

Do bilingual two-year-olds have separate phonological systems?*

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Acknowledgments*

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Abstract

The present study was designed to examine whether bilingual two-year-olds have differentiated phonological systems and if so, whether there are crosslinguistic influences between them. Eighteen English-speaking monolingual, 18 French-speaking monolingual and 17 French-English bilingual children (mean age = 30 months) participated in a nonsense-word repetition task. The children's syllable omissions/truncations of the four-syllable target words were analyzed for the presence of patterns specific to French and English and for similarities and dissimilarities between the monolinguals and bilinguals in each language. Results indicate that bilingual two-year-olds have separate but nonautonomous phonological systems. Explanations for the form and directionality of crosslinguistic effects are discussed.

Key words

*bilingual
first language
acquisition*

*French-English
bilingualism*

*phonological
acquisition*

1. Introduction

1.1 Differentiation

One of the principal concerns of research on the language development of children who are exposed to two languages simultaneously from birth is whether or not these children pass through a stage where they have only one linguistic representation for their dual language input. It has been proposed that bilingual children begin the acquisition process with a single language system that separates or differentiates into two systems sometime between the ages of two to three years (Leopold, 1949/1970; Redlinger & Park, 1980; Swain, 1972; Swain & Wesche, 1975; Toribio & Brown, 1995; Volterra & Taeschner, 1978; except see Vihman, 1985, for differentiation before two years). Genesee (1989) calls this position the Unitary Language System (ULS) hypothesis.

The research focused on differentiation in the phonological system of bilingual two-year-olds provides mixed support for the ULS. Some researchers found that bilingual

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two-year-olds' phonological systems are entirely undifferentiated (Celce-Murcia, 1978; Leopold, 1949/71; Vogel, 1975), or partially differentiated (Deuchar & Clark, 1996; Schnitzer & Krasinski, 1994) at this age. In contrast, other researchers argue that bilingual children can have differentiated phonologies at or before two years of age (Ingram, 1981/2; Johnson & Lancaster, 1998; Paradis, 1996; Schnitzer & Krasinski, 1996).

Determining whether a bilingual child has one phonology or two is complicated by the many crosslinguistic similarities in the composition of early segmental and syllabic inventories and in substitution patterns (Ingram, 1986; Jakobson, 1941/68; Locke, 1981). It is often uncertain whether commonalities between a bilingual's phonologies are due to a unitary system, or due to the lack of language-specific features at that stage in phonological development, which would be apparent in monolinguals as well. For example, Celce-Murcia (1978) cites the presence of similar phonological processes in both languages, such as the vocalization of syllabic liquids and the stopping of fricative consonants, as evidence of a unitary system in the bilingual child she studied (see also Leopold, 1949/71 and Vogel, 1975); however, these are common substitution processes found across children and languages (Ingram, 1986). Another illustration of this problem can be found in Deuchar and Clark (1996)'s investigation of the development of voice onset time (VOT), an acoustic cue which differentiates voiced and voiceless consonants like [p] and [b], in a Spanish-English bilingual child. In the adult languages, Spanish and English employ different VOT's to mark the voiced-voiceless contrast. Even though the child studied had acquired the adult English contrast by 27 months, the adult values for Spanish had not yet been acquired at this age. But, since the language-specific Spanish values are typically acquired much later even by monolinguals, determining early differentiation based on VOT is rendered difficult. These complications highlight the importance of examining not only phonological properties that differ between the two languages being acquired, but also those properties that show language-specific effects at the age in development being studied.

At least two additional methodological limitations can be identified in the previous research on phonological differentiation. First, all prior research is based on single case studies of children acquiring different language pairs, making generalizations across studies difficult. The contradictory findings of Schnitzer and Krasinski (1994, 1996) for two bilingual siblings demonstrate the need for group studies of children acquiring the same language pair to tease apart the possible trends from individual variation. A second weakness apparent in the extant research is the absence of systematic and direct comparisons with monolingual children acquiring each language (Celce-Murcia, 1978; Ingram, 1981/2; Leopold, 1949/71; Paradis, 1996; Schnitzer & Krasinski, 1994, 1996; Vogel, 1975; except see Deuchar & Clark, 1996; Johnson & Lancaster, 1998, for discussion of prior findings on monolinguals). Including monolingual children directly in the study design would reveal the presence and form of language specific phonological properties more clearly.

In order to address these methodological considerations, the first objective of the present study was to examine phonological differentiation by bilingual two-year-olds employing a novel methodological approach to this research question. This study includes a group of bilinguals acquiring the same two languages, two groups of monolinguals acquiring each language, and the data consists of performance on an experimental task.

This nonword repetition task is based on word truncation, a developmental phenomenon in child phonology predicted to show early language-specific patterns.

1.2 Autonomy

If the findings suggest that the children's phonological systems are indeed differentiated, the question still remains whether these systems are entirely autonomous and like that of "two monolinguals in one," or whether some crosslinguistic influences between the systems are apparent. Research on adult bilinguals has shown that interactions between a bilingual's two languages is apparent on many levels, suggesting that this third possibility is a common outcome of bilingual development (e.g., De Groot, 1993; Hazan & Boulakia, 1993; M. Paradis, 1997). The interactional perspective on language representation in adult bilinguals is succinctly summarized by Grosjean (1995): "Bilinguals are not the sum of two complete or incomplete monolinguals but have a unique and specific linguistic configuration" (p. 259). Therefore, the "one system or two?" dichotomy posed in much research on child bilinguals may be too simplistic; if adult bilinguals never achieve full separation of their systems on all levels, then it may be inappropriate to expect child bilinguals to do so. It may be more appropriate to approach the study of bilingual language development with the expectation that interactions between their two languages will occur, even after differentiation.

A debate on autonomy in the syntactic acquisition of bilingual children has recently emerged. Paradis and Genesee (1996, 1997), and Mishina (1997) found evidence of autonomous development for the aspects of syntax they examined, while Döpke (1998) Hulk (1997), Hulk and van der Linden (1996, 1998), and Müller (1998) found evidence of crosslinguistic influences in the acquisition of different syntactic structures. For example, the German-English bilingual children studied by Döpke (1998) showed English-like verb placement in a substantial number of their German utterances over a period of several months; however, she otherwise found ample evidence for differentiation between the languages. Furthermore, she claims that these kinds of word order errors are unattested in monolingual German children.

What factors determine which structures might be transferred and what direction the transfer will take? Both Döpke (1998) and Müller (1998) suggest that crosslinguistic transfer may occur for structures for which there is interlanguage structural ambiguity in the input. For instance, English has fixed word order, verb-object, and German has rule-governed but variable word order, with verb-object as one possibility in certain constructions. Thus, the superficial similarity may have led the children to overuse the verb-object word order in German until they acquired the appropriate German rule for sentence word order. The directionality is determined by the fact that no evidence exists in English for object-verb word orders like those in German, so no ambiguity is present and transfer from German would not be predicted. Hulk and van der Linden (1996, 1998) offer a similar explanation of the effect of ambiguous input. They argue that the object-verb word order in their Dutch-French bilingual subject's French was the result of increased activation of this rare, but legitimate structure in French, rather than the transfer of a syntactic parameter from Dutch. In effect, the presence of so many object-verb sentences in the Dutch input "activated" the rarer structure in French more often than for monolinguals.

To date, the issue of autonomy in bilingual children's phonological development has not been directly studied (but see Schnitzer & Krasinski's remarks on interference,

1994, 1996). Accordingly, the second and related objective of the present study was to examine potential crosslinguistic effects in bilingual two-year-olds' phonology. The additional questions this investigation addressed are: (2) If bilingual two-year-olds have two differentiated phonological systems, are those systems autonomous or are there crosslinguistic influences between them? (3) If crosslinguistic influences are present, does structural ambiguity underlie the form and direction of these influences?

1.3 Word truncation in child phonology

The nonword repetition task designed to investigate differentiation and autonomy in bilingual children's phonological development was based on the phenomenon of word truncation in the monolingual acquisition of metrical phonology. It has been observed that when young children attempt to produce polysyllabic or long adult words, they often omit some of the syllables; for example, the word 'banana' is often truncated to 'nana' (Allen & Hawkins, 1980). This phenomenon has also been observed in children acquiring languages other than English, such as Dutch (Fikkert, 1994; Wijnen, Krikhaar, & den Os, 1994), Spanish (Gennari & Demuth, 1997), Hebrew (Berman, 1977), K'iché (Pye, 1983) and Sesotho (Demuth, 1996). In English, researchers have found that syllables which are perceptually salient, such as stressed syllables and syllables in word final position, are more likely to be preserved than less salient syllables, and they argue that universal perceptual biases underlie the process of truncation (Blasdel & Jensen, 1970; Echols, 1993; Echols & Newport, 1992; Hura & Echols, 1996). Crosslinguistic comparisons reveal that preference for final syllable preservation occurs in other languages as well (Vihman, 1996). However, other researchers have noted that truncation patterns also show the effects of prosodic biases or constraints in production, beyond, or in addition to, the effects of perceptual biases (Allen & Hawkins, 1980; Demuth, 1996; Fikkert, 1994; Gennari & Demuth, 1997; Gerken, 1994a, 1994b; Gerken, Landau, & Remez, 1990; Johnson, Lewis, & Hogan, 1997; Kehoe & Stoel-Gammon, 1997; Pater, 1997a; Pater & Paradis, 1996; Schwartz & Goffman, 1995; Wijnen et al., 1994). Specifically, it has been claimed that English-speaking and Dutch-speaking children have a "trochaic bias" in their selection of which syllables to omit and which to retain in a truncated production (Allen & Hawkins, 1980; Gerken, 1994a, 1994b; Gerken, Landau, & Remez, 1990; Schwartz & Goffman, 1995; Wijnen et al., 1994). Trochaic refers to a particular prosodic rhythm where a two-syllable combination would consist of a strong or stressed syllable (S) followed by a weak or unstressed (W) syllable, as in the word 'monkey' (SW). The opposite of trochaic rhythm is iambic rhythm, as in the word 'giraffe' (WS). Since trochaic rhythm is the dominant rhythmic pattern in nouns in English and Dutch, it is argued that such a trochaic bias in children's truncation patterns indicates a sensitivity to this language-specific prosodic property (except see Allen & Hawkins, 1980). In fact, the trochaic bias may be present before the stage of word production in English-speaking infants. For example, Jusczyk, Cutler, and Redanz (1993) found that English-learning nine-month-old infants preferred to listen to SW words over WS words.

How does the trochaic bias work? Gerken (1994a) found that when truncating words with SWWS and WWSW structures, children preserved the two nonfinal weak syllables differentially; they preserved the weak syllable right-adjacent to the first strong syllable in the words more often than the other weak syllable, so that their outputs corresponded to a

SW template. Such differential preservation of nonfinal weak syllables cannot be explained straightforwardly by perceptual biases alone because both weak syllables are in a perceptually disadvantageous position. One important aspect of Gerken's design is the use of four-syllable long target words. In two- and three-syllable words, the effects of perceptual saliency factors, such as stress and final position, are difficult to disassociate from prosodic constraint factors. For example, in WSW words, the second weak syllable is also a final syllable, so if it preserved in truncation, it is ambiguous whether perceptual or prosodic factors are responsible.

If English-speaking children's truncation patterns demonstrate sensitivity to language-specific prosodic structure, then children acquiring languages with contrasting prosodic patterns should show different truncation patterns, beyond a universal preference for preserving stressed and final syllables. French contrasts with English on many aspects of word-level stress patterns (see also Pater, 1997b). English is a trochaic, quantity-sensitive language with variable placement of primary stress and stress alternations (secondary stress) within words (Dresher & Kaye, 1990; Hayes, 1982; Kenstowicz, 1994). The majority of English words are disyllabic and begin with an initial strong syllable (Cutler & Carter, 1987), although iambic-like patterns can also be found, as in the word 'giraffe' (WS). In contrast, French is primarily a quantity-insensitive language with fixed word-level stress, placed on the final syllable unless the final syllable ends in schwa (Bullock, 1994; Dresher & Kaye, 1990; Fletcher, 1991; Hoskins, 1994; Kenstowicz, 1994). French is traditionally considered to have no stress alternations within a word (Dresher & Kaye, 1990; Kenstowicz, 1994); however, this is currently being debated (Hoskins, 1994; Paradis & Deshaies, 1990). If stress alternations exist in French, they do not seem to be as consistent and prominent as stress alternations in English, so the traditional analysis was adopted for this study. But, we discuss the possible influence of secondary stress on truncation patterns in French. Finally, when we compare disyllabic words, French and English contrast in that French words have iambic rhythm and the majority of English words have trochaic rhythm. Unlike English, French does not have a substantial set of words displaying various rhythm types lexically.

These contrasts in prosodic organization between French and English indicate that for French-English bilinguals, truncation patterns could be a window on sensitivity to language-specific phonological characteristics, and in turn, a window on how separate their phonological systems are at that point in development. Accordingly, the nonword stimuli in the present study were designed for comparison of the effects of trochaic versus iambic word rhythm and quantity-sensitivity.

2. Method

2.1 Participants

There were three groups of participants in this study: 18 monolingual French-speaking children with a mean age of 32 months (range=28 to 36 months); 18 monolingual English-speaking children with a mean age of 29 months (range=22 to 34 months), and 17 bilingual French and English-speaking children with a mean age of 29 months (range=23 to 35 months). The monolingual children were recruited through French and English language

Table 1
French Nonsense Words Used in Repetition Task

IPA ^a	Orthography	Syllable Structure ^b	Word Rhythm ^c
ko.ti.ma.tœ	quotimateux	CV CV CV CV	WWWS
me.la.po.li	mélapolie	CV CV CV CV	WWWS
pe.ly.ma.tan	pélumatane	CV CV CV CVC	WWWS
ra.me.li.no.z	ramelinose	CV CV CV CVC	WWWS
pa.no.fal.dē	panofaldin	CV CV CVC CV	WWWS
tu.ma.taskē	toumatasquin	CV CV CVC CV	WWWS
krabyldomi	crabuldomie	CV CVC CV CV	WWWS
ma.ril.go.pā	marilgopant	CV CVC CV CV	WWWS
by.ltup.amœ	bultoupanmeux	CVC CV CV CV	WWWS
ka.zgu.ma.jō	casgoumaillon	CVC CV CV CV	WWWS

^a IPA=International Phonetic Alphabet
^b C=Consonant, V=Vowel. Spaces indicate syllable boundaries
^c W=Weak or unstressed syllable, S=Strong or stressed syllable

daycare centers and the bilingual children were recruited through newspaper advertisements and word of mouth. All children resided in the greater Montreal area in Quebec, Canada. Detailed language background questionnaires were filled out by parents to ensure that the children who were included in the study were either French monolingual, English monolingual, or French-English bilingual. Trilingual children were excluded. The criteria for inclusion in the bilingual group were that the children had to have been exposed to both French and English consistently from birth, or within the first six months of life, and that they spontaneously produced utterances in both languages at the time of testing. Whether our criteria for bilingualism were met was ascertained both through the language background questionnaire and observations by the experimenters on the initial visit before testing started. It was not required that the children be balanced bilinguals, as dominance or preference for one language is a typical aspect of early bilingual development (De Houwer, 1995). However, we determined whether the bilingual children were English dominant or French dominant in order to ensure that we had a fair balance of dominance types to offset any skew in the group's performance. For this study, dominance was equated with the language of greatest exposure, as indicated in the language background questionnaire. This is a rather informal and nonrigorous criterion (see Genesee, Nicoladis, & Paradis, 1995); however, since dominance was not intended to be a factor in data analysis, it was deemed sufficient. Of the 17 bilingual children, seven were French dominant, nine were English dominant and one was considered to be a balanced bilingual.

2.2 Stimuli

Ten nonsense words in French and 12 nonsense words in English were created to test the children's sensitivity to word rhythm and syllable weight (Table 1 and Table 2). Nonsense words were selected over real words to control for familiarity and length. Children might treat more familiar words differently than less familiar words (Gerken, 1994a; Ohala & Gerken, 1997). Four syllable words were chosen over shorter words to ensure that the children truncated the words (Kehoe & Stoel-Gammon, 1997) and to maximize the

Table 2

English Nonsense Words Used in Repetition Task

IPA ^a	Orthography	Syllable Structure ^b	Word Rhythm ^c
Type 1			
læpætʊmun	lapatimoon	CV CV CV CVC	WS [˘] WS
fəjɪmætək	fahjeematak	CV CV CV CVC	WS [˘] WS
mələubʊkən	maloobikon	CV CV CV CVC	WS [˘] WS
Type 2a			
pətʊlfiɡə	patoolfiga	CV CVC CV CV	WSWWW
ɡəmiɪnjʊpə	gahmeenijpa	CV CVC CV CV	WSWWW
zəmældɪpə	zemałdipa	CV CVC CV CV	WSWWW
Type 2b			
təmbɛɪnɪtə	tambaynita	CVC CV CV CV	SS [˘] VWW
mʊldæptkə	moolɔapika	CVC CV CV CV	SS [˘] VWW
wəptʊokɪmə	wahptɔakima	CVC CV CV CV	SS [˘] VWW
Type 3			
kʊəmɪɡændə	koameeganda	CV CV CVC CV	SWS [˘] W
pəkɪmʊɔktə	pakeemoakta	CV CV CVC CV	SWS [˘] W
bəʊdɪkʊlpə	bowdeekoolpa	CV CV CVC CV	SWS [˘] W

^a IPA=International Phonetic Alphabet^b C=Consonant, V=Vowel. Spaces indicate syllable boundaries^c W=Weak or unstressed syllable, S=Strong or stressed syllable

potential influence of prosodic rhythm constraints on truncation. The use of nonsense words should not restrict generalizability because previous comparisons conducted by other researchers have shown that children's truncation patterns on nonsense words parallel their patterns for real words in both spontaneous and imitated speech (Gerken, 1994a; Gerken et al., 1990; Kehoe & Stoel-Gammon, 1997).

The nonsense word sets in both French and English were created with the assistance of native speakers of each language, and according to the phonotactics and syllabification constraints in each language. There were three components we considered in making these stimuli: segmental, syllabic, and prosodic. Concerning the segmental content, each word contains a unique consonant-vowel pairing for each syllable and the place of articulation of the onset (syllable-initial) consonants was varied. This was done to facilitate the identification of the target syllable in the child's production, and to provide some perceptual contrast between the syllables. In addition, because some researchers have found that children are more likely to omit word-medial syllables with sonorant consonant onsets than with obstruent onsets (Kehoe & Stoel-Gammon, 1997; Pater, 1997a), the order of sonorant and obstruent onsets was alternated within the words to control for this segmental effect. The alternations are not fully systematic, however, due to restrictions dictated by coda (syllable-final) consonants or due to the judgment of native speakers that the order sounded awkward or unnatural. Finally, the coda consonants chosen could not be paired with the onsets to make onset clusters, like [pɪ] in 'play', in either language.

Regarding syllable structure and word rhythm, for the French words there is only one rhythm type, WWWS; however one heavy, CVC (C = consonant, V = vowel) syllable is placed in eight of the words, the position varying between words. This was done for the analysis of quantity sensitivity. There are four word rhythm types in the English set, representing common patterns found for nouns, WS'WS, WSWW, SS'WW and SWS'W. The WS'WS and SWS'W words were created to test the influence of trochaic biases. Also, the WS'WS words are very close to the French pattern and thus provide the potential for interlanguage structural ambiguity. Each of the English words has one heavy (CVC) syllable in it, to parallel the French stimuli set. The WSWW and SS'WW words were included to examine quantity sensitivity.¹ Our predictions for the children's performance with these stimuli are given below.

2.3 Procedure

Two experimenters met with each child individually. One experimenter interacted with the child and the other transcribed the children's repetitions of the target words and operated an audio-tape recorder. For both the sessions with bilingual and monolingual children, the experimenter who interacted with the child spoke the language of the session, French or English, natively, although all experimenters were fluent bilinguals. The children were shown stuffed toys and picture books of unfamiliar animals. Each of the toys and pictures had a nonsense-word name. When the children were introduced to a creature, they were provided with its name and asked to repeat it, for example, "This is a patoolfiga. Can you say 'patoolfiga'?" Working with small children in a naturalistic play setting precluded strict adherence to verbal protocol, so occasionally, the name was also presented in midsentence, as in, "The patoolfiga wants you to say his name. Can you say his name?" The order of nonword presentation varied among the children based mainly on their toy and picture preferences. The children were encouraged to repeat the words more than once, in order to augment the frequency of exemplars for each stimulus.

Bilingual children were tested twice, once in each language, on separate occasions. The order of the two sessions for the bilingual children was counterbalanced for the children as a whole and according to dominance. For example, one half of the English-dominant children had an English session first, and the other half had a French session first.

The setting for testing differed between the monolingual and bilingual groups. The monolingual children were tested in a separate room in their daycare centers. For many of the daycare centers, on-site testing was a requirement for their participation in the study. The bilingual children were tested in their homes, with one parent present. There were two reasons for this difference. First, some of the bilingual children were not attending daycare centers. Second, a bilingual child's home is a bilingual context, unlike most daycare centers. Because bilingual two-year-olds are sensitive to their linguistic context (Genesee, Nicoladis, & Paradis, 1995, for example), it was thought that they might not interact adequately with an experimenter in each language unless testing took place in a fully

¹ The small number of tokens, for the English words in particular, seemed to be an inevitable aspect of the design because two year old children's attention spans are limited, and it was thought that testing should take up one session only in each language. If two sessions were required, then the bilingual children would require four sessions, which may have skewed the results due to practice effects or boredom with the task. We recognize that having a small number of stimuli does limit the strength of the conclusions we can make from the study.

bilingual context. The parent who spoke the language of the session was asked to be present during the session to help set the context.

This difference in setting may have resulted in lower attrition rates for the bilinguals. There were fewer bilingual children who had to be excluded from the study because they did not repeat at least half the stimuli. Nine French monolingual children and nine English monolingual children were excluded, whereas, only five bilingual children were excluded for this reason (participant numbers above are for children included in the study). Perhaps the presence of a parent made the children in the bilingual group less reticent to talk to unfamiliar people.

2.4 Transcription and coding

The children's repetitions of the words from the audio recordings were transcribed (broad phonetics) and compared to the transcriptions made during the session, following the method used in Gerken (1994a, 1994b). Data from children who did not truncate at least half of the words were excluded from further analysis. Seven French monolinguals, four English monolinguals and one of the bilinguals were excluded for this reason (participant numbers above are for children included in the study). The transcription from the audio-tape was done by the experimenter who interacted with the child. Comparison with the transcriptions made during the sessions yielded agreement rates of 88% for French words and 83% for English words. The lower rates for English are most likely due to the presence of a greater variety of word types in the set and the complicating factor of vowel reduction in this language. After agreement rates were calculated, both experimenters listened again jointly to each disputed item, and a final transcription was decided by consensus.

After transcription, the children's productions were coded for preservation of target syllables. Syllables were coded as preserved if they were identical to the target, or if at least the vowel of the target syllable was preserved, without the target onset or coda. Minor mispronunciations and common substitutions of the onset consonants were disregarded, for example, young children often substitute a [t] for an /s/. If the target syllable could not be determined due to gross mispronunciations, or because the child produced two schwa vowels in a row, the syllable was not coded.

Preservation by position scores were calculated for each syllable (first, second, third, fourth) of each target word for each child. The denominators consisted of the number of times each target word was produced by that child and the numerator consisted of the number of times that particular syllable was included in the child's production. The rationale for the choice of denominator was that each time the word was produced, there was an opportunity to produce all four syllables. For the quantity-sensitivity analyses for French, additional scores were calculated for heavy and light weak syllables across the target words and positions for each child. The denominators for the heavy syllable scores consisted of the number of times target words with a weak heavy syllable were produced, and the numerator consisted of the number of times the heavy syllables were included in the child's productions. For weak light syllables, the same operation applied except that each target word contained two or three weak light syllables (as opposed to one weak heavy syllable), so both the numerators and denominators had higher numbers. Quantity-sensitivity analyses in English were determined through the preservation by position scores, as explained in the following section.² (see overleaf)

2.5 Predictions

Let us consider how the contrast in prosodic organization between French and English might produce language specific effects in children's phonological processing of our stimuli. Based on Gerken (1994a, 1994b), we predicted that monolingual English-speaking children would truncate target words in accordance with a trochaic (SW) production template, and that monolingual French-speaking children would truncate target words in accordance with an iambic (WS) production template. Such template-based preferences would produce language-specific differences based on differential preservation of nonfinal weak syllables in WWWS and WS'WS words, and on overall output length for SWS'W words. For example, a trochaic output bias would indicate a preference for preservation of the second weak syllable over the first weak syllable in $W_1S'W_2S$ English words, and a preference for the third weak syllable over the other weak syllables in the $W_1W_2W_3S$ French words. Concerning the SWS'W English words, we can make two predictions. First, when these words are truncated, we expect a preference for either the first or the second SW foot in the children's output because either one conforms to a trochaic template, which a WSW output does not. Second, lower overall rates of syllable omission for the SWS'W English words in comparison with the other words would be expected because the target fits two template sequences exactly, thus reducing the need for truncation. It is important to note that for all the words, we expect stressed syllables and final syllables to be preserved frequently due to both prosodic and universal perceptual factors.

With respect to quantity sensitivity, we expect French-speaking children not to attend to quantity differences in their processing of target stimuli because their language is mainly quantity insensitive. Hence, in spite of the possible greater saliency of heavy syllables due to their duration, French-speaking children should not preserve heavy weak over light weak syllables. In contrast, due to the quantity-sensitive nature of their language, English-speaking children should attend to syllable weight in their processing of English target words and might show a preference for heavy over light syllables because the former are more salient and play an important role in the prosodic organization of the language. Because heavy syllables attract stress in English, we cannot easily compare the preservation of heavy versus light weak syllables, as we can in French. However, we can compare the differential preservation of initial syllables, based on weight, in the SS'WW and WSWW words. Because the initial syllable position is particularly susceptible to omission in general in English truncation (e.g., Ingram, 1986), and in these words, the initial syllable appears before the syllable bearing main stress, this should be a position very vulnerable to omission. Thus, increased preservation of heavy syllables in this position might indicate attention to the language-specific property of quantity sensitivity.

Regarding bilingual children, we predict that if they have differentiated phonological systems, they should demonstrate the same language-specific truncation patterns identified for the monolingual children. If they show evidence of differentiation, then we can examine whether the two systems are autonomous. Based on the findings for syntax

² Following Hura and Echols (1996), because the dependent variables for our analyses are expressed as proportions, arcsine transformations were performed on a subset of the data before the statistical analyses. These results were compared to those for analyzed untransformed data. Like Hura and Echols (1996), no differences were found in the outcomes of the transformed and untransformed data, thus, the rest of the data were analyzed untransformed.

discussed above, we expect crosslinguistic effects to occur at points of structural ambiguity between the two languages. For the stimuli used in this study, the English WS'WS words might provide such a point of ambiguity with the WWWS French words. Our logic is as follows: If WWWS French words were heard as English words, which they may be if secondary stress indeed occurs on the second syllable in French, then we might see greater preference for second syllable preservation in bilinguals than in monolinguals, the latter preferring the third and fourth syllables. Conversely, if WS'WS English words were heard as French words, we might see a greater preservation bias towards the third and four syllables in the bilinguals, to satisfy a WS template; whereas, monolinguals should show a greater bias towards preservation of the second and third syllables, in line with a trochaic template. Based on the directionality observed for crosslinguistic effects in the research on syntax, we further predicted that the influence of French on English words would be more likely to occur because English has a greater variety of lexical word stress patterns than French. In other words, we predicted crosslinguistic effects were more likely to occur for the WS'WS words than for the WWWS words.

3. Results

Preliminary analyses were performed in order to assess the broad similarities between the groups necessary to permit further comparisons. First, the average output length in syllables per child in each language group was similar (French monolinguals = 2.77; English monolinguals = 2.85; Bilinguals - French = 2.68; Bilinguals - English = 2.67), with no significant difference between the French and English output length for the bilinguals, $t(16) = .085$, $p = .9336$. Also, the correlation between age and truncation rate was nonsignificant for all three groups, with French and English calculated separately for the bilinguals. This suggests that the children included in the study were at roughly the same stage in phonological development, despite the range in ages.

It is possible that since the bilingual children underwent two sessions instead of one, their truncations rates may have decreased on the second session due to practice effects. However, this did not occur because the overall output length for the bilingual children did not differ between the first and second sessions (2.59 vs. 2.76, $t(16) = -1.533$, $p = .1448$). Another possible asymmetry in the bilingual data could have been caused by language dominance. But, comparisons between children's mean output length in their dominant and nondominant language showed that they were not significantly higher for the dominant language (2.68 vs. 2.72, $t(14) = -.351$, $p = .7305$).

3.1 Language-specific effects

Nonfinal weak syllables. The mean proportions of preserved syllables in first, second third and fourth position in the target French WWWS words are shown in Table 3 for both the monolingual and bilingual groups. One way within-language group ANOVAs by subjects and items with syllable position as a factor (4 levels: first, second, third, and fourth) revealed that for both the monolinguals and bilinguals the effect of syllable position in the target word had a significant effect on preservation (Monolinguals: $F_s(3,17) = 25.927$, $p < .0001$, $F_1(3,9) = 37.630$, $p < .0001$; Bilinguals: $F_s(3,16) = 47.020$, $p < .0001$, $F_1(3,9) = 62.597$, $p < .0001$). The results of post-hoc Fisher LSD tests for the syllable preservation means for

Table 3
Mean Proportions of Syllable Preservation by Position for the Monolingual and Bilingual Groups for French WWS Words

Position contrasts	Monolingual		Bilingual	
	Means	t-value	Means	t-value
4-3	.92-.71	3.97*	.93-.60	5.12*
4-2	.92-.45	6.97*	.93-.24	10.66**
4-1	.92-.37	8.04**	.93-.32	9.36**
3-2	.71-.45	2.99*	.60-.24	5.55**
3-1	.71-.37	4.06*	.60-.32	4.24*
2-1	.45-.37	2.13 _{ns}	.24-.32	1.31 _{ns}

Note: 4,3,2,1=syllables in fourth, third, second, and first position respectively, that is, W₁W₂W₃S₄
p* < .05 *p* < .01

subjects are presented in Table 3. The preservation patterns for both groups are parallel. First, as expected, the children in both groups preserved the final, stressed syllable (syllable 4) more than any other, which is expected based both on the influence of universal perceptual and on language-specific prosodic factors. Comparisons indicative of language-specific factors alone are those among the nonfinal weak syllables. For both groups, syllables in third position were retained more than syllables in second position and first position. There was no difference in preservation between syllables in second and first position. This differential preservation of weak syllables in third position over those in second and first position is consistent with an iambic template bias in truncation.

The mean proportions of syllables preserved in first, second, third and fourth position in the target for English WS'WS words are shown in Table 4 for both the monolingual and bilingual groups. One-way within-language group ANOVAs by subjects and by items with syllable position as a factor (4 levels: first, second, third, and fourth) demonstrated that the effect of syllable position in the target word had a significant effect on preservation for both language groups (Monolinguals: $F_s(3,17)=56.011, p<.0001, F_i(3,2)=55.905, p<.0001$; Bilinguals: $F_s(3,16)=24.745, p<.0001; F_i(3,2)=34.857, p<.0003$). The results of post-hoc Fisher LSD tests for syllable preservation means for subjects are presented in Table 4. First, as expected and similar to the results for the French words, final and stressed syllables (syllables 4 and 2) were preserved more than the weak syllables by the monolingual children and by the bilingual children in all comparisons except between syllables in second and third position. This difference between the monolinguals and bilinguals is not relevant to the nonfinal weak syllable comparisons we are examining primarily here, and are reconsidered below with other results in the *Crosslinguistic Effects* section. Concerning predicted language-specific factors, both groups of children preserved the nonfinal weak syllables in third position more than those in first position, in accordance with a trochaic template bias.

English SWS'W words. We first examined whether the children truncated all the items in the stimuli sets in each language equally using one-way ANOVA procedures with items as a factor (10 levels for French; 12 levels for English). Both the monolingual and bilingual children truncated all the words in the French stimuli set equally (Monolingual: $F(9,25)=$

Table 4

Mean Proportions of Syllable Preservation by Position for the Monolingual and Bilingual Groups for English WS'WS Words

Position contrasts	Monolingual		Bilingual	
	Means	t-value	Means	t-value
4-3	.89-.51	5.35*	.87-.47	4.52**
4-2	.89-.89	0.13 _{ns}	.87-.55	3.63*
4-1	.89-.11	11.03**	.87-.11	8.60**
3-2	.51-.89	5.35*	.47-.55	0.89 _{ns}
3-1	.51-.11	5.81**	.47-.11	4.08*
2-1	.89-.11	11.16**	.55-.11	4.97**

Note: 4,3,2,1=syllables in fourth, third, second, and first position respectively, that is, W₁S₂W₃S₄

* $p < .05$ ** $p < .01$

1.250, $p > .05$; Bilingual: $F(9,28) = 1.192$, $p > .05$). In contrast, the monolingual and bilingual children did not truncate all the English words equally (Monolingual: $F(11,28) = 4.596$, $p < .001$; Bilingual: $F(11,25) = 1.795$, $p < .05$). Following our hypothesis, planned contrasts (Maxwell & Delaney, 1990) were performed on the monolinguals' and bilinguals' truncation rates of the SWS'W words versus the other word types combined in English (WS'WS, W/SS'WW). As predicted, both the monolinguals and the bilinguals truncated the SWS'W words significantly less than the other word types (Monolinguals: $F(1,308) = 50.99$, $p < .01$; Bilinguals: $F(1,275) = 15.875$, $p < .01$). The monolingual and bilingual children's mean truncation rates for the SWS'W words were 3.26 and 3.00 syllables, respectively, while for the other word types they were 2.67 and 2.59 syllables, respectively. Fewer truncations of the SWS'W words provides further support for the operation of a trochaic bias in syllable omission patterns.

In addition to hypothesizing that these words would be truncated less, we also predicted that when they were truncated, the children would tend to circumscribe one foot, rather than produce a three-syllable truncation. The mean proportions of syllables preserved as a function of position in the SWS'W targets are shown in Table 5 for both the monolingual and bilingual groups. One-way within-language group ANOVAs by subjects and by items with syllable position as a factor (4 levels: first, second, third, and fourth) showed that for both the monolinguals and bilinguals the effect of syllable position in the target word had a significant effect on preservation (Monolinguals: $F_5(3,9) = 19.144$, $p < .0001$; $F_1(3,2) = 7.731$, $p < .01$; Bilinguals: $F_5(3,12) = 17.280$, $p < .0001$; $F_1(3,2) = 18.971$, $p < .001$). Note that the number of subjects is smaller for this comparison because some subjects in both groups did not truncate the words of this type. A two-way mixed ANOVA with language group as a between factor (2 levels: monolingual and bilingual) and syllable position as a within factor (4 levels: first, second, third, and fourth) was not significant, indicating that the monolinguals and bilinguals treated these words in the same way overall, $F(3,63) = 1.424$, $p > .05$. The results of post-hoc Fisher LSD tests for the one-way ANOVAs are presented in Table 5. The similar preservation patterns for both groups are as follows: Syllables in fourth and third position were preserved more often than those in second position and first position. There were no significant differences between the preservation rates for

Table 5
Mean Proportions of Syllable Preservation by Position for the Monolingual and Bilingual Groups for English SWS'W Words

Position contrasts	Monolingual		Bilingual	
	Means	t-value	Means	t-value
4-3	.81-.85	0.34 _{ns}	.96-.67	2.35 _{ns}
4-2	.81-.11	6.13**	.96-.17	6.38**
4-1	.81-.39	3.64*	.96-.35	4.95**
3-2	.85-.11	6.47**	.67-.17	4.032*
3-1	.85-.39	3.98*	.67-.35	2.60*
2-1	.11-.39	2.49*	.35-.17	1.44 _{ns}

Note: 4,3,2,1=syllables in fourth, third, second and first position respectively, that is, S₁W₂S₃W₄
p* < .05 *p* < .01

syllables in third and fourth position. The groups differed with respect to syllables in first and second position. The monolinguals preserved the syllables in first position more than those in second position, but the bilinguals preserved them equally. This difference is not directly relevant to the consideration of a trochaic template bias, and did not yield a significant between-group difference in the two-way, mixed ANOVA.

The preservation by position patterns for the truncated productions of SWS'W words appear to indicate that the children in both groups most frequently preserved the final SW foot when they truncated these words. Taken with the output length results, these findings suggest that the children either did not truncate these words, or preserved one SW foot, both strategies being consistent with a trochaic template bias.

Heavy versus light syllables. Preservation scores for heavy and light weak syllables for the French WWS words were compared for the monolingual and bilingual groups. As predicted for a quantity-insensitive language, it was found that both the monolingual and the bilingual children did not preserve heavy weak syllables more than light weak syllables (Monolinguals: 45% vs. 53%, *t*_s(17) = -1.779, *p* = .0931; Bilinguals: 33% vs. 40%, *t*_s(16) = -1.277, *p* = .2198). An item analysis was also nonsignificant (Monolinguals: 59% vs. 60%, *t*_i(7) = -.160, *p* = .8776; Bilinguals: 32% vs. 40%, *t*_i(5) = -.710, *p* = .5097).

For the weight analysis of the English words, the preservation of the initial heavy and light syllables in W/SS'WW (Type 2a and 2b) words was compared. Because there are just three tokens in each group, an item analysis was not undertaken. The monolinguals and bilinguals performed differently on this analysis. The monolinguals preserved the heavy initial syllables more than the light initial syllables (27% vs. 17%, *t*_s(17) = 2.116, *p* < .05). The difference is even greater when only truncations three syllables in length are examined. In three-syllable truncations, 40% of heavy initial syllables were included, while only 13% of light initial syllables were included. In contrast, the bilingual children preserved 17% of the heavy initial syllables and 14% of the light initial syllables in all truncations. Even though the trend is in the right direction, the difference is nonsignificant, *t*_s(16) = -.311, *p* > .05.

In sum, for French words, both groups demonstrate the predicted language-specific quantity-sensitivity effects, but only the monolingual children demonstrated these effects for the English words.

Crosslinguistic effects. Since all the analyses except for syllable weight in English indicate that the bilinguals show evidence of language-specific truncation patterns, and thus, differentiated phonological systems, the next step is to examine whether these systems are autonomous or show signs of crosslinguistic effects. Accordingly, we looked for differences between bilinguals and monolinguals in their treatment of structurally-ambiguous targets: WWWS and WS'WS words. To briefly reiterate one prediction, if WWWS words were being treated as English words (especially if secondary stress were being perceived on the second syllable), we might see greater preference for second syllable preservation by bilinguals than monolinguals, to satisfy a trochaic bias. However, the preservation means for the bilinguals from Table 3 are 24% for syllables in second position, and 45% for syllables in third position, which is clearly in the wrong direction. Moreover, a two-way mixed ANOVA with language group as a between factor (2 levels: monolingual and bilingual) and syllable position as a within factor (4 levels: first, second, third, fourth) showed no differences between the bilingual and monolingual groups for syllable preservation by position for the French WWWS words, $F(3,99) = 1.548, p > .05$.

Recall that we predicted crosslinguistic influences to be more likely from French to English, due to the greater variety in lexical stress patterns in English. If English WS'WS words were being perceived and treated as French words, we would expect different preservation preferences for the second syllable than if they were treated as English words. For example, if a trochaic bias is operative, a S_2W_3 foot would be preserved preferentially, but if an iambic bias holds, a W_3S_4 foot would be preserved preferentially. A two-way mixed ANOVA with language group as a between factor (2 levels: monolingual and bilingual) and syllable position as a within factor (4 levels: first, second, third, fourth) showed a significant interaction effect, indicating that the monolinguals and bilinguals did not treat WS'WS words in the same way, $F(3,99) = 4.550, p < .005$. Post hoc Fisher LSD comparisons of the between-language group means showed that there was a significant difference between the mean preservation rates for the second syllable between the monolinguals and bilinguals (89% vs. 55%, $t(7) = 4.238, p < .005$). No other interlanguage comparisons between syllable positions were significant.

The greater preservation of the second position syllables by the monolinguals suggests a stronger trochaic bias for this group. Furthermore, post-hoc comparisons from the within-group one-way ANOVA performed above on preservation by position showed that the bilinguals preserved strong syllables in second position and weak syllables in third position equally in WS'WS words, unlike the monolinguals (55% vs. 47%, $t(3) = .89, p > .05$, from Table 4). The absence of relative preference for syllables in second position could indicate the influence of an iambic template bias. Taken together, these results suggest an influence from French in the bilingual children's truncation of WS'WS words, and hence, the presence of crosslinguistic effects.

4. Discussion

The main objective of this study was to contribute to the research on phonological differentiation using an experimental paradigm and larger sample sizes than is typical for research in this area. Did these methods of investigation show that bilingual two-year-olds have two phonological systems? We first consider our findings with respect to trochaic versus iambic biases. For both nonfinal weak syllable preservation patterns in WWWS and WS'WS words and output lengths for SWS'W words, bilinguals and monolinguals performed identically and in line with expected language-specific biases. Thus, both groups of children appeared to be processing and producing the target words according to language-specific phonological principles, beyond the preservation preferences for final and stressed syllables, which are expected to be universal crosslinguistically. In contrast, the results of the quantity-sensitivity analyses are more equivocal. Monolinguals and bilinguals in French behaved in the predicted language-specific fashion with respect to heavy versus light weak syllable preservation. However, the two groups differed in their treatment of initial syllables in English. The bilingual children did not differentially preserve heavy initial syllables and thus did not demonstrate quantity sensitivity, a language-specific property. Perhaps the performance in English is not as reliable because stress and weight are confounded factors and it may be impossible to obtain a true window on quantity sensitivity alone with this kind of task (see also Turk, Jusczyk, & Gerken, 1995). However, there is a possibility that these findings do indicate true monolingual-bilingual differences, and furthermore suggest a crossover influence from French to English. The bilingual children may not have attended to heavy syllables to the same degree as the monolinguals because they were acquiring a quantity-insensitive language in tandem with English. If the latter interpretation is correct, then this constitutes an area of nonautonomy between the two systems that is not predicted by a structural ambiguity account.

Even though the preponderance of evidence is consistent with the conclusion that these bilingual children have differentiated phonological systems, their separate systems do not appear to be autonomous. In addition to one interpretation of the weight analyses, our planned comparison of interlinguistic structurally ambiguous words also suggests nonautonomy. As predicted, English WS'WS words appeared to be a source of difference in truncation patterns between monolinguals and bilinguals, while other word types, French WWWS and English SWS'W words, did not. Furthermore, the particular difference in the patterns, namely the differential preservation of the second and third syllables, is in line with the expected crosslinguistic effects of trochaic versus iambic biases, and in the right direction, from French to English.

As such, these findings appear to parallel those for crosslinguistic effects in syntax as found in Döpke (1998). But, before we firmly conclude these results to support Döpke's (1998) account, we should consider two important limiting factors. First, the absence of different word rhythm patterns in the French stimuli, even if these are marginal in the language, would need to be presented to the children in order to be certain about directionality of influence. As shown by Hulk and van der Linden (1996, 1998), it is possible that even marginal patterns might activate crosslinguistic influences. Second, it would be important to consider the impact of individual language dominance on the direction of crosslinguistic effects. It is possible that individual dominance, rather than between-

language asymmetries in lexical stress variety, determines the direction of crossover influence.

As mentioned in the *Method* section, we assigned a dominant language to each child for the purposes of counterbalancing stimuli set presentation, and to ensure a nearly equal number of English and French dominant children in the bilingual group. Thus, because dominance was not intended to be a factor in our main analyses, we used a rather informal criterion for dominance determination. Nonetheless, as a post-hoc consideration, we looked at the possible influence of dominance, as measured by our informal criterion, on the children's treatment of the English WS'WS words. This examination was motivated by the equal preference of second and third syllables in preservation. We wished to know if *each* child was vacillating between treating these words as French or English, or whether this was the result of a *split* in the group where half the children were treating these words as French, and the other half as English.

In order to investigate this possibility, the preservation scores for syllables in second and third position for WS'WS words were divided into English-dominant and French-dominant groups. Balanced bilinguals were excluded. The results of this recalculation support the possibility of a dominance effect. English-dominant bilinguals preserved syllable two 64% of the time and syllable three 41% of the time. The French-dominant bilinguals showed the opposite trend: 36% of syllables in second position were preserved while 57% of syllables in third position were preserved. Thus, the French-dominant group appears to have shown a stronger tendency to treat English WS'WS words like French words. Therefore, it is possible that dominance, and not differences in between-language lexical stress variety, could be responsible for the directionality of crosslinguistic effects in these structurally ambiguous forms. This post-hoc analysis points to the importance of including dominance as an a priori factor in future investigations of crosslinguistic effects.

In conclusion, the results of this study suggest that language-specific prosodic sensitivities are apparent in the phonological production of bilingual two-year-olds, and thus indicate that bilingual children of this age can have differentiated phonological systems. However, because their truncation patterns were not identical to those of monolinguals on all measures considered, it cannot be concluded that their phonological systems are entirely autonomous. The crosslinguistic effects evident in the bilingual children's truncation patterns seem to appear at points of interlanguage structural ambiguity. The directionality of these effects could be influenced by between-language asymmetries in lexical stress variety, or by the children's language dominance. The restricted nature of the crosslinguistic effects further supports the claim that the children indeed have two phonological representations, as more random interference would be expected from a unified store. However, these conclusions could be strengthened by further studies employing a wider range and number of stimuli as well as a more direct consideration of the effects of language dominance in the study design.

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