

Acquisition of Fricative Contrasts in Children Enrolled in a Mandarin-English Bilingual Education Program



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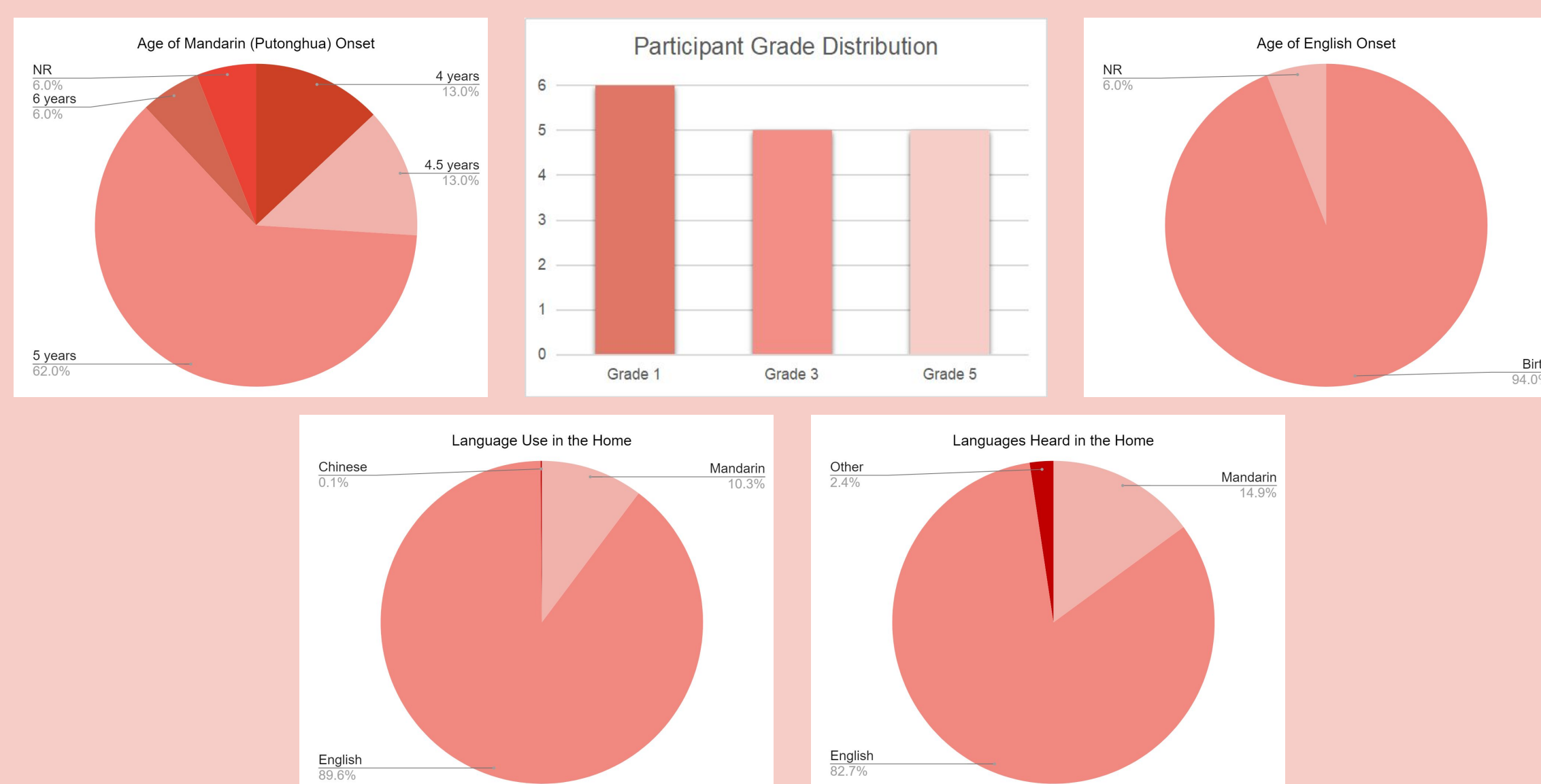
Introduction

- Mandarin is increasingly prevalent in Canada (Statistics Canada, 2011).
- Second language proficiency plays a role in academic and career success (Bayliss, 2004; Whiteside, Gooch, & Norbury, 2017).
- Research into the nature of sequential bilingualism is lacking. While some research suggests that bilingual children acquire languages with similar developmental trajectories to monolingual children (Grunwell, 1982; Major, 2001), others have argued that properties of the first language (L1) are transferred to second language (L2) (Anderson, 2004; Yang & Fox, 2017).
- This study is part of a larger, ongoing project that aims to develop a profile of children learning Standard Mandarin as L2 in the Edmonton Public Schools Chinese (Mandarin) Bilingual Program.
- Findings from this study will help to elucidate fricative development in English and Mandarin. English demonstrates a 2-way fricative contrast (alveolar, post-alveolar), whereas Mandarin possesses a 3-way contrast (alveolar, palatal, retroflex).
- Our findings will help explain cross-language interactions during second-language acquisition, such as the mis-categorization of non-native phonemes during L2 acquisition (Iverson et al., 2003).
- Data collected may be used to improve instructional methods in bilingual programs, allowing for better educational outcomes.

Methods

Participants:

- 16 English-speaking children (7F, 9M) learning Mandarin sequentially
 - Eligibility criteria: Test of Non-verbal Intelligence (TONI-4) and normal hearing by administration of a pure tone screening



Word Elicitation Task:

- Goldman-Fristoe Test of Articulation 3 (Goldman & Fristoe, 2015) and a Mandarin equivalent (adapted from Zhao & Bernhardt, 2012)

| English Word Elicitation Task | /s/ | /ʃ/ | Mandarin Word Elicitation Task | /s/ | /ɛ/ | /ʃ/ |
|-------------------------------|--------|--------|--------------------------------|--|------------|--|
| soap | [sɒp] | shoe | three | [sən ⁵⁵] | watermelon | [sən ⁵⁵] |
| seven | [sɛvn] | shovel | sweep the floor | [səi ⁵⁵ kwa ⁵⁵] | panda | [səi ⁵⁵ kwə ⁵⁵] |
| | | | | [sau ²¹ h ⁵¹] | hand | [sau ²¹] |

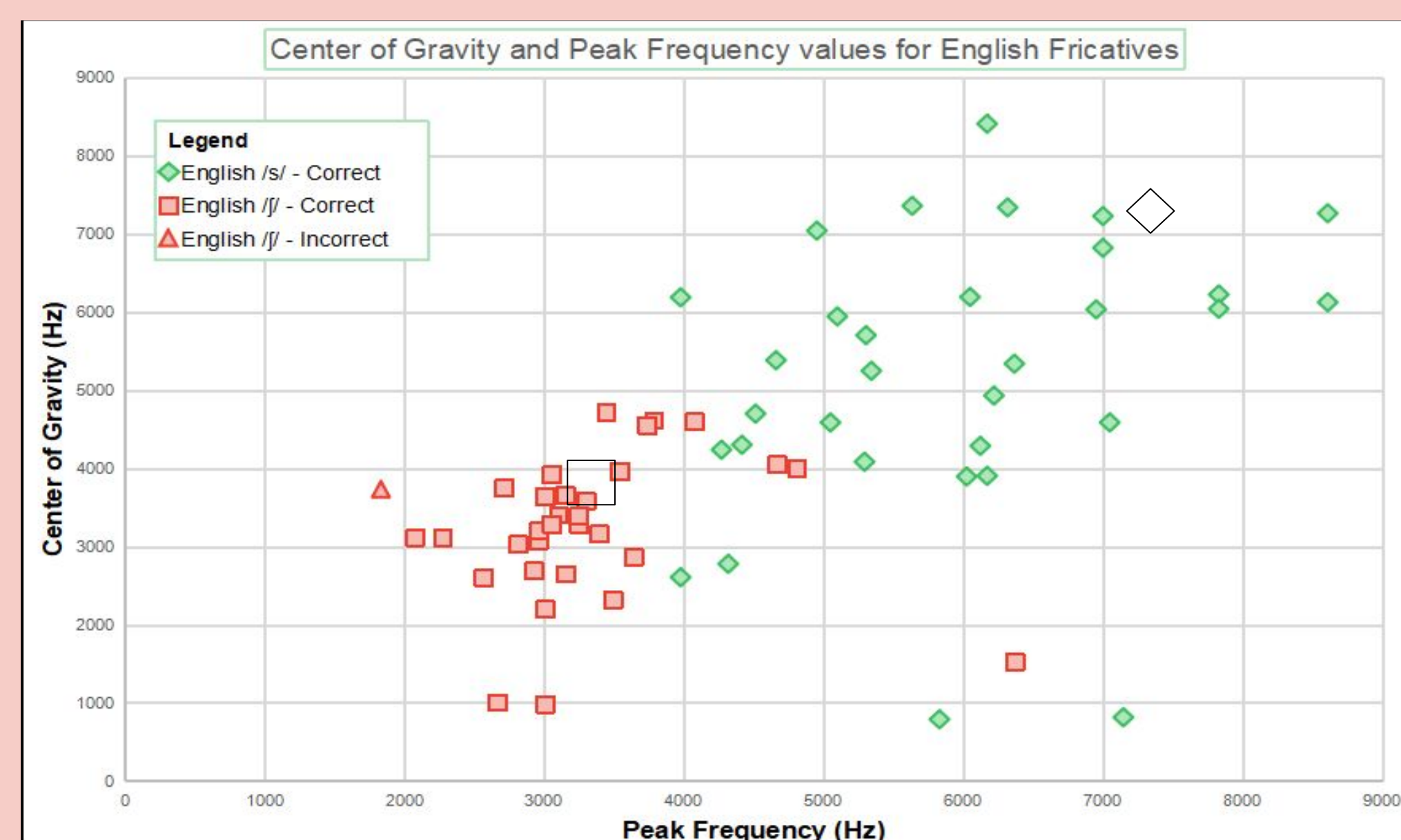
Analysis:

- Phonetic transcription: Phon, native speakers of Mandarin (2) and English (4)
- Acoustic analysis: Praat, for Center of Gravity (Hz) and Peak Frequency (Hz)
- Perceptual analysis: Judged as incorrect or correct productions by native speakers of Mandarin (2) and English (4)
- Interrater reliability for English was 97.70% (blind) and Mandarin 98.46% (side-by-side)

Research Question

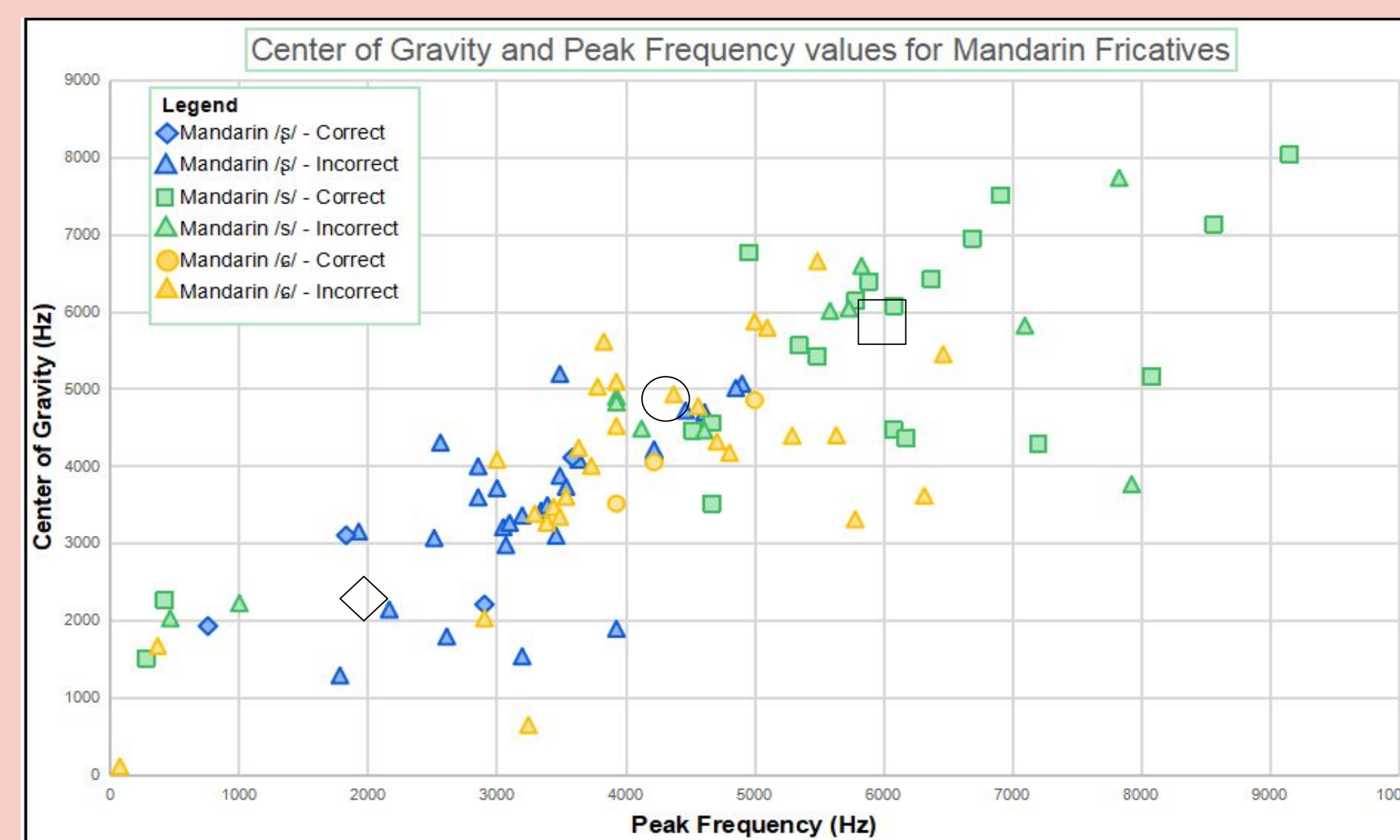
Do children learning Mandarin sequentially in a Mandarin-English Bilingual Program develop a 3-way fricative contrast in Mandarin (i.e., /s/, /ɛ/, /ʃ/)?

Results



Significant difference in peak frequency (Hz) in /s/ (M = 5900.3, SD = 1077.4) and peak frequency (Hz) in /ʃ/ (M = 3282.2, SD = 599.7); $t(15) = 11.4, p = 0.000$
 Significant difference in center of gravity (Hz) in /s/ (M = 5209.7, SD = 1444.2) and center of gravity (Hz) in /ʃ/ (M = 3374.3, SD = 694.4); $t(14) = 4.7, p = 0.000$.

For the English fricatives, a paired-samples t-test was conducted to compare peak frequency (Hz) and center of gravity (Hz) in /s/ and /ʃ/. In English, participants produced a 2-way fricative contrast between /s/ and /ʃ/.



Significant difference in peak frequency (Hz) in /s/ (M = 5702.7, SE = 403.1), /ʃ/ (M = 3254.0, SE = 146.5), and /ɛ/ (M = 4197.2, SE = 205.5); $F(2, 28) = 27.994, p = 0.000$.
 Significant difference in center of gravity (Hz) in /s/ (M = 5186.9, SE = 320.8), /ʃ/ (M = 3416.4, SE = 209.1), and /ɛ/ (M = 4146.6, SE = 228.3); $F(2, 30) = 12.084, p = 0.000$.

For the Mandarin fricatives, a one-way repeated measures ANOVA was conducted to compare peak frequency (Hz) and center of gravity (Hz) in /s/, /ɛ/, and /ʃ/. In Mandarin, participants produced a 3-way fricative contrast between /s/, /ɛ/, and /ʃ/.

| Language | Fricative | % Correct | Perceptual Analysis |
|----------|-----------|-----------|---|
| English | s | 100 | |
| | ʃ | 96.9 | ʃ (1) |
| Mandarin | ʃ | 12.5 | ʃ (24), ʃ ^h (2), ʃ ^w (2) |
| | s | 62.5 | s̥ (7), s ^l (3), s ^l (1), ts ^h (1) |
| | ɛ | 12.5 | ʃ (10), s ^l (7), ɛ (4), s (2), ʃ ^h (2), s̥ (1), ts ^h (1), ɛ ^w (1) |

The majority of perceptual errors were phoneme substitutions, along with dentalizations, fronting, palatalizations, gliding, depalatalizations, & affrication.

Perceptual error-analysis indicated that participants had the most difficulty with productions of /ʃ/ and /ɛ/.

Discussion

- Our participants demonstrate a distinct, 3-way fricative contrast albeit with acoustic and perceptual variations that differ from native monolingual Mandarin speakers.
- Fricative productions were inaccurate with respect to acoustic measures, but the errors made appear to reflect developmentally appropriate acquisition (Zhu and Dodd, 2000).
- /s/, /ɛ/, and /ʃ/ are later-developing sounds in Mandarin (Lin, 2011). Given that the average onset of Mandarin exposure was 4.8 years of age, it would be expected that more time is needed to refine this contrast.
- Mandarin productions may have been affected by L1 background. Given that language transfer effects are observed in typologically similar languages, influence from L1 English to L2 Mandarin would be expected (Jia, Strange, Collado, & Guan, 2006).
- While the children in this study produced a 3-way contrast in Mandarin based on acoustic measures, phonetic transcriptions by native speakers of Mandarin did not capture these contrasts.
- A limitation of our study was that Mandarin productions were largely elicited through imitation, which may have facilitated productions as well.

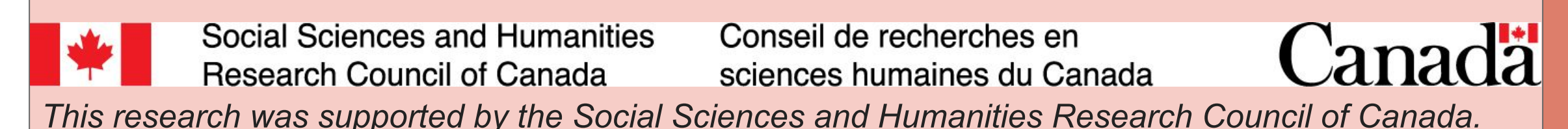
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In memory of Principal Dave Kowalchuk



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