The Acquisition of English Lexical Stress by Cantonese-English Bilingual Children at 2;06 and 3;0

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Abstract

This study investigates the acquisition of English lexical stress by simultaneous Cantonese-English bilingual children at the age of 2;06 and 3;0 respectively, comparing them with the English monolingual peers. Research on early bilingual phonological acquisition often focuses on segmental level. Few studies are available when it concerns prosodic features, especially in children speaking non-Indo-European languages. This study examines an important prosodic feature, lexical stress, in Cantonese-English bilingual children. The results showed that there is delayed acquisition of English lexical stress among the bilingual children, as reflected in less contrastive syllable duration and peak F0, possibly due to a lack of lexical stress in Cantonese, a typical syllable-timed language. This study helps to understand the bilingual interaction of two distinctive prosodic systems, and broaden our knowledge about early bilingual prosodic development.

Index Terms: lexical stress, Cantonese, English, bilingual acquisition

1. Introduction

Lexical stress (word stress) is the stress placed on a given syllable, and the assignment of lexical stress in words is language-specific. For example, in languages like Czech and Finnish, stress is always assigned on the first syllable of a word; while in some other languages like English and Russian, the position of stress in a word is less predictable. In English, there are two main types of stress patterns in English: trochaic and iambic [1]. Trochaic word refers to a disyllabic word with stressed-unstressed pattern (e.g. baby); iambic word refers to an unstressed-stressed pattern (e.g. behind). The acoustic correlates of lexical stress in English have been examined extensively ([4][7][11][12]). Most of these studies focused on minimal pairs, in which the placement of stress determines whether the word is a noun or a verb. The results consistently indicate that within a lexical word, the stressed syllable has higher fundamental frequency (F0), longer syllable duration, and greater intensity than the unstressed syllable. Besides, vowel quality has also been considered as an important acoustic correlate of English lexical stress, and failure in reducing vowels in unstressed syllable contributes to non-native accent ([10][14][24]).

Previous studies suggested that English-speaking children's early acquisition of lexical stress involves enlarging the stress-unstressed ratios in all acoustic correlates (F0, syllable duration and intensity), especially by reducing the unstressed syllable duration but maintaining the stressed syllable duration ([1][8][19][21]). An equally important question is how bilingual children at a young age acquire lexical stress. However, there is a dearth of empirical data in this line of research. Most previous studies focused on preference of word truncation by bilingual children ([18][20][22]). For example, [18] conducted a nonsense-word repetition task in French-English bilingual children. English and French contrast in that the majority of English words have a trochaic rhythm while French words have an iambic rhythm. [18] found that the English-dominant bilinguals tend to preserve trochaic pattern and the French-dominant bilinguals tend to preserve iambic pattern, indicating cross-linguistic effects and the prominent influence of language dominance on the directionality of the effects. In contrast, based on an English-French bilingual child's speech, [20] found no evidence for trochaic bias in the data. By far, few studies have used an acoustic approach to investigate prosodic development in young bilingual children, especially before the age of three. Mok ([16] [17]) investigated the acquisition of speech rhythm in Cantonese-English bilingual children at the age of 2;06 and 3;0. She found that the bilinguals displayed less variable syllable duration and less vowel reduction in unstressed syllables, compared with their English monolingual peers. Contrastive syllable duration and vowel reduction are important indicators for lexical stress, too. Therefore, Mok's studies ([16][17]) provide insights into the present study that cross linguistic effects in the acquisition of lexical stress in Cantonese-English bilingual children can also be found.

Unlike English, Cantonese does not make use of lexical stress, and neither has it phonological vowel reduction. As a tone language, F0 in Cantonese is primarily used to differentiate lexical meaning. Additionally, Cantonese is a typical syllable-timed language ([15]). It is thus worth investigating whether the different experience with F0, syllable duration and vowel quality in Cantonese would influence the acquisition of English lexical stress in simultaneous Cantonese-English bilingual children. Given that the period between age 2;0 and 3;0 is an important stage for children's prosodic and lexical development, the present study examines the acoustic correlates (F0 and syllable duration) of lexical stress in Cantonese-English bilingual children and in English monolingual children at 2;06 and 3;0 respectively.

2. Method

2.1. Subjects

Based on the age of the children, there are two groups of data: 2;06 and 3;0. In the 2;06 group, there are seven simultaneous Cantonese-English bilingual children and five English monolingual children; in the 3;0 group, there are eight bilingual children and six monolingual children. The bilingual children all came from the YipMathews corpus in CHILDES (http://childes.psy.cmu.edu/media/Biling/YipMatthews/). Yip and Matthews [23] gave detailed introduction to the background of the children. The data of monolingual children came from various sources, which will be introduced in the following sections.

Table 1. *Background information of the bilingual children.*

Child	Input languages	Sex	Language dominance	Age range for data used	
				2;06	3;0
B1	BrE/Cantonese	M	Cantonese	2;5.12-2;7.07	2;11.12-3;1.13
B2	BrE/Cantonese	F	Cantonese	2;5.16-2;7.01	2;11.05-3;0.09
B3	BrE/Cantonese	F	Cantonese	2;6.02-2;7.28	2;11.19-3;0.24
B4	BrE/Cantonese	F	Cantonese	---------	2;11.27-3;0.18
B5	BrE/Cantonese	F	English	2;5.19-2;6.16	2;10.29-3;0.03
B6	BrE/Cantonese	M	Cantonese	2;6.20-2;7.04	2;11.29-3;0.27
B7	HKE/Cantonese	M	Cantonese	2;5.05-2;7.00	2;11.05-3;0.03
B8	HKE/Cantonese	M	Cantonese	2;4.29-2;7.24	2;10.03-3;2.03

2.1.1. Bilingual children

Table 1 shows the background information of the bilingual children. Six of them, B1, B2, B3, B4, B5 and B6, were exposed to Cantonese and English from birth and grew up in a 'one parent one language' environment, with one parent being a native speaker of British English and the other a native speaker of Cantonese. The other two children, B7 and B8, grew up in Hong Kong families and were exposed to Hong Kong English and Cantonese from birth. Except for B5, all the other children were Cantonese dominant.

2.1.2. Monolingual children

Table 2 shows the background information of the monolingual children. Their parents are all British English native speaker.

Table 2. *Background information of the monolingual children.*

Child	Input Languages	Sex	Age of recordings	
			2;06	3;0
M1	British English	F	2;5-2;7	2;11
M2	British English	F	---	3;1
M3	British English	F	2;7.01	3;1
M4	British English	M	2;7.01	3;0
M5	British English	M	---	3;0
M6	British English	F	2;5-2;6	---
M7	British English	M	2;6.00-2;6.22	3;0

Data of M1 and M7 came from the Forrester corpus ([6]) and the Thomas corpus ([13]) in CHILDES respectively. M1's natural conversations were recorded and all participants involved in the dialogues were British, white, and middle class. M7 was born in a middle class family and he was primarily cared for by his mother. The frequency of data between 2;00,12 and 3;00,12 is very intensive, and during this period, M7 was recorded for one hour each time, five times a week, every week for the entire period. Two of the English speaking children M2 and M5 were recruited in an English-medium kindergarten in Hong Kong for children from expatriate families. The other two English children M3 and M4 were twins from an expatriate family living in Hong Kong.

2.2. Materials

Disyllabic words of both trochaic (strong-weak) and iambic (weak-strong) patterns were used. We have gone through every video/audio recording, extracted the target words, and saved them as .wav files for acoustic analyses. The quality of some recordings was not very good, so we only used interpretable utterances that have clear formant structure in the spectrogram. To exclude excessive initial F0 raising and duration shortening, as well as final lengthening and lowering, we only chose disyllabic words in sentence-medial position, which means the target word together with the preceding word and the following word all come from the same intonational phrase. We also excluded words with excessive stress on one of the syllables. For example, in many cases, the child was shouting, singing, crying or arguing with his/her siblings. Utterances produced under such occasions were not used. Since corpus data were used, there may be segmental and sentential context effects that affect the acoustic properties of the targets words, but this is unavoidable.

The number of the extracted utterances varies from child to child, but it does not affect the overall results because the F0 ratios and duration ratios were averaged across all the tokens from the same child. We use stressed/unstressed ratios for cross group comparison because ratios can demonstrate how contrastive the stress pattern is, and more importantly, they normalize the data for individual variation. We obtained many more trochaic words than iambic words. The imbalance of the two types of disyllabic words can be explained by the fact that there are many more trochaic words than iambic words in English ([9]).

2.3. Measurements

Each disyllabic word was labeled, and the syllable duration and peak F0 of the vowel of each syllable were measured with Praat ([3]).

When measuring syllable duration, if the word begins or ends with a stop, then the closure phase of the stop would be excluded because there is no reliable cue for marking it ([14][16]). Each disyllabic word was segmented into two syllables, and word-medial consonants were segmented based on the maximal onset principle. For example, the /p/ in 'paper' was treated as the onset of the second syllable. Peak F0, which is the highest point on the F0 contour of the vowel, was automatically tracked by Praat. After the values of syllable duration and syllable peak F0 of all the disyllabic words had been measured, stressed-/unstressed-syllable ratios were calculated, and then they were averaged across tokens for each child.

3. Results

3.1. Children at 2;06

The stressed/unstressed ratios of syllable duration in trochaic words for the 2;06 years old bilingual and monolingual children are shown in Table 3. Calculating ratio means the value of the stressed syllable duration is divided by the value of the unstressed syllable duration. Therefore, a value >1 means that the stressed syllable duration is longer than the unstressed syllable duration (as expected), and vice versa.

It can be seen that for trochaic words, the stressed and unstressed syllable duration ratios are comparable across the bilingual children, hovering around 1. In contrary, the stressed syllable durations are consistently higher than the unstressed syllable durations within the same disyllabic words for monolingual children. An independent-samples t-test was conducted to compare the ratios in the bilinguals and the monolinguals. There was a significant difference in stressed and unstressed syllable duration ratios between the bilinguals and the monolinguals [$t(10) = -5.50$, $p<0.01$]. The results showed that the difference between stressed and unstressed syllable duration is larger in monolingual than bilingual children.

Table 3. *Syllable duration ratios (s.d.) for bilingual children: 2;06.*

Bilinguals	Duration ratio	Monolinguals	Duration ratio
B1	1.12(0.42)	M1	1.35(0.24)
B2	1.19(0.36)	M3	1.64(0.35)
B3	0.94(0.32)	M4	1.57(0.48)
B5	0.93(0.21)	M6	1.65(0.57)
B6	1.08(0.28)	M7	1.25(0.31)
B7	1.01(0.30)	---	---
B8	1.09(0.23)	---	---
Mean	1.05(0.10)	Mean	1.49(0.18)

Table 4. *Peak F0 ratios (s.d.) for bilingual children: 2;06.*

Bilinguals	Peak F0 ratio	Monolinguals	Peak F0 ratio
B1	1.03(0.10)	M1	1.75(0.18)
B2	1.00(0.04)	M3	1.04(0.05)
B3	1.24(0.69)	M4	1.17(0.42)
B5	1.15(0.19)	M6	1.15(0.25)
B6	1.04(0.06)	M7	1.04(0.19)
B7	1.08(0.44)	---	---
B8	1.02(0.03)	---	---
Mean	1.08(0.09)	Mean	1.23(0.30)

The stressed/unstressed ratios of peak F0 in trochaic words for all the children are listed in Table 4 and the data show more individual variation. Among the bilingual children, B3 (1.24) had a larger difference in peak F0 between stressed and unstressed syllables, while the others had comparable stressed and unstressed peak F0, hovering around 1. The monolinguals did not show as distinct a stress pattern in peak F0 as they did in syllable duration, e.g., M1 having very contrastive peak F0 (1.75) while M7 showing similar F0 peaks (1.04). Overall, in terms of peak F0, the monolingual children did not show more distinct pattern than the bilingual children. Independent t-test confirmed that the difference between the bilinguals and the monolinguals was not significant [$t(10) = -1.28$, $p>0.05$].

In the 2;06 age group, iambic words were not analysed because of the lack of data. For example, in all the monolingual speech, only two iambic words were found in M6's utterances.

3.2. Children at 3;0

3.2.1. Trochaic words

The stressed/unstressed ratios of syllable duration of trochaic words for the bilingual and monolingual children at the age of 3;0 are shown in Table 5.

Table 5. *Syllable duration ratios (s.d.) for bilingual children: 3;0.*

Bilinguals	Duration ratio	Monolinguals	Duration ratio
B1	1.02(0.26)	M1	1.71(0.30)
B2	1.15(0.28)	M2	1.60(0.52)
B3	1.15(0.31)	M3	1.98(0.71)
B4	1.02(0.23)	M4	1.67(0.52)
B5	1.06(0.40)	M5	1.63(0.38)
B6	0.99(0.46)	M7	1.69(0.63)
B7	1.32(0.51)	---	---
B8	0.99(0.30)	---	---
Mean	1.09(0.11)	Mean	1.71(0.14)

Table 6. *Peak F0 ratios (s.d.) for bilingual children: 3;0.*

Bilinguals	Peak F0 ratio	Monolinguals	Peak F0 ratio
B1	0.99(0.12)	M1	1.17(0.24)
B2	0.99(0.15)	M2	1.26(0.66)
B3	1.14(0.40)	M3	0.97(0.19)
B4	1.08(0.13)	M4	1.10(0.24)
B5	1.09(0.23)	M5	1.23(0.37)
B6	1.01(0.12)	M7	1.15(0.40)
B7	1.07(0.36)	---	---
B8	1.13(0.24)	---	---
Mean	1.06(0.06)	Mean	1.15(0.10)

It can be seen that the stressed-unstressed syllable duration ratios are comparable among bilingual children. Although B7 (1.32) appears to have more distinct stress pattern than the other bilingual children, his duration ratio is still lower than the lowest value for monolingual children (M2: 1.60). On the other hand, the stressed/unstressed ratios of syllable duration in monolingual children are consistently higher than those in the bilingual children, suggesting that the monolinguals have more contrastive stressed/unstressed syllable durations than the bilinguals. An independent-samples t-test confirms the significant difference in stressed and unstressed syllable duration ratios between the bilinguals and

the monolinguals [t(12) = -9.48, p<0.01]. The results showed that the difference between stressed and unstressed syllable duration is larger in monolingual than bilingual children at the age of 3;0.

The stressed/unstressed ratios of peak F0 in trochaic words for all the bilingual and monolingual children are listed in Table 6. The values are comparable across the bilingual children, and the condition is similar for the monolingual children, except that M2 (1.26) and M5 (1.23) seem to have more contrastive stressed/unstressed peak F0. Independent t-test indicated no significant difference between the bilingual group and the monolingual group in terms of ratios of peak F0 [t(12) = -1.93, p>0.05].

3.2.2. Iambic words

The number of iambic words in the 3;0 group is also very limited. All the iambic words are listed in Table 7, and the value in bracket is the number of tokens obtained from all the utterances of all the children.

Table 7. *Iambic words: 3;0.*

Bilingual		Monolingual
about (3)	*behind* (1)	*about* (6)
alright (1)	*cannot* (1)	*again* (1)
around (1)	*forgot* (2)	*around* (2)
away (2)	*Michelle* (3)	*because* (1)
because (6)	*upstairs* (1)	*behind* (1)

It can be seen in Table 7 that the majority of the iambic words are function words. Given the small number of them, no statistics can be used to compare the stressed/unstressed ratios in terms of peak F0 and syllable duration between the two groups of children. Nevertheless, the average stressed/unstressed syllable duration ratio is much larger in the monolinguals (2.72) than that in the bilinguals (1.55); while the average ratios in peak F0 are comparable across the two groups (monolingual: 1.18; bilingual: 1.13). The observed patterns of iambic words confirm the findings in trochaic words very well that monolingual children displayed more distinct stress pattern than the bilingual children did, demonstrated by more contrastive syllable duration. It is interesting to note that, the bilinguals seem to perform better in contrasting stressed syllable duration from unstressed syllable duration in iambic words than in trochaic words. It is possible that because the iambic function words are more frequently heard in the input language, and so acquired better by the bilingual children.

3.3. Cross-age comparison

Besides cross language comparisons, cross age comparisons were also carried out within each group of children. For instance, paired sample t-test were conducted to compare the stressed and unstressed syllable duration ratios in the monolingual children at 2;06 and that in the same children at 3;0. The results show that the stressed and unstressed syllable durations are more contrastive in the monolinguals at 3;0 (M = 1.76, SD = 0.14) than at 2;06 (M = 1.45, SD = 0.18), with a significant difference [t(3) = -4.2, p<0.01]. Interestingly, this was the only significant result in all the cross age comparisons. It suggested that English monolingual children were enlarging the contrast between the stressed and unstressed syllable durations between 2;06 and 3;0, but the development of syllable durational contrast is much slower in Cantonese-English bilingual children.

4. Discussion

This study aims to investigate whether the linguistic experience of Cantonese would affect the acquisition of English lexical stress in simultaneous Cantonese-English bilingual children. Data of eight Cantonese-English bilingual children and six English monolingual children were used, including two ages: 2;06 and 3;0.

In both age groups, monolingual children displayed more contrastive syllable duration than the bilingual children did in disyllabic words, and the difference is significant. Both monolingual and bilingual children have comparable stressed and unstressed syllable peak F0. It was expected that Cantonese-English bilingual children would use F0 to contrast stressed/unstressed syllable better than the monolinguals, since they have more experience with F0 variation in Cantonese. However, the finding that even English monolingual children did not contrast stressed/unstressed peak F0 suggests that, syllable duration, rather than peak F0, is the primary cue to distinguish stressed syllable from unstressed syllable by children, at least before the age of 3;0. Unlike the monolingual children, the Cantonese-English bilingual children do not show clear stress pattern in either of the acoustic correlates, and they have less reduction in unstressed syllable duration. Besides, cross age group comparison indicated the development of English lexical stress pattern is much slower in the Cantonese-English bilingual children between the age of 2;06 and 3;0, when they are compared with the English monolingual children.

The results confirm our prediction, and the delayed development of lexical stress is possibly due to the fact that Cantonese lacks lexical stress and phonological reduction. Lack of durational variation in Cantonese has affected the acquisition of durational contrast in English. But the finding that both bilinguals and monolinguals have comparable stressed and unstressed peak F0 suggests that, first, F0 is not the primary cue for lexical stress contrast in children by the age of 3;0; second, though the bilingual children have more intricate use of F0 in Cantonese tones, they had not applied it in contrasting English lexical stress.

Further investigation is still required to examine whether and when the bilingual children can catch up with the English monolingual children and acquire adult-like lexical stress pattern.

5. Conclusions

The results of the current study have broadened our knowledge about early bilingual acquisition of lexical stress from several aspects. Firstly, for English monolingual children before the age of three, syllable duration, rather than F0, is the primary cue for lexical stress contrast. Secondly, Cantonese-English bilingual children have a delay in developing syllable durational contrast for clear lexical stress pattern. The delayed development is possibly due to the fact that Cantonese, as a typical syllable-timed language, lacks lexical stress, and the experience with less variable syllable duration causes negative cross-linguistic effects.

6. References

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