Interaction between Prosodic Position and Obstruent Voicing: A Case of English Lettered Word in Wenzhou Wu Chinese

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ABSTRACT

The use of English initialisms (e.g. VIP, henceforth 'English lettered words') in Chinese has increased substantially, with the phonetic form adapted into phonological systems of Chinese languages. Obstruents in Wu Chinese contrast phonologically in voicing, whereas true phonetic voicing is normally found word-medially (similar to English plosives), while in word-initial positions, the voicing contrast of Wu Chinese is realised as a phonation contrast of the following vowel. Given the similarity in prosodic position-dependent realisation of voicing in the two languages, this study focuses on the English lettered words in Wenzhou Wu to investigate whether the phonetic nature varies in prosodic positions as a result of loanword adaptation. The results show that the distribution of true voicing seems to be an effect of the phonetic environment only, regardless of the existence of prosodic boundaries, and the realisation of vowel phonation contrast is dependent on the syllable's position in the prosodic hierarchy.

Keywords: voicing, vowel phonation type, prosodic position, Wu Chinese, loanword adaptation

1. INTRODUCTION

1.1. English lettered words

In modern Chinese languages, the number of words partially or purely consisting of English letters has increased substantially in recent decades [1], and an individual section 'words with letters of Western alphabets' is now included in the authoritative *The Contemporary Chinese Dictionary* [2]. These English lettered words include 1) acronyms, e.g. APEC, Wi-Fi, 2) initialisms, e.g. GDP, ICU, and 3) hybrids of English letters with native Chinese morphemes or numerals, e.g. T *xùshān* ('T-shirt'), PM2.5. This study focused on the latter two types of English lettered words only.

Concerning the phonological form of the English lettered words in Chinese, normally the English pronunciation is used for the letters in initialisms and hybrid lettered words [3]. Though the specific phonetic form of the English letters is likely adapted to the Chinese phonological system – for instance, one of the tones in the inventory would be assigned to each letter – the phonological adaptation is still based on the English pronunciation of the letters for most Chinese languages.

However, Wenzhou Wu is a special case among Chinese languages in that the phonetic form of English letters is not merely the adapted form pronounced in accented English. Instead, our pilot investigation showed that there were a set of localised pronunciations. As in the examples of letters pronounced with the /iː/ vowel in English such as B, D, P, T, they are pronounced with a diphthong /ei/ instead, although /bi/, /di/, /pʰi/ and /tʰi/ are all well-formed syllables in Wenzhou Wu. It may have resulted from historical reasons as a vowel shift of /i/ to /ei/ could be observed comparing the current vowel inventory with the documentation in the first Wenzhou Wu textbook in English, *Introduction to the Wênchow Dialect* published in 1893 [4, 5]. Given that the Romanised script of Wenzhou Wu invented by Christian missionaries was widely used in Wenzhou, it could be inferred that the English letters had been localised since then and were treated equally as native Chinese lexical items in sound change in the past century.

1.2. Prosodic position and voicing realisation

Wu Chinese still preserves the voicing contrast of obstruents in syllable-initial position phonologically, which has been lost in almost all other Chinese languages. However, recent phonetic research on some dialects of Wu Chinese such as Suzhou and Shanghai Wu found that the phonologically defined 'voiced' obstruents are only phonetically voiced in intervocalic positions, while in initial positions the contrast is realised as different phonation types of the following vowels – breathy vowel after phonologically voiced consonants and modal vowel after phonologically voiceless ones, while this vowel phonation contrast does not exist in intervocalic positions [6, 7, 8]. Described as 'intervocalic position' in the literature, only word-medial obstruents were investigated and potential phonetic effects of prosodic hierarchy were usually ignored. A previous study on native Wenzhou words shows a significant age-dependent variation, and the phonetic

realisation of voicing in other Wu dialects mentioned above is applicable for the younger speakers, while the vowel phonation feature may not be consistently observed in the elders' speech [9].

As for English plosives, it is well acknowledged that prevoicing is uncommon in initial position and voicing seems to have little perceptual importance, while the phonetic voicing contrast exists more consistently in medial position [10, 11, 12]. Since there is no vowel phonation contrast like that in Wu Chinese in English, the English 'voiced' plosives followed by a modal vowel in initial position are phonetically highly similar to the Wu syllables beginning with voiceless unaspirated plosives. Given the similarity and difference mentioned above in prosodic position-dependent realisation of voicing in the two languages, it is interesting to investigate how the phonetic realisation of phonological voicing is adapted in language contact. The current study does not limit the 'intervocalic' position to prosodic word level, but includes larger prosodic units to examine the phonetic nature of obstruent voicing in English lettered words in Wenzhou Wu occurring in various prosodic positions.

2. METHOD

2.1. Participants

Since the prosodic position-sensitive realisation of voicing mentioned above seems either unstable or inconsistent among older speakers, only younger speakers were recruited for the current study [9]. Six native speakers (3 male and 3 female) aged 27 to 30 years old participated in the experiment. All participants were Wu-Mandarin simultaneous bilingual speakers born, raised and now live in Wenzhou downtown. The parents of the informants were also all native speakers and Wenzhou Wu is the only language used in the family.

2.2. Prosodic phrasing and experiment stimuli

The current study examined the obstruent voicing in four different prosodic positions in English lettered words as follows, and all positions are exemplified in Table 1.

2.2.1. Absolute initial position

The English lettered words in the absolute initial position (with preceding silence), which could reflect the adapted phonological form of English letters in isolation in Wenzhou Wu, were included and the parameters extracted from the absolute initial (#initial) position could serve as a baseline for comparison with other prosodic positions.

Among the 26 English letters in Wenzhou Wu pronunciation, the eligible candidates for this study with a phonologically voiced obstruent initial include B /bei^{31}/, D /dei^{31}/, G /dʑi^{31}/, J /dʑei^{31}/, V /vei^{31}/ or /ʋei^{44}/ and Z /zei^{31}/. As there is no English lettered word found with an initial J or Z, and the initial consonant of V seems to fluctuate between fricative and approximant, only the three letters, B, D and G, were involved in forming stimuli for the experiment. In other word, this study focused on two phonologically voiced plosives and one affricate.

2.2.2. Prosodic word-medial position

As mentioned above, according to previous research on Wu voicing contrast, the phonological voicing contrast is realised as true phonetic voicing in this position. For Wu Chinese speakers, prosodic word is a prominent unit in their intuition because of its role as the bearing unit of lexical sandhi tones [13]. Some phonologists also proposed that the lexicalisation of short syntactic phrases in Wu Chinese is phonologically marked by the assignment of lexical sandhi tone [14]. The English lettered words, as one single lexical sandhi domain, with B, D, G at medial position were hence included as a part of the stimuli.

2.2.3. Prosodic phrase-medial / word-initial position

Prosodic phrase in Wenzhou Wu is also a prosodic unit with transparent phonological marker proposed as 'phrasal tone sandhi' or 'tone neutralisation' in different phonological analyses [14, 15, 16]. Verb-object constructions are normally typical prosodic phrases with the monosyllabic verb reduced to zero (atonic). This type of experiment stimuli was hence formed by simply combining a monosyllabic verb and the stimuli used for #initial position to form verb-object constructions.

2.2.4. Prosodic phrase-initial position

To form the experiment stimuli for intervocalic prosodic phrase-initial position, the aforementioned stimuli for #initial position were embedded in a carrier sentence 'ŋ^{24} tse^{42} dɤu^{0} i^{0} pi^{42} __ (I read once again __)'. In this case, neither lexical nor phrasal tone sandhi is possible to be applied across the prosodic boundary between 'i^{0} pi^{42} (once)' and the targeted syllable, that is, the targeted syllable cannot be prosodically connected to the preceding word.

2.2.5. Experiment design

In summary, the stimuli used for the current study included three English letters, B /bei^{31}/, D /dei^{31}/ and

G /dʑi^{31}/, in four prosodic positions, and there were two tokens for each letter in each prosodic condition, i.e., 24 unique tokens in total. The participants were asked to read the experiment stimuli shown in a random order twice. Simultaneous acoustic and elctroglottography (EGG) signals were recorded using Glottal Enterprises EG2-PCX EGG.

#Initial	**B**RT (bus rapid transit), **D**VD, **G**DP
PW-medial	A**B**C (‘basic facts’), 3**D** (film), 4**G**
PP-medial	ma^{0} **D**VD (‘to buy a DVD’)
PP-initial	ŋ^{24} tse^{42} dɤu^{0} i^{0} pi^{42} **B**RT (‘I read BRT once again’)

Table 1: Examples of experiment stimuli (‘PW’ for prosodic word; ‘PP’ for prosodic phrase).

2.3. Parameters and data processing

Since the phonological voicing contrast of initial obstruents in native Wenzhou Wu words involves phonetic voicing and vowel phonation type as aforementioned, we would focus on these two phonetic properties in the current study as well. Regarding voicing, the phonetic correlate to be extracted is the voice onset time (VOT).

As for the EGG signal, in this study, the time interval between the peak value of the derived curve of EGG signal (dEGG) and the time point when EGG signal exceeds the 25% threshold was designated as the contact phase [17, 18, 19]. The parameter of contact quotient (CQ), the ratio of the contact phase to the whole cycle, was then calculated. The CQ data were extracted from the vowel, with time normalised as having 10 time points, and the Smoothing Spline ANOVA model was used to test the statistical significance of the difference between CQ curves. The result could be interpreted as statistically significant (at a level of $\alpha = 0.05$) if the different shaded areas do not overlap.

3. RESULTS

3.1. VOT analysis

To figure out the effect of prosodic position on the distribution of true phonetic voicing, the VOT values of the two plosives /b/ in letter ‘B’ and /d/ in ‘D’ in different prosodic positions were examined.

As shown in Figure 1, the distribution pattern of negative VOT in English lettered words seems to be an effect of the #initial/intervocalic distinction only, which does not concern the specific prosodic structure. The phonologically voiced plosives were phonetically voiced in all intervocalic positions, no matter whether there was a prosodic boundary at the word or phrase level involved. In the #initial position, the phonologically voiced plosives were in fact voiceless with short positive VOT (12.27 ms for /b/ and 12.62 ms for /d/ on average).

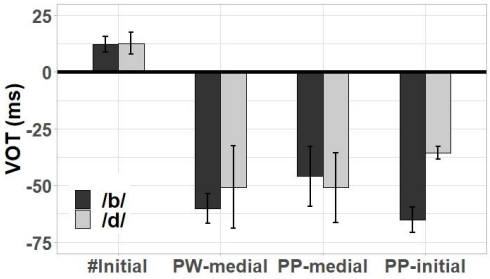

Figure 1: VOT of /b/ and /d/ in different positions.

3.2. Vowel phonation analysis

Different from native Wu syllables, there are no phonologically voiceless unaspirated obstruents contrasting with the phonologically voiced ones in English lettered words. To explore the potential vowel phonation feature existing in these words with obstruents in different prosodic positions, the #initial position (the basic form in isolation) data was used as a baseline in comparison.

3.2.1. Prosodic word-medial position

Consistent with previous findings on native Wu words, the voicing of the obstruents in prosodic word-medial positions in English lettered words is also realised in the following vowels. Figure 2 shows that the vowels following obstruents in #initial and prosodic word-medial positions were significantly differentiated by their phonation type. The CQ of the vowels in prosodic word-medial syllables was higher at least for the first half of the syllable duration, supporting that the vowels in word-medial syllables were less breathy compared to the ones in #initial positions.

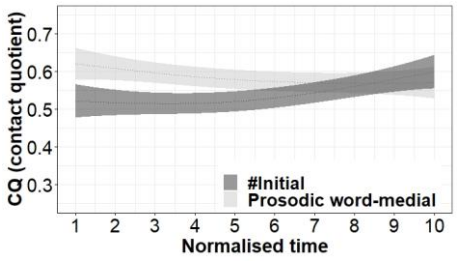

Figure 2: CQ of vowels in #initial and prosodic word-medial syllables.

3.2.2. Prosodic phrase-medial / word-initial position

Though a prosodic word boundary is introduced into the middle of this type of constructions (prosodic phrase), the pattern of CQ values was similar to the

vowels in word-medial syllables (Figure 3). The vowel phonation of this prosodic position is even more differentiated from the vowels following #initial position obstruents. Hence, vowel phonation (breathiness) still served as an articulatory correlates of the phonological voicing of its preceding obstruents in prosodic phrase-medial position.

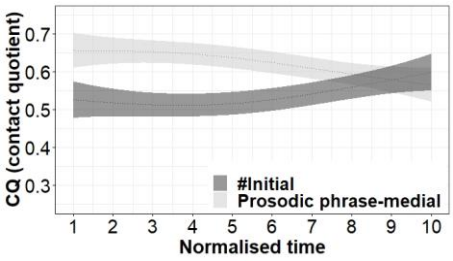

Figure 3: CQ of vowels in #initial and prosodic phrase-medial / word-initial syllables.

3.2.3. Prosodic phrase- initial position

Regarding the voiced obstruents in prosodic phrase-initial syllables, no significant difference on the phonation type of the following vowel could be observed in comparison with the ones in #initial positions as shown in Figure 4.

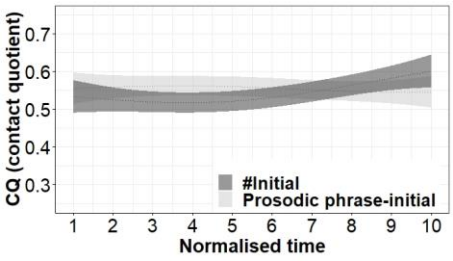

Figure 4: CQ of vowels in #initial and prosodic phrase-initial syllables.

According to the experiment results on vowel phonation in different prosodic positions presented above, it can be concluded that prosodic position does have an effect on the realisation of vowel phonation in English lettered words in Wenzhou Wu. The breathy vowel seems not to appear in word-medial and phrase-medial syllables. In other words, the breathiness feature of the vowels following phonologically voiced obstruents does not exist in medial positions of prosodic domain at the phrase level or lower in the prosodic hierarchy.

4. DISCUSSION

It can be concluded that prosodic position conditions the phonetic realisation of obstruent voicing in English lettered words in Wenzhou Wu Chinese, and both phonetic voicing and vowel phonation are involved. The phonetic adaptation reflected in the data seems strongly relevant with the common position-sensitive feature of the phonetic realisation of obstruent voicing in both Wenzhou Wu and English. The existence/absence of phonetic voicing is shown to be an effect of the #initial/intervocalic distinction only, with no interaction with the prosodic hierarchy – being voiceless in absolute initial position but otherwise phonetically voiced.

However, the phonation contrast of the vowel, which also plays an important role in voicing contrast realisation in native Wu words, depends on the prosodic structure. By virtue of the data which shows that vowels in #initial and prosodic phrase initial syllables are breathier than the ones in prosodic word-medial / phrase-medial syllables, we can infer that the vowel breathiness feature seems to only exist in prosodic phrase-initial positions (including #initial positions). Since the application of tone sandhi (at lexical and phrasal level) is regarded as a transparent prosodic marker of prosodic word and prosodic phrase in Wenzhou Wu, we can also draw the conclusion that the obstruent voicing can be realised as breathiness of the following vowel in the initial position of any sandhi tone bearing domain only. The overall interaction between prosodic position and obstruent voicing in English lettered word in Wenzhou Wu is summarised in Table 2 below. The phonologically constrained vowel phonation feature of Wu voiced obstruents has been applied to the localised pronunciations of English letters. Whether the devoicing only in absolute initial position results from articulatory factors like English [20], or adapts from the realisation of Wu voiced obstruents requires further comparison with non-loanword productions in different prosodic positions.

	#Initial	PW-medial	PP-medial	PP-inital
VOT	−	+	+	+
Phonation	+	−	−	+

Table 2: Interaction between prosodic position and voicing realisation.

It is quite special that prosodic phrasing and segmentation is transparently represented by the tone sandhi patterns in Wu Chinese. Now that the interaction between this prominent prosodic property of Wu Chinese and voicing contrast could be observed in this study, the interaction mechanism between these two segmental and suprasegmental features is also worthy of further research.

5. ACKNOWLEDGEMENTS

This study was supported by the RGC General Research Fund 2019/20 Project Reference 14607619 awarded to the second author.

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