or style of acquisition, and in terms of the presence of error patterns. By "linguistic", I refer to those studies which have focused on specific phonetic and phonological properties (e.g., coda consonants, clusters, rhythm, Voice Onset Time (VOT)) in one or both of the bilingual's languages (Almeida, Rose, & Freitas, 2012; Bunta & Ingram, 2007; Kehoe, Lleó, & Rakow, 2004; Lleó, Kuchenbrandt, Kehoe, & Trujillo, 2003; Mayr, Howells, & Lewis, 2015; Mok, 2011, 2013). These studies have focused on cross-linguistic interaction, the nature and direction of it, and how to account for it by appealing to factors such as frequency or complexity. The separation between these two sets of studies is not sharp and clinical-type studies have also attempted to account for cross-linguistic interaction and linguistic-type studies have also explored the clinical implications of the findings.

To summarize the results of these two sets of studies, we refer the reader to a review article by Hamby, Wren, McLeod, & Roulstone (2013) on the influence of bilingualism on speech production. This study summarized the findings of 66 studies (63 individual articles) conducted during the last 50 years (1960 to 2010) on the speech production of bilingual infants and adults. There are two caveats which concern this review article: 1. it only includes studies in which one of the bilingual's languages is English; 2. Over one third of the studies (24 out of 66) are based on Spanish-English children, indicating that much of what we know on bilingual speech acquisition pertains to this population. Keeping these limitations in mind, the conclusions of this review article are clear cut. In terms of global measures (typical of the clinical-type studies), there is no evidence that the speech of bilinguals differs greatly from that of monolinguals: bilinguals may do better than monolinguals (Goldstein & Bunta, 2012 ; Grech & Dodd, 2008; Johnson & Lancaster, 1998), less well than monolinguals (Gildersleeve-Neumann, Kester, Davis, & Peña, 2008; Law & So, 2006), or behave similarly to monolinguals (Goldstein et al., 2005; MacLeod, Laukys, & Rvachew, 2011). The authors stress, nevertheless, that there may be qualitative differences in acquisition and increased variation in speech production. More in-depth studies (typical of the linguistic-type studies) suggest that acquisition of sounds and sound structures may be accelerated or delayed depending upon interaction between the specific language structures under consideration. The fact that different types of interaction patterns take place at the same time may explain why no overall differences between monolingual and bilinguals are observed on global measures. There may indeed be a cancelling out effect. In the next section we explore cross-linguistic interaction in more detail starting first with a definition of it.

Cross-linguistic Interaction

Paradis and Genesee (1996) define cross-linguistic interaction (or interdependence) as "the systemic influence of the grammar of one language on the grammar of the other language during acquisition, causing differences in a bilingual's patterns and rates of development in comparison with a monolinguals" (p. 3). By "systemic", they mean that the influence is at the level of representation and it is sustained over a period of time. Paradis and Genesee (1996) consider three potential manifestations of cross-linguistic interaction, which are summarized below**:**

1. **Transfer**: the incorporation of a grammatical property into one language from the other;
2. **Acceleration**: the situation in which a certain property emerges in the grammar earlier than would be the norm in monolingual acquisition;
3. **Delay**: when the acquisition process is slowed down due to the burden of acquiring two languages.

In addition, the two grammars may not interact at all, in which case a bilingual's grammatical development would resemble that of two monolinguals. This is referred to as *autonomous development.*

Before we consider some classic examples of cross-linguistic interaction, some clarification of terminology is called for. We prefer to characterize "delay" as the opposite of acceleration, that is, a certain property emerges in the grammar later than would be the norm in monolingual acquisition, rather than using the definition of Paradis and Genesee (1996), which according to Tamburelli, Sanoudaki, Jones, and Sowinska (2015), is an outdated interpretation of delay. Rather than the term

"delay", Fabiano-Smith and Goldstein (2010b) recommend the term "deceleration" since the former may have pejorative connotations suggesting impairment; however, for the purposes of this article, we maintain the original term "delay". The use of "transfer" here refers specifically to the presence of a non-native sound or structure in one of the bilingual's languages which comes from its presence in the other bilingual's language. It should not be confused with a more general employment of "transfer" which is used synonymously with cross-linguistic interaction (e.g., positive and negative transfer).

Examples of cross-linguistic interaction

The examples of cross-linguistic interaction presented below stem from studies conducted at the Research Centre for Multilingualism in Hamburg Germany. Four simultaneous bilinguals were recorded from the onset of word production through to six years (Project B3/E3). Three other bilingual children were tested from word production through to two to three years of age (Project PEDSES). The bilinguals were children of Spanish-speaking mothers and German-speaking fathers. Each parent followed the "une personne, une langue" rule by addressing the child in his/her respective language. In addition, four monolingual Spanish children were recorded in Madrid, Spain, and five monolingual German children were recorded in Hamburg, Germany, from the onset of words through to about three years (Project PAIDUS; see Lleó, 2012, for a more detailed description of the monolingual and bilingual corpora). All children were audio-recorded in their homes, while interacting with a parent and an experimenter. Sessions were phonetically transcribed by native speakers of the respective languages and words were extracted from the sessions depending upon the phonological properties under analysis.

Acceleration

An example of acceleration comes from a study by Lleó et al. (2003) on the acquisition of syllable-final consonants or codas. An important phonological difference between German and Spanish is in the area of syllable structure. Spanish has less complex syllable structure than German. Spanish rhymes consist of a single vowel (e.g., yo [jo] "I"), a diphthong (e.g., ley [leɪ] "law") or a vowel plus consonant (e.g., sol [sol] "sun"). Only a restricted set of consonants appear in coda position, namely coronals such as /n/, /r/, /l/, /s/, /ð/, /θ/ (Harris, 1983). Complex codas do occur but they are rare. In contrast, the German rhyme allows many more possibilities. It consists minimally of two positions: a long vowel or diphthong (e.g., Tee [teː] "tea", Frau [fʁaʊ] "woman" or "wife") or a vowel with a consonant (e.g., Ball [bal] "ball"). There are no restrictions on consonants in coda position. They may be labial, coronal, or dorsal. The German rhyme may consist of more than two positions: a long vowel followed by a consonant (e.g., Hahn [haːn] "cock"), a short vowel followed by two consonants (e.g., Mund [mʊnt] "mouth"), or a long vowel followed by two consonants (e.g., Mond [moːnt] "moon"). Frequency data reveal that Spanish has 27% syllables with codas compared to German which has 67% (Meinhold & Stock, 1980). In sum, codas are more frequent in German and they are more complex.

Lleó et al. (2003) posited that two types of interaction effects may be observed in bilingual German-Spanish children acquiring codas. There may be acceleration of codas in Spanish due to their high frequency in German or delay of codas in German due to their low frequency in Spanish. They examined the structural presence of codas in the productions of three monolingual Spanish, three monolingual German, and five bilingual children (2 children from Project B3/E3; 3 children from Project PEDSES) from word onset to 2;4 years (1 child was only tested through to 1;9). Figures 1 and 2, adapted from Lleó et al.'s (2003) study, present the findings on coda production for the monolingual and bilingual children respectively. Figure 1 shows that coda production was higher in German than in Spanish monolingual children at all time points, reaching over 90% at the last time point in German compared to 30 to 40% in Spanish. Figure 2 shows that the bilingual children started to produce relatively high percentages of codas in Spanish as of 1;9 years. Coda production remained always higher in German than in Spanish but, importantly, coda production in Spanish was higher in the bilinguals than in the monolinguals. Thus, of the two possible interaction effects predicted by Lleó et al. (2003), only one was found, namely, acceleration of codas in Spanish. Lleó at al (2003) hypothesize that the high frequency of codas in German influenced the production of them in Spanish.

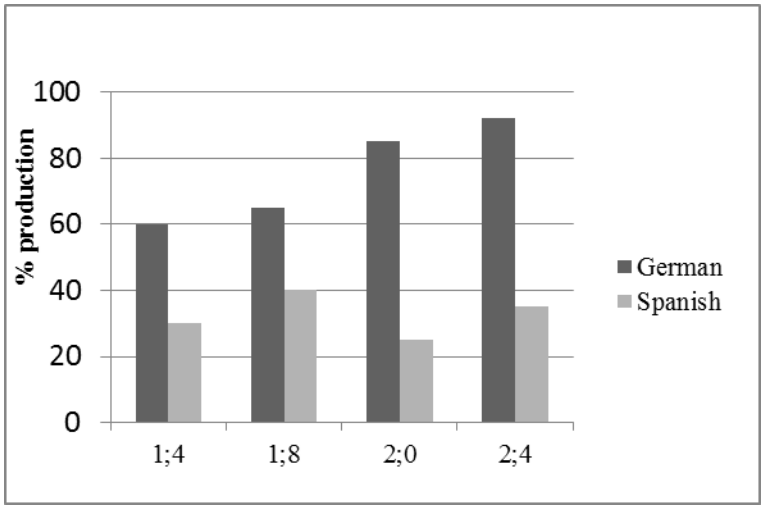

Figure 1. Percentages of codas produced by German and Spanish monolingual children (adapted from Lleó et al., 2003)

Delay

An example of delay comes from a study by Kehoe (2002) on the acquisition of vowel length in German-Spanish bilinguals. The German vowel system is more complex than the Spanish one. It not only has more vowels but it also has a phonological opposition that does not exist in Spanish, vowel length, which is characterized by both quantity (phonetic length) and quality (formant frequency) differences between long and short vowels. In contrast, Spanish has a classic five vowel system. Kehoe (2002) predicted that bilingual children might show a delay in their acquisition of vowel length. Her rationale was that vowel length is a marked phenomenon which requires a certain amount of positive evidence. In the bilingual situation, there is a dilution of this evidence leading to a possible delay in acquisition.

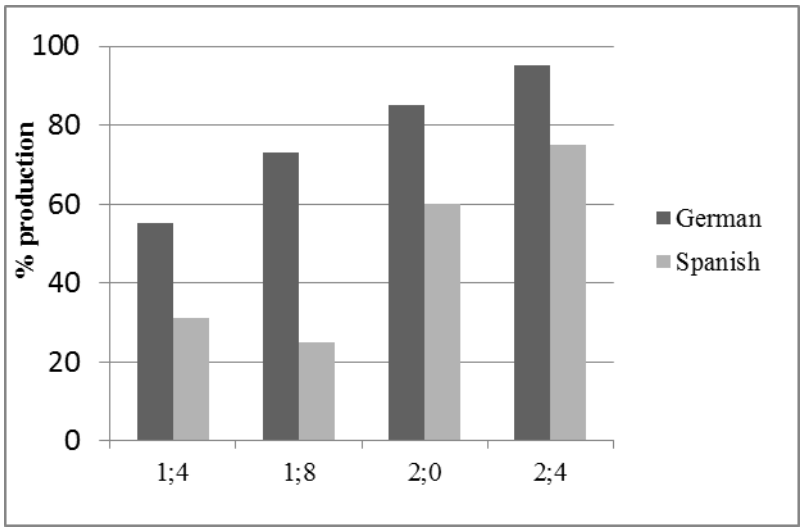

Figure 2. Percentages of codas produced by bilingual children in German and Spanish (adapted from Lleó et al., 2003)

Kehoe (2002) conducted both acoustic and transcriptional analyses of the word productions of three monolingual German and three bilingual German-Spanish children at two time periods: 1;10 - 2;0 and 2;3 - 2;6. The monolingual children produced long vowels significantly longer than short vowels in monosyllables and disyllables at both time periods. In contrast, the bilingual children did not produce long vowels significantly longer than short vowels in monosyllables and only some of the time in disyllables. Furthermore, the magnitude of the duration difference between long and short vowels was reduced compared to the one produced by the monolinguals (average ratio was 1.3 for bilinguals vs.

1.9 for monolinguals). This pattern is evident in Figure 3, which displays the duration values of long and short vowels in disyllables at 2;3 - 2;6 for the monolingual and bilingual children.

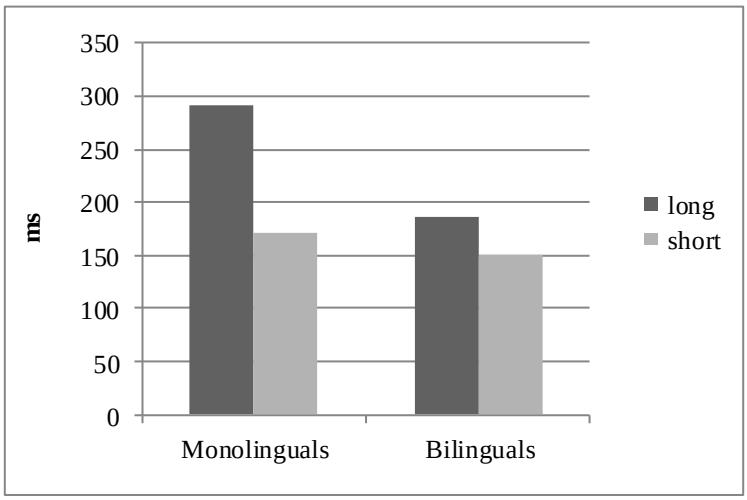

Figure 3. Mean duration values (ms) for target long and short vowels in disyllables spoken by monolingual and bilingual German-speaking children (adapted from Kehoe, 2002)

The transcriptional analyses supported the acoustic analyses in showing that bilingual children experienced more difficulty producing long and short vowels. Whereas monolinguals achieved accuracy rates of 80 to 90% for target long and short vowels at 2;3 to 2;6 in disyllables, the bilinguals achieved accuracy rates of only 50 to 70%. In sum, the findings confirmed Kehoe's (2002) predictions: bilingual children experienced difficulty acquiring the marked system of German vowels. Importantly, when Kehoe (2002) examined the children's acquisition of the five vowel system in Spanish, differences between monolinguals and bilinguals were not observed.

Transfer

The final example, that of Transfer, stems from a study of VOT by Kehoe et al. (2004). Both German and Spanish have voiced /b, d, g/ and voiceless /p, t, k/ stops but the phonetic basis underlying the voicing distinction is different in the two languages. In German, the opposition is between long and short lag whereas, while in Spanish it is between short lag and lead voicing.

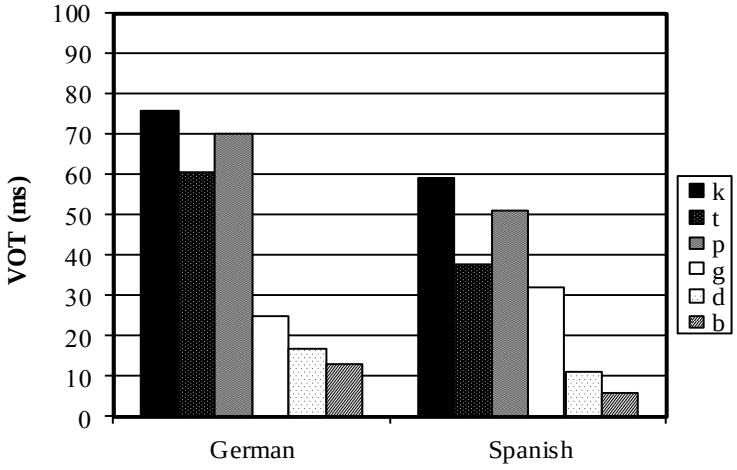

Figure 4. Mean VOT values of voiced and voiceless stops of Nils, a Spanish-German bilingual child at age 2;3 to 2;6 (adapted from Kehoe et al., 2004).

Kehoe et al. (2004) examined the acquisition of VOT in four bilingual children, aged 2;0 to 3;0 years. The bilinguals displayed several different patterns of acquisition; however, for the purposes of this section we concentrate on Nils, who at 2;3 to 2;6 produced not only his German voiceless stops in the long lag region but his Spanish ones were also produced with high VOT values (mean = 50 ms) (see Figure 4). Kehoe et al. (2004) interpreted this pattern as transfer of long lag voicing from German into Spanish. One of the possible reasons for this transfer was that Nils was becoming dominant in German due to his participation in a German kindergarten.

In sum, findings on the same group of German-Spanish bilingual children revealed different patterns of cross-linguistic interaction: acceleration of codas in Spanish, delay of the vowel length distinction in German, and transfer of long lag voicing into Spanish.

Seeking generalizations across studies

Having examined some classic examples of cross-linguistic interaction in the Hamburg data, we widen the literature base to look more closely at cross-linguistic interaction in other studies. We are interested in determining whether they have obtained similar results to Lleó, Kehoe and colleagues. We consider two points of comparisons: a) similar contact situations; and b) similar predictive factors.

Similar contact situations

By "similar contact situation" we refer to the situation in which the linguistic properties of the bilingual's two languages are similar to those under examination in another study. For example, a similar contact situation to Lleó et al.'s (2003) study on codas would be a situation in which a language with a high frequency of codas comes into contact with a language with a low frequency of codas. In the following sections, we examine studies on coda acquisition and VOT.

Acquisition of Codas

An analogous study to Lleó et al. (2003) would be that of Keffala, Barlow, & Rose (submitted) which examined syllable structure acquisition in Spanish-English bilinguals; English, like German, is a language which has many closed syllables. Gildersleeve-Neumann et al. (2008) also examined Spanish-English bilinguals, although their study is limited by the fact that only the English of the bilinguals was examined. Nevertheless, we include it in the current list to see if their results were consistent with those of Lleó et al. (2003) at least for one of the languages. Apart from these two studies, we found few other studies, which have examined coda production in children who are acquiring languages which are characterized by high and low frequencies of codas. There are several other studies which have measured coda production in bilinguals but they are not included because the percentages of coda production were too high to allow a good differentiation between the bilingual's two languages (e.g., Goldstein & Washington, 2001). Thus, we considered also complexity or the distributional features of the codas. As mentioned above, codas are more restricted in Spanish, being only coronal, whereas in German (also English) they are more varied, allowing all places of articulation. German (and English) may also contain coda clusters whereas they are infrequent in Spanish. Using a criterion of restricted/low complexity versus less restricted/high complexity codas, studies by Almeida et al. (2012) on Portuguese-French, and Ezeizabarrena and Alegria (2015) on Basque-Spanish can be included. Portuguese has more restricted use of codas, analogous to Spanish. In contrast, French and Basque allow more segmental diversity in their codas, analogous to German and English. In terms of frequency, however, closed syllables are not frequent in any of these languages. Almeida et al. (2012) focus on word-medial codas whereas the discussion of the other studies concern word-final codas. Table 1 lists the above-mentioned studies.

Table 1. Studies examining cross-linguistic interaction in coda production

Investigators	Languages	Results
Keffala et al. (submitted)	**Spanish – low frequency/restricted**	**Acceleration in Spanish**
	English- high frequency/ unrestricted	
Gildersleeve-Neumann et al. (2008)	**Spanish – low frequency/restricted**	**Delay in English**
	English- high frequency/ unrestricted	**(Spanish not tested)**
Almeida et al. (2012) (word-medial codas)	**Portuguese – restricted**	**Delay in French**
	French - unrestricted	
Ezeizabarrena & Alegria (2015)	**Spanish - restricted**	**No difference**
	Basque - unrestricted	

This comparison does not take into consideration differences in methodology. Rather, we are concerned with whether a similar contact situation: high frequency/unrestricted codas versus low frequency/restricted codas leads to similar outcomes in terms of cross-linguistic interaction across studies. The findings appear to be equivocal. The most similar study to Lleó et al. (2003), namely Keffala et al. (submitted), did find support for acceleration: bilinguals were more accurate than monolinguals in their production of codas (both in terms of structural and segmental accuracy) in Spanish. They also observed reduced coda production in the English of the bilinguals in comparison to the monolinguals; however, the differences were not significant. In contrast, Gildersleeve-Neumann et al (2008) did find significantly reduced coda production in the English of their bilinguals in comparison to the monolinguals, suggesting a delay effect. As mentioned, the results of the Spanish of their bilinguals are unavailable. The other two studies in which frequency played a lesser role did not find an acceleration effect. Almeida et al. (2012) found delay in the language with the less restricted use of codas (i.e. French) similar to Gildersleeve-Neumann et al.'s (2008) findings for English. In contrast, Ezeizabarrena and Alegria (2015) found that their subject produced more codas in Basque than in Spanish, which led them to conservatively interpret their findings in terms of language-specific development, meaning that there was no interaction between the two languages. In sum, three different interaction effects (acceleration, delay, and no differences) were documented in the current contact situation in which codas were examined.

VOT

Table 2 lists studies which have examined VOT in children acquiring languages with a long lag-short lag distinction and a short lag-lead distinction. We focus here on the development of long and short lag stops and not on lead voicing as many sources suggest that it is acquired late (Allen, 1985; Khattab, 2000; Macken & Barton, 1980). Table 2 makes clear that several different patterns of interaction have been documented in bilingual children acquiring languages with both long lag and lead voicing. Indeed, in the study by Kehoe et al. (2004), three different patterns amongst four children were observed. Two children exhibited a delay in the acquisition of long lag stops; one child acquired long lag stops similarly to monolinguals and one child displayed transfer of long lag stops into Spanish. These patterns have also been observed in the other studies on VOT. Fabiano-Smith and Bunta (2012) report VOT values in the short lag region for English /p/ by their bilingual Spanish-English three-year-olds, values lower than the monolingual English-speaking children. This result is consistent with delay. In contrast, Deuchar and Clark's (1996) study of a Spanish-English child suggests similar findings to that of monolinguals. Their subject, Manuela, produced voiced stops as short lag and voiceless stops as long lag in English, and made a type of contrast in the short lag region for Spanish. Khattab's (2000) study of VOT acquisition in slightly older Arabic-English children (ages 5, 7, and 10 years) also revealed few differences that could be directly related to bilingualism.

The bilingual children produced VOT values for short and long lag stops in English that were similar to those of monolinguals. Johnson and Wilson (2002) report findings consistent with transfer of long lag voicing from English into Japanese. They found that their English-Japanese bilingual children produced voiceless stops with long lag values in English but they also did so in Japanese instead of producing them in the short lag region. A similar pattern was reported for older French-English bilinguals (ages 6-, 8-, & 10 years) by Watson (1990). The bilingual French-English children produced voiceless stops with similar VOTs in both languages.

In conclusion, a review of studies on the acquisition of VOT in early and slightly older child bilinguals reveals varied findings. This is particularly apparent in the Hamburg study in which different patterns were observed across children despite similar experimental conditions.

Table 2. Studies examining cross-linguistic interaction in VOT

Investigators	Languages	Results
Kehoe et al. (2004)	**German**	**1. No differences; 2. Delay of long lag; 3. Transfer of long lag**
	Spanish	
Deuchar & Clark (1996)	**English**	**No difference**
	Spanish	
Fabiano-Smith & Bunta (2012)	**English**	**Delay of long lag**
	Spanish	
Khattab (2000)	**English**	**No difference**
	Arabic	
Johnson & Wilson (2002)	**English**	**Transfer of long lag**
	Japanese	
Watson (1990)	**English**	**Transfer of long lag**
	French	

Examining predictive factors

Given that an analysis of two contact situations related to coda presence and VOT were characterized by variable patterns amongst bilinguals, the current section takes a different perspective. We now seek generalizations by examining predictive factors which have been used to explain cross-linguistic interaction. We consider four main factors: frequency, complexity/markedness, structural ambiguity, and dominance. The first three are considered language-internal factors and the last, a language-external factor; although we acknowledge that frequency may arguably be placed as a language-external factor.

Frequency

"Frequency" here refers to the high or low presence of a segment or a phonological structure in a given language. As Lleó and Cortes (2013) note, frequency is a "gradual notion"; it is difficult to make a clear distinction between what is frequent and infrequent. Nevertheless, using phoneme or syllable-type counts, some kind of frequency grouping can be made. Using these measures, numerous studies in monolingual acquisition show that frequency is important in accounting for order of acquisition within a language: frequent structures are acquired before less frequent ones (Kirk & Demuth, 2003; Levelt, Schiller, & Levelt, 1999/2000; Stites, Demuth, & Kirk, 2004; Zamuner, Gerken, & Hammond, 2005). Frequency is also important in explaining order of acquisition cross-linguistically: a frequent phoneme or structure in one language is mastered earlier than the same less

frequent phoneme or structure in another language (Lleó et al., 2003; Pye, Ingram, & List, 1987; So & Dodd, 1995).

How does "frequency" work in the bilingual situation? In fact, we know very little. To illustrate this, we wish the reader to imagine a table which contains those studies which have examined cross-linguistic interaction due to frequency effects. The frequency of a phonetic property in language A would be shown along the X-dimension, and the frequency of the same phonetic property in language B would be shown on the Y-dimension. To simplify matters, frequency would be divided up into discrete categories: high, moderate, low, and absent, the latter meaning that the phonetic property is not present. For the moment, whether a phonological property is present or absent is subsumed under frequency, but a finer distinction between these two factors may be necessary (see Lleó and Cortés, 2013, who distinguishes between frequency and "additive", the latter being concerned with whether the phonological property is present in the two languages of the bilingual). The intersection of "Language A - high frequency" and "Language B - low frequency" could be filled in with the studies of Lleó et al. (2003), Keffela et al. (submitted), and Gildersleeve-Neumann et al. (2008) which dealt with the situation of high frequency codas in German, respectively English, and low frequency codas in Spanish. Lleó et al. (2003) and Keffela et al. (submitted) reported acceleration of codas in Spanish whereas Gildersleeve-Neumann et al. (2008) reported results consistent with delay of codas in English. Unfortunately, we are unable to fill in many other squares in this table due to the lack of pertinent data. That is not to say that other studies on bilingual acquisition have not made reference to frequency. For example, Fabiano-Smith and Goldstein (2010b) found that bilingual Spanish-English children produced sounds that were shared amongst Spanish and English more accurately than sounds that were not shared. They then examined whether this effect could be due to the frequency of the phonemes rather than due to cross-linguistic interaction per se. They found that frequency did not predict the accuracy of shared sounds, suggesting that other factors were at play.

More recently, Tamburelli et al. (2015) found that frequency was not the decisive factor in explaining the acceleration effect that they observed in the acquisition of /s/ + obstruent clusters in the English of Polish-English bilinguals (aged 7 to 9 years). Despite the fact that /s/ + obstruent clusters were more frequent in Polish than in English in both word-initial and word-medial position (twice as frequent according to corpora based on the most frequent words in Polish and English), it was only in word-initial position that bilinguals performed significantly better than monolinguals in terms of cluster accuracy. The authors explained the differential effects between word-initial and word-medial position in terms of complexity rather than frequency (see further discussion under complexity).

The mechanism underlying the frequency effect in bilingual acquisition is also not well understood. Is there a pooling of the input such that a high frequency phenomenon in one language, when combined with a low frequency phenomenon in the other language, becomes moderately frequent across both languages? Is it then the moderate presence of this phenomenon in the overall input which is responsible for its faster acquisition rate? Or does the high frequency of a phonetic structure in one language leads to its faster acquisition in that language? The target structure is then transferred to the other language by mechanisms of cross-linguistic interaction, related to enhanced phonological representations and motor-speech practice. Applying MacWhinney's (2005) Unified Competition Theory to bilingual phonological acquisition, several authors suggest the second possibility is the most likely (Gildersleeve-Neumann & Wright, 2010; Goldstein & Bunta, 2012). According to these authors, structures and phonological properties common across languages will lead to frequent, strong, and reliable cues, which will result in the bilingual using knowledge in one language to aid acquisition in the other language. They use the term "positive transfer" to describe this process, whereby "transfer" is employed in the more general sense of "cross-linguistic interaction".

In reality, these two possibilities, pooling of the input or "positive transfer", may be difficult to distinguish; however, there is some evidence that the second is more likely. Kehoe and Lleó (2003) examined the order of onset and coda cluster acquisition in German and Spanish monolinguals and bilinguals. German has both onset and coda clusters whereas Spanish has only onsets clusters (and very infrequent coda clusters). They found that coda clusters were still acquired before onset clusters in the German of the bilinguals, similar to the monolingual situation, despite the fact that onset

clusters were more frequent overall in the pooled input of German and Spanish than coda clusters (18.6% vs. 11.4%; see Table 4 in Kehoe & Lleó, 2003, based on Delattre & Olsen, 1969). In other words, Kehoe and Lleó (2003) did not find any evidence that the overall frequency of syllable types in the pooled input influenced the order of syllable type acquisition, although it had been shown to do so in the monolingual situation (Levelt et al., 1999/2000).

Complexity/markedness

Complexity, like frequency is a relative term which is difficult to define. In general, a phonetic /phonological property that contains more elements (e.g., features), more structure, or is more difficult to produce is more complex than a phonetic/phonological property that contains fewer elements, less structure, or is less difficult to produce. Complexity may be used synonymously with markedness or it may be distinguished from it. Lleó and Cortes (2013) use "markedness" in the sense of Jakobson (1968/1941): an unmarked entity is acquired earlier than a marked one and is more common in the languages of the world, whereas, complexity, in their approach, refers specifically to phonetic phenomena which involve allophony and allomorphy. In this section, we will use complexity and markedness similarly, although we acknowledge that a more detailed examination of this term should differentiate the two.

Several studies in bilingual phonological acquisition indicate that complex phonological entities may be associated with delay. Goldstein and Washington (2001) observed that complex sound classes such as fricatives and liquids were more likely to be delayed in Spanish-English bilingual children relative to monolingual controls than less complex sound classes such as stops and nasals. As mentioned previously, Kehoe (2002) found phonological vowel length to be delayed in the German of Spanish-German bilinguals but not the less complex system of Spanish vowels. Lleó (2002) found that bilingual Spanish-German children were delayed in the acquisition of unfooted syllables in Spanish; unfooted syllables being considered as marked. Studies focusing on rhythm have shown that stress-timed rhythm poses more difficulty for bilingual children than syllable-timed rhythm (Bunta & Ingram, 2007; Mok, 2011; 2013). In all of the above examples, a possible explanation is that the acquisition of a complex entity requires frequent exposure which is reduced in the bilingual situation, and consequently, delay ensues.

More recently, a number of studies have pointed to an alternative manifestation of complexity in bilingual acquisition, that of acceleration. Keffala et al. (submitted) argue that onset clusters in Spanish and English are complex, but in different ways. English onset clusters are structurally complex, containing both two- and three-element clusters (s-adjunct clusters), whereas Spanish onset clusters are segmentally complex, containing more marked or smaller sonority differences. They hypothesize that bilinguals will display accelerated acquisition of onset clusters because they are exposed to two different types of complexity across their languages. Their results confirmed their predictions: bilingual children were more accurate in onset cluster structure (i.e. cluster structure regardless of segmental accuracy) in Spanish and in onset cluster segments (i.e. segmentally accurate clusters) in both languages compared to monolingual controls. Similar findings have been reported by Tamburelli et al. (2015) for English onset cluster acquisition in Polish-English bilinguals. The authors argued that bilinguals displayed acceleration in word-initial /s/ + obstruent clusters because they were exposed to increased complexity (small sonority differences) in Polish clusters. Importantly no effect was found in word-medial position because structurally they are coda-onset sequences and not onset clusters. Mayr et al. (2015) also report results consistent with acceleration of word-final English clusters in their Welsh-English bilinguals. In comparison with norms on English monolingual children's acquisition of word-final clusters (Templin, 1957), their bilinguals performed better.

In contrast to the above findings, not all studies on cluster acquisition have reported acceleration. Gildersleeve-Neumann et al. (2008) observed delay in the acquisition of English clusters by their bilinguals. This finding is more consistent with the earlier presented results in which marked structures may be associated with delay. For example, Gildersleeve-Neumann et al. (2008) observed delay in the acquisition of codas and clusters in their bilinguals but not in the acquisition of less marked aspects of phonology such as vowels.

In the area of phonological rhythm, Schmidt and Post (2015) document acceleration in one aspect of rhythm, namely consonantal variability. Their two-year-old English-Spanish bilinguals displayed lower consonantal variability in English, closer to the adult targets, than the English monolinguals. The authors propose that bilinguals have a developmental advantage over monolinguals because they are exposed to more varied structures, including different types of consonant intervals, across their two languages.

The second group of findings, on the acquisition of clusters (Keffela et al., submitted; Mayr et al.; Tamburelli et al., 2015) and on rhythm (Schmidt & Post, 2015) appeals to a different literature on complexity, one that shows that exposure to linguistic complexity may promote acquisition (Dinnsen & Elbert, 1984; Gierut, 1999, 2001, 2007). For example, Gierut (1999) found that children with phonological disorders when treated with a linguistically complex target (e.g., cluster with a smaller sonority difference) evidenced greater learning than those children treated with a less complex target. In the area of bilingual acquisition, the rationale appears to be that exposure to a complex structure in one language may lead to enhanced development of this same structure in the other language, although in the case of rhythm, Schmidt and Post (2015) found the acceleration effect in the structurally more complex language.

One important question is whether these two sets of findings, one showing delay and the other showing acceleration can be reconciled. In Tamburelli et al.'s (2015) study on onset clusters, the bilingual was acquiring similar types of structures, /s/ + obstruent clusters, albeit their differing complexity, in both languages. Thus, there may be a reinforcement effect. In studies which have shown delayed acquisition of segments, for example, liquids, the bilingual child was acquiring a complex target that occurred in only one of the languages (e.g., Spanish trill). Similarly, the spirant-stop alternation in Spanish (Goldstein & Washington, 2001; Lleó & Rakow, 2005) or the phonological vowel length distinction in German (Kehoe, 2002) are rules or structures that appear in one of the languages of the bilingual. The generalization could be that complex targets which appear in one of the bilingual's languages are associated with delay. This generalization cannot account for all the findings, however. Keffela et al.'s (submitted) and Gildersleeve et al.'s (2008) studies of clusters included structures which were present across both languages of the bilingual (e.g.,, obstruent + liquid clusters) and structures which were found only in English (e.g., /s/ + consonant clusters) and yet one study reported acceleration and one delay. In sum, additional research is needed to understand the outcome of "complexity" in bilingual phonological acquisition.

Structural ambiguity

Structural ambiguity has been posited as a possible explanation of cross-linguistic interaction (Döpke, 1999; Müller & Hulk, 2000; Paradis, 2000, 2001). The idea behind it is that cross-linguistic interaction occurs when there is partial structural overlap between two languages and one of the languages offers multiple options for analysis. This proposal has been mainly investigated in morpho-syntax and has led in recent years to the Interface Hypothesis, namely, that bilingual children have most difficulty acquiring language at interfaces: internal (syntax, semantic) or external (syntax, discourse) (Sorace, 2005; Sorace & Serratrice, 2009; White, 2011).

Recourse to structural ambiguity has not been frequent in studies on bilingual phonological acquisition, although two studies are noteworthy. Paradis (2000, 2001) accounted for the different truncation patterns of monolingual English and bilingual English (-French) children by appealing to structural ambiguity. The monolingual and bilingual children did not differ on the truncation patterns of SWSW words but they did on the truncation patterns of WSWS words. Paradis (2000, 2001) argued that WSWS words resemble the French WWWS words and, thus, are structurally ambiguous, whereas the SWSW words do not resemble any French pattern and thus are not structurally ambiguous and consequently are not affected.

Almeida et al. (2012) accounted for both delay in the acquisition of codas in French, and acceleration in the acquisition of onset clusters in Portuguese in terms of structural ambiguity. For matters of space, we will consider the case of onset clusters in Portuguese and French only. Vowel deletion is frequent in spoken Portuguese leading to many surface examples of consonant sequences. The Portuguese child, thus, has the difficult task of distinguishing between those sequences which are true

clusters and those which are not true clusters but are due to surface elision. According to Almeida (2011), the fact that the same onset clusters exist in French and Portuguese (e.g., obstruent + liquid clusters) helps the bilingual child to identify true onset clusters in Portuguese and, thus, aids the child to acquire them more quickly.

Apart from these two studies, there are few other references to structural ambiguity in phonological studies of early bilinguals, possibly because phonology does not lend itself to ambiguity in the same way that morpho-syntax does. The extension of structural ambiguity, the Interface Hypothesis, has also not been extensively studied in early bilingual phonological research with the exception of Lleó (In press). Lleó (In press) explored interfaces in phonetics and phonology to determine if they are vulnerable domains for bilinguals as has been claimed in syntax. She identified numerous interfaces in the phonetic/phonology domains (e.g., segments and lexemes, segments and prosodic position, phonemes and phones, phonology and morphology, prosody and syntax, prosody and semantics, and prosody and pragmatics), but ultimately, discarded them as sources of difficulty for bilinguals. There are interface phenomena which do not appear vulnerable to cross-linguistic interaction (e.g., association of meaning and intonation in Prosody-Pragmatic interface) and other non-interface phenomena which are (see White, 2011).

Dominance

The language that the child hears and uses the most is typically his dominant language. Many studies label their bilingual children as being dominant in one language or the other (Ball, Müller, & Munro, 2001; Law & So, 2006; Mayr et al., 2015). These studies generally show that the dominant language of a bilingual is associated with faster phonological acquisition. For example, Law & So (2006) observed that Cantonese dominant bilinguals have faster Cantonese phonological development than Putonghua dominant bilinguals and vice versa. Mayr et al. (2015) found that Welsh-dominant bilinguals were more accurate on Welsh clusters than English-dominant bilinguals. However, another interesting finding from these studies has been that when complexity and dominance are pitted together, complexity often wins out. In the case of Cantonese and Putonghua, bilingual children acquired the segmental aspects of Cantonese phonology faster than the more complex Putonghua, regardless of their dominance. Similarly, bilingual children, regardless of whether they were English- or Welsh-dominant, produced English word-final clusters earlier than Welsh ones, presumably because they were less complex.

Dominance as an explanatory factor has been used to account for transfer in several studies on bilingual acquisition. Keshavarz and Ingram (2002) observed that their Farsi-English bilingual produced English two-syllable words with final stress (word stress in Farsi is predominantly on the final syllable) during a period in which he was dominant in Farsi. He then acquired the English stress patterns when he became dominant in English. As mentioned, Kehoe et al. (2004) observed transfer of long lag voicing from German into Spanish in Nils, a child who was becoming dominant in German. Other authors have also reported transfer of long lag voicing in the situation in which the ambient language also contains long lag stops, suggesting effects of dominance (Johnson & Wilson, 2002). One curious finding in these transfer cases is that complex structures may be transferred (e.g., iambic stress, long lag voicing), suggesting that the relationship between dominance and complexity is in itself complex.

While several studies make reference to dominance as an important explanatory factor, other studies do not find it useful. Almeida et al. (2012) point out that dominance cannot explain the patterns of their Portuguese-French bilingual, who displayed both acceleration of clusters and delay of codas during the same time period. It would be impossible for their child to be dominant in both languages at the same time. Rose and Champdoizeau (2007) document clear differences between the acoustic manifestations of stress in a French-English bilingual, consistent with the language-specific stress patterns, despite the fact that the child was dominant in English.

Seeking generalizations across studies: Summary

Our survey of four main predictive factors in bilingual phonological acquisition has yielded variable and unsatisfying results as did the previous analysis based on contact situations. Frequency has not

been well studied in early bilingualism. Complexity appears to be better understood; however, there are opposing findings on complexity which remain to be reconciled. Structural ambiguity has not been fully explored in the phonological domain and may have limited application in this area. Dominance appears to matter but perhaps less so than other factors such as complexity.

One possible reason as to why few generalizations could be gleaned when examining similar contact situations or predictive factors is that we have ignored important methodological differences between studies. Some studies are based on small groups of bilinguals (very rarely, large groups) whereas others are single case studies. Some use word naming tasks to elicit productions whereas other are based on longitudinal naturalistic recordings. These factors may potentially lead to different outcomes in terms of cross-linguistic interaction.

Using a homogeneous data set: Lleó and Cortés' (2013) model

An alternative approach to seeking generalizations across studies is to seek generalizations within a single data-base, looking at several different phonological phenomena at the same time. This has been the approach of Lleó and Cortés (2013) who have developed a model of cross-linguistic interaction based on the Hamburg data. They have brought together findings on coda acquisition, vowel length in German and VOT (see above) as well as on place assimilation of nasals in Spanish, and on the spirantization rule in Spanish. In their model, four factors (frequency, unmarkedness, additive, and uniformity) account for the varied effects of acceleration, delay, and transfer; transfer being viewed as a more negative form of cross-linguistic interaction than delay. Their model is formalized as a table in which phonological phenomena receive plus or negative signs depending upon their values on the four factors: "Frequency" is marked positively if a phonological phenomenon has a high frequency (e.g., coda consonants in German). "Unmarkedness" receives a "+" if the phenomenon is unmarked. "Additive" is marked positively if the phenomenon under consideration occurs in both languages of the bilingual and "uniformity" is marked positively if the phonological phenomenon is not characterized by allophony or allomorphy. Tabulating across various phenomena, Lleó and Cortés (2013) conclude that frequency plays a greater role in accounting for the findings than markedness which in turn plays a greater role than uniformity and additiveness. Overall, they find the most positive effects manifest when a phenomenon occurs in both languages but is more frequent in one of the languages (e.g., codas in German and Spanish) and the most negative effects manifest when a phenomenon occurs in only one of the languages and violates uniformity (e.g., spirants in Spanish). In-between effects manifest when a phenomenon is low frequency in both languages (e.g., unfooted syllables in Spanish) or occurs in only one of the languages but doesn't violate uniformity (e.g., vowel length in German).

In sum, we may conclude that, at this stage in early bilingualism research, generalizations can only be obtained by looking at a homogenous set of data as Lleó and Cortés (2013) have done. Additional research is necessary before generalizations can be made across a broad range of studies. Before this research is conducted, however, it is worth reviewing what changes could be made before attempting new studies. We turn to the second section of this paper.

Prospective

Critical look at the research

Critical look at methodology

One striking limitation of research on bilingual phonological production is the lack of studies with large numbers of children. The review article by Hambly et al. (2013) illustrates the fact that single or multiple case studies (29 out of the 66 studies) predominate in this field, particularly in linguistic style studies which are pertinent to the topic of cross-linguistic interaction. Case studies are still very informative in the field of early bilingualism but they increase the risk that effects interpreted as cross-linguistic interaction may be due to individual differences. One clear reason for the low "n"s is the time consuming nature of bilingual research which often includes analyses of the two languages of

the bilingual child as well as analyses of the two sets of monolingual controls, which multiples the number of subjects in a single study by four fold. Phonetic and phonological production research is also intrinsically time consuming when transcription and acoustic analyses are involved.

A second limitation of research on bilingualism is the fact that data on monolingual controls is not extensive for many languages of the world. Given that the current definition of cross-linguistic interaction refers to differences between bilinguals and monolinguals, a decision as to whether cross-linguistic interaction takes place can only be made when a study includes monolingual controls or when it refers to a solid base of monolingual data. Unfortunately, this cannot always be done.

There are other methodological limitations, including the fact that few are experimental, few are longitudinal, and few include extensive information on the language background of the children; however, the focus of this section is on another major limitation of current research, namely, the lack of a research model in early bilingualism.

Critical look at research model

One clear handicap of current approaches to early bilingual phonology is the lack of a research model specially designed to account for cross-linguistic interaction. In the overview to this article, we situated early bilingualism between the larger fields of first and second language acquisition. We noted that early bilingualism shares characteristics in common with both fields; however, it has not necessarily integrated these characteristics into a coherent model. If anything, early bilingualism has leant more towards the field of second language acquisition, but, even here, it has not adopted all aspects that could be useful to it. In the following sections, we expand upon findings in First and Second Language Acquisition research which could be incorporated into current approaches to early bilingualism.

Leaning on Second Language Acquisition

One of the most well-known models in second language research, the Speech Learning Model (SLM) of Flege (1995) has motivated some research in early bilingualism (Fabiano-Smith & Goldstein, 2010b; Gildersleeve-Neumann & Wright, 2010) although, strictly speaking, it is a model which is intended for children acquiring a second language after the age of five to six years (Flege, 1997), and, thus, does not concern the majority of studies presented here. Certain central tenets of the SLM are, nevertheless, implicit in speech production research in early bilingualism, in particular, that the two linguistic systems share a common phonological space in which bidirectional interaction occurs. It also provides a taxonomy for classifying the relationship between L1 and L2 sounds, which is sadly absent in early bilingualism.

In the SLM, an L2 sound is new (i.e. differs acoustically and perceptually from the L1 sound), identical (i.e. there is no significant acoustic difference between the L1 and L2 sound), or similar (i.e. there are significant and audible differences between the L1 and L2 sound, but both sounds can be transcribed with the same IPA symbol) with respect to the L1 system. It is the similar (but not identical) sounds which create the most difficulty for second language learners. Their acquisition often leads to two processes: perceptual assimilation or dissimilation. The acquisition of a similar L2 sound may result in equivalence classification which prevents a new L2 category from being formed and the categories of the L1 and L2 are merged together. “Merging” phenomena have been reported in acquisition of VOT, whereby second language learners produce stops in their L1 and L2 with similar VOT values (Flege, 1987). The acquisition of a similar L2 sound may lead to an opposite phenomenon in which the two categories move away from each other to avoid crowding the phonetic space. These “deflecting” phenomena have also been reported in the acquisition of VOT. Mack (1990) reports excessively high VOT values for English long lag stops (e.g., 108 ms) in a 10 year-old French-English bilingual child. Since the child produced French voiceless stops also in the long lag region (e.g., 66 ms), the long VOTs in English allowed the child to maintain phonetic contrast between his L1 and L2 systems. We return to a discussion of “merging” and “deflecting” phenomena below.

The main research model applied to speech production in early bilingualism has not been the SLM of Flege (1995) but Paradis and Genesee’s (1996) model, which, in reality, is not a model but a

framework for describing patterns of cross-linguistic interaction. Furthermore, we may ask whether the three patterns outlined by Paradis and Genesee (1996): transfer, acceleration, and delay, are sufficient for accounting for all the findings in early bilingualism. We believe the answer is no (see Lleó, 2015, for similar views).

a. Transfer

First we consider "transfer". There are numerous studies which indicate that "transfer" is not frequent in young bilinguals. Goldstein and colleagues report percentages of below 1% for transfer effects in Spanish-English bilinguals (Goldstein & Washington, 2001; Goldstein, et al., 2005). Specifically, Fabiano and Goldstein (2005) report seven incidences out of a total of 1269 possible occasions in three bilingual Spanish-English children, aged 5;0 to 7;0. The seven instances included Spanish to English influence (e.g., /v/ →[ß] and English to Spanish influence (e.g., /s/ →[θ], /o/ →[ə], /r/ →[ɹ]). In another study, Fabiano-Smith and Goldstein (2010b) documented low percentages of transfer in two of their eight bilingual Spanish-English subjects. Examples included de-aspiration of stop consonants in English, which is consistent with difficulties in VOT. Apart from the findings with Spanish-English bilinguals, studies with other groups of bilinguals find equally low percentages of transfer. Law and So (2005) report few examples of transfer in Cantonese-Putonghua bilinguals; Salameh, Nettelbladt, and Nolan (2003) documented only occasional examples in their study of Swedish-Arabic bilinguals; and Mayr et al. (2015) also note few cases in word-final clusters in Welsh-English bilinguals.

Nevertheless, transfer has been documented on more than an occasional basis in certain phonetic and phonological domains, for example, VOT and /r/ acquisition. Not only did Kehoe et al. (2004) observe transfer of long lag voicing into Spanish from German but they also observed transfer of lead voicing from Spanish into German in one of the bilinguals in their study. Fabiano-Smith and Barlow (2010) report transfer of Spanish /r/ (i.e. [ɾ]) in five out of eight bilingual children's English phonetic inventories. We also observed high percentages of /r/ transfer in an unpublished case study of a trilingual child, acquiring French, Spanish, and Italian, in Geneva, Switzerland (Di Vietri, 2012). The bilingual child, aged two to three years, produced the uvular /r/ in French but also produced the uvular /r/ exclusively in Italian, and most of the time in Spanish as well. The /r/ in Italian is an alveolar trill and in Spanish, it is an alveolar trill and tap.

Given that transfer is not a frequent phenomenon in early bilingual speech production, we may wonder whether the examples of transfer in VOT and /r/ mentioned above are true examples of transfer or could be better captured under alternative classifications of cross-linguistic interaction (see below) or could be due to language external factors. VOT is a fragile phonetic domain in bilingual and second language acquisition and patterns of interaction may be specific to the temporal aspects of this domain. Lleó (2015) considers Nils' transfer of long lag voicing as an example of "fusion" (similar to "merging" described below). She advocates widening the definition of "transfer" to not only includes segments but rules and structures. In the case of /r/ transfer in the trilingual presented above, language-external factors related to dominance (the child was growing up in Geneva) or non-native input (the child was exposed to non-native speakers of Italian or Spanish) might explain the apparent high transfer rate in this child.

While "transfer" is an interaction pattern that is not frequent in early bilingualism, there are other interaction patterns which do occur and which are currently not included in Paradis and Genesee's (1996) list. We refer here to the "merging" and "deflecting" patterns, discussed above. They cannot be easily slotted into the categories of "acceleration" and "delay".

b. Merging patterns

Kehoe and Lleó (in press) document merging patterns in the vowel reduction processes of German-Spanish bilingual children. They measured the ratios of stressed-to-unstressed syllable durations in German and Spanish. Differences between ratios of stressed-to-unstressed syllable durations were significant in the German versus Spanish monolingual children. The ratios were greater than 1.0 in the German monolingual children (1.4 in phrase-final and 1.7 in phrase-medial position), but close to 1.0 in the Spanish monolingual children (.87 in phrase-final and 1.0 in phrase-medial position), reflecting

the syllable-timed nature of Spanish and the fact that German unstressed syllables are schwa syllables, leading to greater acoustic distances between stress and unstress. Differences between the ratios of stressed-to-unstressed syllables durations in German and Spanish were not significant in the bilingual children. The ratios were reduced in the case of German (1.32 in phrase-final and 1.24 in phrase-medial) and similar or slightly increased in Spanish (.98 phrase-final and 1.04 in phrase-medial), resulting in a less extreme contrast between the German and Spanish systems, that is, in a merging effect. Other examples of merging patterns have been reported in acoustic measures of rhythm in Spanish-English bilinguals (Kehoe & Lleó, 2005; Kehoe, Lleó, & Rakow, 2011), intrinsic vowel duration in English-German bilinguals (Whitworth, 2000) and in VOT (Watson, 1990; Lleó, 2015b).

c. Deflecting patterns

Dodane and Bijeljic-Babic (in press) present findings on acquisition of the acoustic correlates of stress in French-English bilinguals which are consistent with deflecting patterns. They measured duration, F_0, and intensity in the disyllabic productions of French- and English-monolinguals and in French-English bilingual children, aged 4;0 years. Here we concentrate on their findings on duration and F_0 in the French productions of the monolingual and bilingual children. The monolingual children displayed a substantial final lengthening effect (the ratio of syllable 2 to syllable 1 was 1.72) and they produced no pitch accent on the first syllable, consistent with the language-specific stress pattern of French. The bilingual children also displayed a substantial final lengthening effect, significantly larger than the one made by the monolingual children (the ratio of syllable 2 to syllable 1 was 2.29) and larger than the one made in their English words (ratio of syllable 2 to syllable 1 was 1.3), although they also produced a pitch accent on the first syllable suggesting influence of English stress. What interests us in this section is the exaggeration of the final lengthening effect in French which allowed the bilinguals to make a maximal contrast between their two language systems.

Another example of a deflecting pattern has recently been reported by Yang, Fox, and Jacewicz (2015) in the area of vowel development. They documented acquisition of English vowels in a Mandarin child, aged 3;7. Although the child initially perceptually assimilated English vowels to L1 categories, after two months, the child drastically reduced English vowel space, producing his English back vowels as central variants. This abrupt restructuring of the vowel system was interpreted by the authors as an attempt by the child to maximize the contrast between his two languages; the reduction in L2 space was also accompanied by a mild expansion of the L1 Mandarin vowel space. Subsequent development of the L2 system was characterized by gradual enlargement of the reduced vowel space.

A different example of a "deflecting" effect comes from Paradis's (1996) reanalysis of Hildegard's German and English productions (Leopold, 1949/1971). She found that Hildegard used different prosodic structures in English compared to German (e.g., more disyllables in English; more closed monosyllables in German; reduplicated forms in English but not in German) despite the fact that the prosodic structures in the German and English words that she selected were very similar. In other words, Hildegard appeared to impose contrasts in her output which were not present in her input forms.

In sum, merging and deflecting effects do not only belong to the realm of second language acquisition but may be observed in young simultaneous and sequential bilinguals as well. It may be the case that merging patterns do not just reflect perceptual assimilation as in older bilinguals but may be the by-product of increased variability or of common speech-motor constraints which lead to similar output effects across both languages of the young bilingual. Deflecting patterns show consciousness of the need for contrast, either maximizing an existing contrast or imposing a new contrast, which appears already well developed in the young bilingual.

The previous section has highlighted the importance of looking towards second language acquisition for ways to expand upon the approach currently used in early bilingualism. We have recommended enlarging the set of interaction patterns, while at the same time reducing the importance of "transfer" as a possible manifestation of cross-linguistic interaction. We now turn to how approaches in first language acquisition may complement a possible research model.

Leaning on First Language Acquisition

Three themes central to first language acquisition will be discussed here: 1. speech motor control; 2. the developing lexicon; and 3. individual differences. The latter theme is linked to the first two. Phonological acquisition may be conceptualized as having two basic components: 1) a biologically based component associated with the development of speech-motor capacities; and 2) a cognitive-linguistic component associated with learning the phonological system of the ambient language (Stoel-Gammon, 2011). While the cognitive-linguistic component may vary between a bilingual child's two languages, the speech motor skills which underlie the two phonological systems may not necessarily vary. In actual fact, we know very little about the speech motor development of young bilinguals. There have been few studies that have separately studied phonological and motor speech aspects; however, studies on bilinguals with motor speech involvement (e.g., childhood apraxia of speech) show similar patterns across languages on motor-based tasks such as diadochokinetic tasks or token variability suggesting that aspects of motor control are language-neutral (Preston & Seki, 2011).

The fact that a bilingual child's phonological systems share a common speech-motor base as well as have many segments and phonological structures in common may explain findings in the literature which show that a bilingual child's two phonologies approximate each other at certain levels. These findings include the presence of common templates (Vihman, 2002, 2015; Kehoe, 2015); merging patterns (see above), and similar orders of acquisition of phonological structures (Almeida et al., 2012; Lleó, 2015b). That is, we may expect between-language correlations in the phonological domain of an order not typically observed in other domains of language such as semantics or morpho-syntax (Kehoe, 2011, 2015).

Acquiring a phonological system involves acquiring words. In emergent approaches to phonological development, learning phonological categories and acquiring words goes hand in hand (Edwards, Munson, & Beckman, 2011). Numerous studies have focused on the relationship between phonological and lexical development in monolingual children (see Stoel-Gammon, 2011 for a review). For example, studies on late talkers in English, Cypriot Greek, Italian and French consistently show that children with small vocabularies have less developed phonologies than children with large vocabularies (Bortolini & Leonard, 2000; Kehoe, Chaplin, Mudry, & Friend, 2015; Petinou & Okalidou, 2006; Paul & Jennings, 1992). These findings support the presence of a bidirectional relationship between phonology and the lexicon. Only recently have researchers started to examine the relationship between lexical and phonological development in bilingual children (Kehoe, 2011; 2015; Vihman, 2002; 2015), although many aspects of this relationship remain unstudied. For example, we do not know whether a language-specific or a combined vocabulary score is most predictive of a bilingual child's phonological ability in each language.

Developing articulatory and lexical abilities are important components of phonological acquisition which need to be controlled since they may lead to considerable individual differences amongst children. Interestingly, they are factors that are rarely controlled in studies on bilingual phonological acquisition, with some rare exceptions. Scarpino (2011) examined what factors were the best predictors of phonological production (as measured by PCC and whole word proximity) in a large group of Spanish-English children (n=199), aged 3;0 to 6;4 years. Important to the current discussion is that she found that language-specific vocabulary scores and the phonological accuracy in the other language were highly predictive of phonological proficiency in both the English and Spanish of the bilingual children. Other important factors were language use and age. Scarpino (2011) hypothesized that the predictive nature of the other language's phonological score reflected general developmental factors (articulatory maturation) and individual aptitude. Again, these findings emphasize the importance of general articulatory abilities and lexical development in understanding bilingual phonological development.

To illustrate the role that speech production differences may play in cross-linguistic interaction, we cite recent work by Kartushina and Frauenfelder (2013, 2014) in the area of second language acquisition. They examined the influence of individual L1 vowel production data on the perception and production of L2 vowels. To determine individual production ability, they measured the acoustic distance from the L1 and L2 vowel categories and the compactness of the L1 vowel category. We will

focus on their findings on vowel compactness. They found that speakers who exhibit high variability in the way they produce the same L1 sound (high within-category variability), that is, sloppy speakers, experienced greater difficulty perceiving and producing L2 vowels. Conversely, speakers with compact L1 spaces established more precise L2 vowel categories. Translating these findings to early bilingualism, we may posit that young bilinguals, who display greater token variability, may be the ones to show more difficulties establishing native-like phonological categories and structures in both of their languages. In other words, our sloppy bilingual speakers may display the greatest degree of cross-linguistic interaction.

In sum, research in first language acquisition highlights the importance of considering the child's developing speech motor and lexical abilities as crucial factors to be controlled in studies on early bilingualism. These factors may lead to considerable individual differences among children which is inherent in the current state of research in the field. Individual production capacities may also be predictive of cross-linguistic interaction, as suggested by the research of Kartushina and Frauenfelder (2013, 2014).

Critical look: Summary

To conclude this section, we have argued that a new research model is sorely needed in early bilingualism. This is not only our conclusions but was one of the main recommendations of the review article by Hambly et al. (2013):

> "Developing models of cross-linguistic bilingual speech acquisition that take into account age of acquisition, length and type of L2 exposure, language proficiency, the development and capacity of perceptual and cognitive systems, individual variation alongside other phonological areas, such as rhythm and intonation is an enormous challenge but will assist practitioners as they assess the speech of bilingual children." (p.13)

This model needs to integrate important components from first and second language acquisition as well as develop its own unique aspects. We recommend that it expands upon existing manifestations of cross-linguistic interaction and considers the role of developing articulatory capacities and lexical abilities as a way of controlling for individual differences amongst bilingual children.

New Perspectives

One of the main conclusions of this review article is that it is time to examine more systematically what factors underlie cross-linguistic interaction in early bilingualism. Several researchers have already embarked upon this enterprise: Lleó and Cortés (2013) have developed a model of cross-linguistic interaction based on the Hamburg data; Keffela et al. (submitted) and Tamburelli et al. (2015) have examined the separate effects of frequency and complexity on syllable structure acquisition. In the remaining parts of the paper, we consider three other new perspectives in early bilingualism which should also enrich further research attempts: new methodologies, tracking cross-linguistic interaction over time, and the role of the input.

New methodologies

The majority of studies in early bilingual phonology are based on naturalistic language sampling procedures or word elicitation tasks. Many times, these methods bear witness to high production proficiency on the part of the young bilingual already by 3;0 years of age. The presence of high performance scores leads to ceiling effects which reduce the possibility of documenting important cross-linguistic effects.

Non-word repetition or sentence repetition tasks are useful procedures with bilingual populations as they reduce the effects of linguistic knowledge on test performance. Thus, they are very effective in diagnosing specific language impairment (Ferré, dos Santos, & Almeida, 2015; Thordardottir & Brandeker, 2013). They may also serve as alternative approaches for examining cross-linguistic interaction, since they augment the difficulty of the task thereby allowing more effective

discrimination of monolingual-bilingual differences (Tamburelli et al. 2015; Marecka, Wrembel, Zembrzuski, & Otwinowska-Kasztelanic, 2015). Marecka et al. (2015) asked phonetically trained raters to assess the sentence repetitions of Polish monolingual and bilingual children aged 5;9 years. The bilinguals were simultaneous Polish-English bilinguals growing up in the United Kingdom. The raters were required to assess cross-linguistic interaction on several dimensions including vowel errors and stress change. Importantly the raters were blind as to whether they were assessing a bilingual or a monolingual speaker. The bilinguals made more speech errors than monolinguals and were judged as displaying more cross-linguistic interaction than their monolingual counterparts. These results underscore the usefulness of sentence repetition in combination with a rating scale as an alternative way of measuring cross-linguistic interaction.

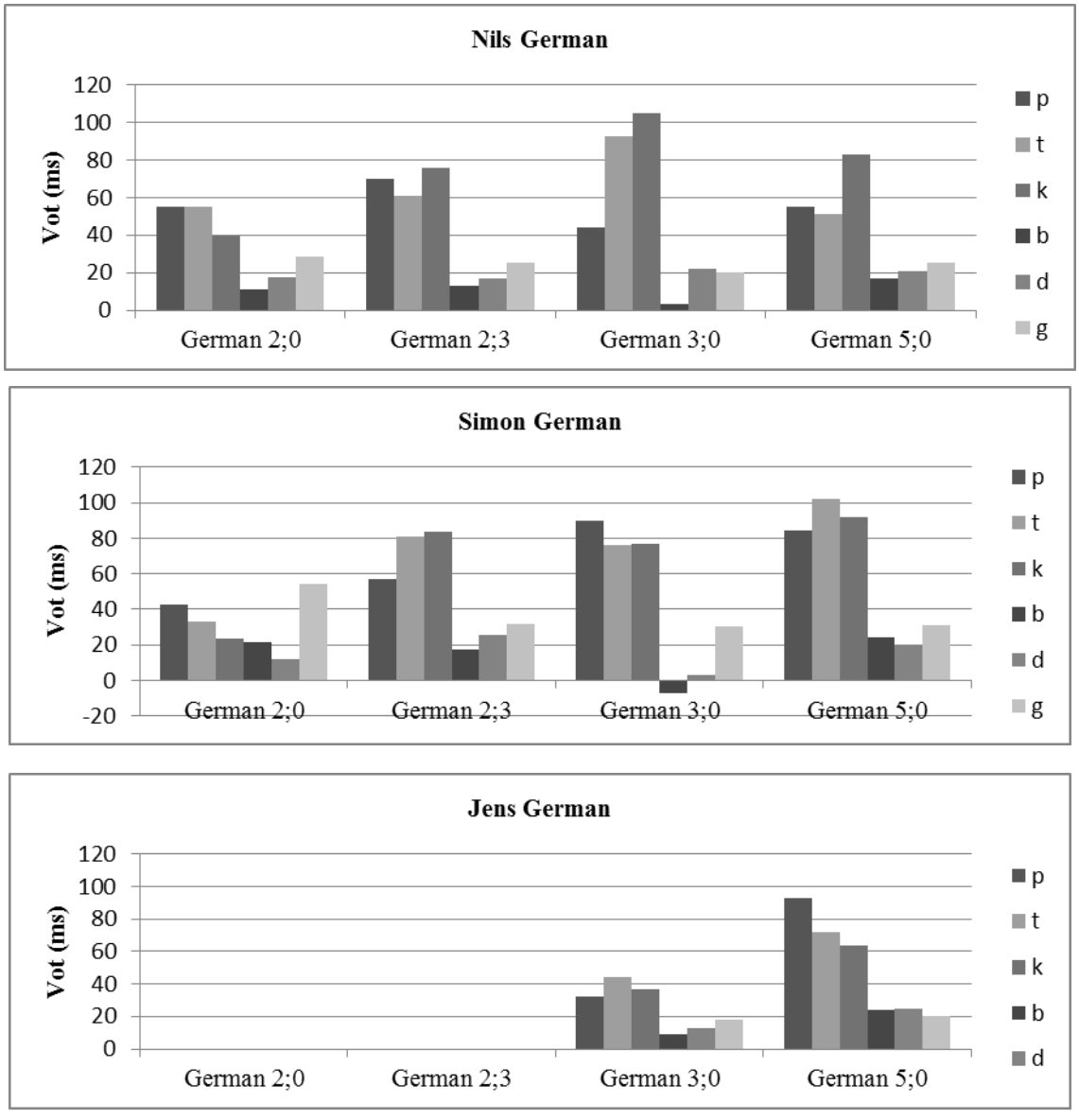

Figure 5. VOTs for target German voiced and voiceless stops in German-Spanish bilingual children at ages 2;0, 2;3, 3;0 and 5;0 (adapted from Rakow & Lleó, 2008).

Tracking Cross-linguistic Interaction

How momentary or persistent is cross-linguistic interaction? The current study has focused at one end of the life continuum, at two to five years of age. There is a growing collection of studies which have looked at the other end of the continuum, that is, at adult bilinguals who have acquired their languages from birth or very early on. These studies show that adult bilinguals may still differ from monolingual speakers in certain aspects of phonetics and phonology (e., VOT, foreign accent), particularly in their non-dominant language (Benmamoun, Montrul, & Polinsky, 2013; Kupisch, Barton, Lein, Schröder, Stangen, & Stöhr, 2014; Lein, Kupisch, & van de Weijer, 2015). There have been very few studies, however, that have looked in-between these two extremes and have tracked cross-linguistic interaction from childhood over an extended period of time. Such studies would provide useful information on the dynamic nature of phonological systems and their vulnerability.

One of the few studies that has been conducted stems from the Hamburg project. It tracked VOT development in three German-Spanish bilinguals, at 2;0, 2;3, 3;0 and 5;0 years (Rakow & Lleó, 2008). Two of the bilinguals were part of the group studied in Kehoe et al. (2004). At 5;0 years, all three bilinguals showed native-like distinctions between long and short lag stops in German but only one of the bilinguals, Simon, showed native-like distinctions between short lag and lead voicing in Spanish. These results are shown in Figures 5 and 6 for the German and Spanish voicing systems respectively. Of the two children who didn't acquire lead voicing, one of the children (Jens) made a distinction between voiced and voiceless stops in the short-lag region for two out of three places of articulation in Spanish. The other child (Nils) produced target voiceless stops with long lag values (> 40 ms) in Spanish. Why some children continue to display cross-linguistic interaction after a period and others do not remains mysterious; however, it should be noted that Simon, who achieved native-like voicing patterns in Spanish at 5;0 years, was not delayed in VOT acquisition (short vs. long lag distinction) at age 2;3. The other two children who did not acquire lead voicing in Spanish were already delayed in VOT acquisition at the earlier age ranges (for Nils at 2;0 and 2;3; for Jens at 3;0). This may suggest that factors contributing to cross-linguistic interaction are active over an extended period of time and may even be child-specific.

The role of the input

This review paper has mainly considered the role of language-internal factors (e.g., frequency, complexity, structural ambiguity) in influencing bilingual phonology. We have considered one language-external factor, dominance, which relates to quantitative aspects of the input. We have not considered qualitative aspects of the input such as whether the input the child is receiving is provided by native speakers or by multiple speakers. Indeed the source of language input for many bilingual children may be a single person or a small group of people.

Mayr and Montanari (2015) recently compared the role of input setting on the VOT acquisition of two trilingual English-, Italian-, and Spanish-speaking children, aged 6- and 8-years, growing up in the United States. The children's input in English was from their native English father and from the native speakers in the surrounding environment. The children's VOT values in English were essentially native-like and not susceptible to cross-linguistic interaction. The children's input in Italian was from their native Italian-speaking mother but also from English-accented input by the English dominant children in the Italian school the two children were attending. The children's VOTs in Italian were not native-like. They produced their target velar stops with high VOT values and they did not produce target voiced stops in Italian with consistent lead voicing. The children's input in Spanish came from a single person, the Spanish-speaking nanny. Surprisingly, the children's VOT values in Spanish were similar to the adult model and appeared unaffected by cross-linguistic interaction. The authors hypothesize that input from a single source may be conducive to phonological acquisition and may limit the effects of cross-linguistic interaction. This is an intriguing hypothesis and warrants further investigation. In sum, qualitative aspects of the input (e.g., presence of non-native input, single vs. multiple speakers) need to be given more attention in studies on early bilingualism.

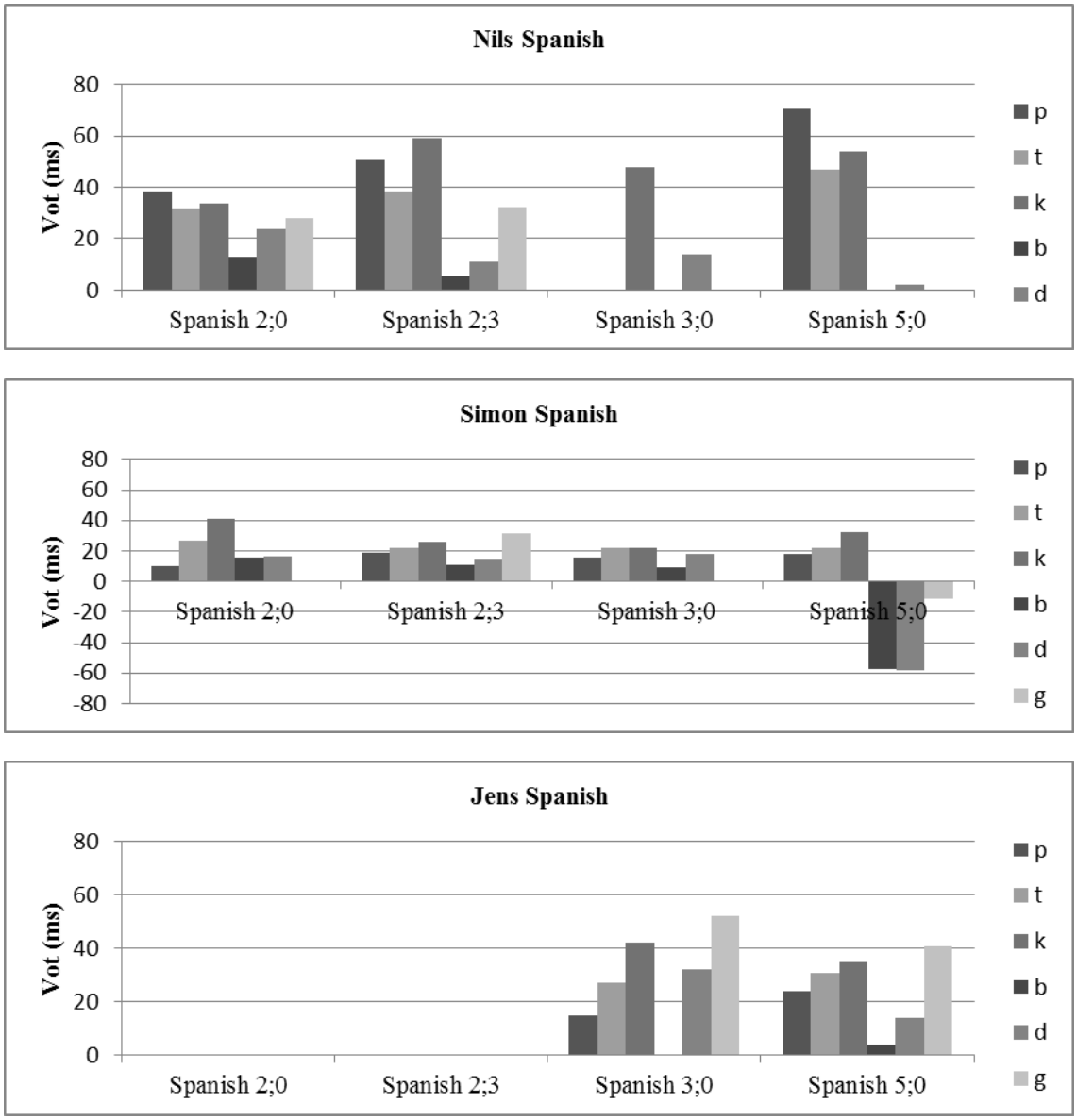

Figure 6. VOTs for target Spanish voiced and voiceless stops in German-Spanish bilingual children at ages 2;0, 2;3, 3;0 and 5;0 (adapted from Rakow & Lleó, 2008).

There are many possible new avenues of research in early bilingualism. We have focused on three areas: using new methodologies as a way of avoiding ceiling effects in phonological production research; tracking cross-linguistic interaction over time as a way of determining vulnerable domains in cross-linguistic interaction, and focusing on qualitative aspects of the input, a theme that may also give valuable information on what language-external factors influence the occurrence of cross-linguistic interaction.

Conclusion

Our review of the literature on cross-linguistic interaction leads to modest conclusions. Cross-linguistic interaction has been documented in multitudes of studies but it is still not well-understood. Our attempts to seek generalizations across similar contact situations or by examining common predictive factors have not yielded many salient outcomes. We observed that a similar contact situation (e.g., high frequency of codas in one language vs. low frequency in the other language) may

result in diverse findings; the same predictive factor (e.g., high vs. low complexity) may also be subject to differing outcomes or interpretations. Methodological limitations related to small subject numbers and lack of extensive monolingual data contributes to the lack of generalizability of the findings. In addition, current research is hindered by an insufficient research model which does not take into account all the possible interaction patterns that may occur, or the importance of speech-motor or lexical factors in influencing early bilingual phonological development. We believe these factors should be incorporated into new models of early bilingualism as they may help to explain the striking individual differences that are evident in research on young bilinguals. Other goals of future research should be to track cross-linguistic interaction over time so as to understand which domains are particularly affected by bilingual input. It is hoped that future research which systematically examines predictive factors and which utilizes new methodologies may provide a clearer understanding of when and why cross-linguistic interaction occurs. It may be the case that seeking generalizations in this field will never be easy, however, due to the inherent uniqueness of each bilingual child. That is, the "woods" may remain always difficult to detect.

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