

Investigating the Predictability of an Upcoming Code-switch in Cantonese-English Bilinguals

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Systematic phonetic cues are observable in bilingual speech. For example, code-switched utterances exhibit a number of phonetic variations in the phones approaching a code-switch (Fricke et al., 2016; Olson 2013; Piccinini & Garellek, 2014, Torres Cacoullós, 2020), and bilingual listeners use these cues to aid the processing of an upcoming code-switch (Shen et al., 2020). Although prosodic and segmental features have been shown to vary when approaching a switch, the consistency and relative magnitude of effect for each of these features have not yet been compared. A major goal in this investigation is to give a clearer picture of the gradient nature of bilingual phonetic variation in code-switched utterances. In this investigation, I empirically and computationally explore the phonetic variability in words immediately before a code-switch from English to Cantonese to assess which phonetic features aid more in the acoustic predictability of the upcoming code-switch. The data is taken from the SpiCE Corpus, a corpus of sociolinguistic interviews with Cantonese-English bilinguals (n=34) (Johnson, K. A. et al., 2020). Firstly, vowel qualities (Fricke et al., 2016) are taken from words directly preceding a code-switch. These are then normalized (using ΔF normalization (Johnson, K, 2020; Stanley, 2023)) and compared against their corresponding vowel categories in words not directly preceding the site of a code-switch. Only vowels with primary stress were included in these initial results due to the insufficient quantity of tokens for unstressed vowels and vowels with secondary stress. Secondly, speech rate (Fricke et al., 2016; Piccinini & Garellek, 2014; Torres Cacoullós, 2020) is assessed in words approaching a code-switch, and then, once again, are compared against words not directly preceding the site of a code-switch. Since speech rate is difficult to extract with only one monosyllabic word, the two words directly preceding a code-switch were taken for the code-switching cues group (Feinberg 2022). Only code-switching from English to Cantonese was phonetically analyzed, and acoustic features were only taken from the English words. The aforementioned data on speech rate and vowel quality were submitted to inferential statistical analysis. The results for speech rate mirror what has been found in past literature: when approaching a code-switch speech rate decreases ($p < 0.05$). Figure 1 presents a boxplot showing that the words preceding a code-switch generally have a lower speech rate than words that are not. However, the formant analysis results were less robust. Figure 2 shows the average F1 and F2 values for each vowel along with their code-switch grouping, demonstrating little change in vowel formants apart from “UW”. Observationally, there seems to be some /u/ fronting before a code-switch, however, when fitting a general linear model for F2 change approaching code-switch, no statistical significance was obtained. Lastly, two separate PyTorch neural networks (Paszke et al., 2019) were trained (11 epochs) to assess the usefulness of vowel quality and speech rate in predicting an upcoming code-switch. The test accuracy for vowel quality was 42.31% while the speech rate data showed a 60% accuracy. Overall, the results of this study shed light into the systematicity of bilingual speech, particularly as regards speech rate effects, which neural models suggested as the stronger predictor of upcoming code-switches. Additional speech features should be investigated in order to shed light on potential language-specific cues of code-switching, such as tonal variability given its prominent role in Cantonese. Further iterations of this work will investigate phonetic variability in Cantonese speech preceding a code-switch into English, which were abundant in the corpus, and more importantly, allow for cross-language comparisons between each language preceding a code-switch into the other.

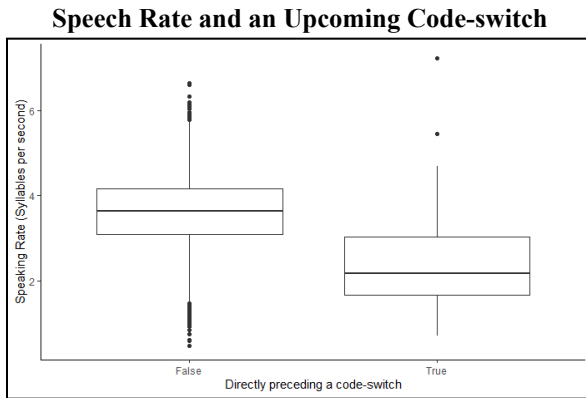


Figure 1: Speech rate values from words approaching a code-switch (right) and those not (left)

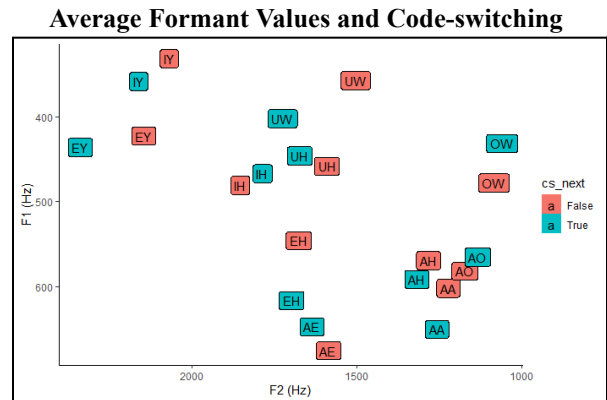


Figure 2: F1 and F2 values of primary stressed vowels, blue = vowels in words directly preceding a code-switch, red = vowels in words not directly preceding a code-switch)

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