Phonetics of Voiceless Stops and Word-Level Prosody of Paiwan in Urban Migration Communities

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ABSTRACT

This paper examines phonetic correlates of voiceless stop phonemes and innovative word-level prosody of an indigenous language in urban migration communities, where Mandarin and Taiwanese are the primary languages for communication. Two groups of the Paiwan speakers participated in the investigation: first and second generations in the urban communities, with respectively frequent and infrequent contact with traditional Paiwan villages in Southern Taiwan. Results show that palatal and uvular stop phonemes produced by the second-generation speakers were undergoing extensive mergers. Measurements of pitch and duration of vowels show that prosodic prominence produced by the second-generation speakers was not consistent with that attested in traditional Paiwan villages. Phonetic innovations could be resources for the production of the Paiwan language and the perception of their own values as individuals in the migration communities.

Keywords: voiceless stop, word-level prosody, Austronesian, Paiwan, migration

1. INTRODUCTION

Paiwan is a minority Austronesian language spoken in mountain and plain areas of Pingtung and Taitung Counties, Taiwan. Paiwan has different phonological structures and prosodic representations from other languages such as Mandarin and Taiwanese spoken in its geographically contiguous districts. The Paiwan language is notable for its large number of consonantal phonemes, compared with the other Formosan languages. The traditional Paiwan language does not show extensive mergers and splits among stops. Paiwan language has parallel palatal stops which are rarely attested in the other Formosan languages. The importance of Paiwan has been mentioned in Ferrell's [1] dictionary. The major phonological change among the Paiwan dialects lies in the palatal stops, palatal lateral, and uvular stop [2]. Palatal and uvular stops are attested in native Piuma Paiwan, Kulalau Paiwan, and Sinvaujan Paiwan but are absent in Stimul Paiwan and some other dialects in Northern Paiwan. Table 1 shows consonantal phonemes of Piuma Paiwan [2].

Table 1: Consonantal phonemes of Piuma Paiwan

	Lab	**Alv**	**Ret**	**Pal**	**Vel**	**Uvu**	**Gtl**
Stop	p b	t d	ɖ	c ɟ	k g	q	ʔ
Fric.	v	s z					(h)
Affr.		ts					
Trill		r					
Nas.	m	n			ŋ		
Lat.			ɭ	ʎ			
Glid.	w			j			

Due to frequent language contact with Mandarin and Taiwanese in the migration communities in urban Central Taiwan, voiceless stop phonemes and prosodic features of lexical stress produced by young speakers deviate from those produced by traditional village aborigines in the Southern Taiwan. Chen [2] [3] has found that the Paiwan informants in traditional villages under the age of fifty tend to randomize prosodic patterns in their speech and lose the prosodic features of the ancestral tone. Young speakers of Paiwan are able to say a Paiwan lexical word, as many second language learners can do, but the change of prosodic patterns in their speech could result in misunderstanding of communication or the loss of verbal arts.

Sound patterns can operate as abstract phonological rules [4]. Three candidates for inclusion in the set of phonetic universals were proposed, including intrinsic vowel duration, extrinsic vowel duration, and voicing time. The three assumed phonetic universals are not automatic results of speech physiology. They are at least in part determined by language-specific rules [4] [5]. In the case of voicing time, for instance, none of the patterns found is universal, and the patterns are a key to the relation among physical motivation, phonetic rules, and the grammar [6]. Traditional Piuma Paiwan has bilabial, alveolar, palatal, velar and uvular stops. Voice Onset time (VOT) measures were taken for the voiceless non-aspirated stops in urban migration communities. Voice onset time (VOT) is defined as the interval between the release of a stop consonant to the onset of voicing and

known to vary with place of articulation [6]. Stops with a more extended articulatory contact have a longer VOT [7]. VOT is shortest before bilabial stops in cross-linguistic studies [8]. Although some differences in VOT may be determined by aerodynamic factors, others simply reflect the behaviour associated with a particular language, as studies on VOT have revealed the inconsistent variation between the stops [6]. On the other hand, three cues including f0, duration, and intensity signal stress across languages [9] [10] [11], but languages may vary in how other cues correlate with stress [12] [13] [14] [15] [16]. Pitch height, vowel durations, and intensity were measured for the phonetic representations of lexical stress and word-level prosodic words in Paiwan.

This paper examines phonetic correlates of voiceless stop phonemes and innovative word-level prosody of an indigenous language in urban migration communities Fieldwork in the Taichung migration communities had been conducted to survey the phonetic representations of voiceless stops and word-level prosody of the Paiwan speakers. Piuma Paiwan has bilabial, alveolar, palatal, velar, and uvular stops while Stimul Paiwan has bilabial, alveolar, and velar stops. Given that phoneme mergers are important indices for the loss of regional features in Paiwan, empirical studies were conducted to verify the phonetic variation in the urban migration communities.

2. METHODOLOGY

The present study is based on a corpus of speech uttered by twenty-four speakers of Paiwan, including first and second generations of Paiwan aborigines. Eight male and sixteen female speakers of Paiwan aged 12-70 participated in the recordings in the migration communities. The speakers were divided into two groups, first-generation and second-generation, with equal number in each group. The first investigation on the phonetic variation was conducted in both Paiwan hometowns and urban migration communities. The major difference between the Paiwan hometown and urban migration communities lies in the ethnic distribution of the residents. More than 90% of the residents in the hometown communities were the Paiwan aborigines, and Paiwan was the primary communication language in the hometown villages. Each informant in the first investigation was asked to say 800 basic words in Paiwan. In the second investigation, word lists and carrier sentences in elicitation were recorded from the Paiwan speakers.

The Paiwan speakers in the urban migration communities moved from Paiwan hometowns including Pinghe (Piuma), Gulou (Kulalau), Mudan (Sinvaujan), Pingtung to Taiping, Taichung, more than 200 miles of migration. All participants reported no history of hearing impairments or speech disorders at the time of the investigation.

In the investigation of the VOT, the target words were recorded in isolation form, one repetition per item. The structure of the sentences consisted of at least two prosodic words, verbs plus subjects or nouns (subject or predicate). Words for VOT investigation in Paiwan voiceless stop consonants are illustrated in Table 2.

Table 2: Words for VOT investigation in Paiwan voiceless stops

CV	Paiwan W1	Paiwan W2	Paiwan W3
pi	piku	pida	pitu
pu	puk	puq	pudək
pa	padaj	pana	panaq
pə	pənaŋuɭ	pəntəl	pəntəq
ti	tima	tikaj	tidiv
tu	tutsu	tutu	tuvuʌ
ta	tata	tapal	takit
tə	təquŋ	təʌar	tənvəɭa
ci	cipuc	cikiliɭ	cikuraj
cu	curuvu	cuvu	cuguʌ
ca	cakit	cakaz	capaq
cə	cəvus	cəɭu	cəruq
ki	kisi	kina	kirats
ku	kutsu	kuku	kuka
ka	kapaz	kava	kasiv
kə	kədi̯	kəviŋ	kərəc
qi	qiʌas	qipu	qiri
qu	quɟaʌ	quzu	quʌav
qa	qaʌits	qavu	qatia
qə	qətsap	qətim	qəcuc

The recorded data were sampled at 44,100 Hz using Praat. The interval between the onset of the release burst and the first glottal pulse was measured on simultaneous waveform and spectrographic displays. Release was recognized as a wave with higher intensity in the waveform and a vertical striation in the spectrogram. A total of 1440 elicitation tokens (60 X 24) from twenty-four Paiwan speakers were measured. The data were analysed in R, and a series of LME models was conducted using the lme4 package. The lmerTest package was used to obtain the *p* values for all the LME models. *Post-hoc* pairwise comparisons were

conducted with the emmeans package. The LME models included by-Speaker random slopes for Place to capture the variability in Speakers' VOT relative to the type of Place of articulation.

Voiceless unaspirated stops produced at the back of the oral tract have longer VOTs than those produced at the front. The VOTs for a velar stop tend to be longer than that for a bilabial stop, and the VOTs for a uvular stop will tend to be longer than that for a velar stop [6]. The investigation on VOT covariation with places of articulation in Paiwan predicts a uvular stop will have longer VOT among the voiceless stops, given that the parameter of VOT is straightforward.

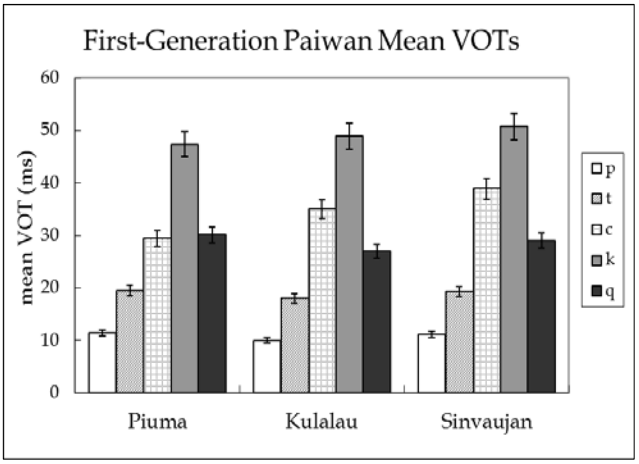
Word-level prosody such as stress patterns and prosodic variation were also investigated using sentence carrier corpus. A Paiwan word typically has a single primary stress in its elicitation form. Word stress usually falls on its penultimate syllable. Word lists in the recorded data included **tata** 'ring', **tutu** 'breast', **kaka** 'siblings', **va** 'lung', **vava** 'wine', **vat** 'nutlet', **vu** 'intensities', **vuvu** 'grandparents'. The tokens were recorded in elicitation, one repetition per item. To avoid the effect of final lengthening, no target words were placed in the word-final or phrase-final positions. A total of 576 elicitation tokens (8 words X 24 speakers X 3 times) from the Paiwan speakers were selected for the measurements of vowel length, pitch height, and intensity. The F0 at the temporal midpoint of the vowel in each syllable of the target word was measured, using the auto-correction method. Vowel durations of the target vowels were measured from 300Hz bandwidth spectrograms, including the portion from the onset of the first full glottal pulse to the offset of the last full glottal pulse corresponding with the end of visible energy. Average intensity of the vowels was measured for the syllable nuclei of the target words.

3. RESULTS

3.1. Voiceless stops

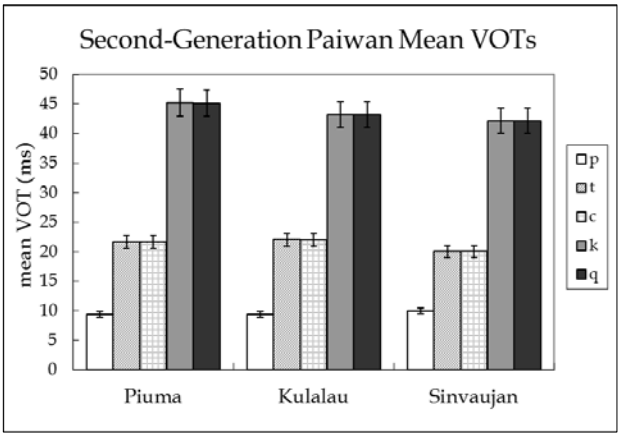
Results from VOT measurements are summarized in Figure 1 and Figure 2. Tokens produced by the second-generation speakers were separated from those produced by first-generations, due to their place of birth in Taichung in Central Taiwan and the mergers of palatal and uvular stops. The dialects Piuma, Kulalau, and Sinvaujan in Figure 2 represents the hometowns of the Paiwan mothers. The output of the LME model of Second-Generation Paiwan showed that there was a significant difference between the Place Bilabial vs. Place Alveolar ($p < 0.001$) and Place Alveolar vs. Place Velar ($p < 0.001$). However, there were no significant differences between Place Alveolar vs. Place Palatal and Place Velar vs. Place Uvular.

Figure 1: Mean VOT of First-Generation Paiwan Stops



In *post hoc* analyses for First-Generation and Second-Generation groups, the labial stops were distinct from alveolar and velar stops at $p < 0.001$, and there was significant VOT difference ($p < 0.001$) between alveolar and velar stops. Palatal stops are distinct from uvular stops at $p < 0.001$ in first-generation Paiwan group, including speakers from Gulou (Kulalau) and Mudan (Sinvaujan). In Piuma Paiwan, there was no significant VOT difference between palatal and uvular stops in first-generation group. Yet, velar stops were distinct from uvular stops at $p < 0.001$ in first-generation Piuma Paiwan group. The VOTs for labial stops tend to be the shortest among the stops produced by second-generation Paiwan speakers, as shown in Figure 2. Mergers of palatal stops to alveolar stops and uvular stops to velar stops were attested in the second-generation group, regardless of their mother's Paiwan hometown villages.

Figure 2: Mean VOT of Second-Generation Paiwan Stops



3.2. Word-level prosody

In most of the Paiwan dialects, the primary stress falls on the penultimate (second-right) syllable. In the Piuma dialect, however, the primary stress falls on either the penultimate (second-right) or the final (rightmost) syllable, depending on whether the penult has a *schwa* nucleus and the syllable number of the roots [2].

Results show that the duration of a stressed vowel is 1.2 times that of an unstressed vowel produced by the first generation speakers. Stressed vowels average 215 Hz pitch height for female speakers while unstressed vowels average 168Hz at midpoints. Analyses of variance have shown that the effect of stress was significant ($p < 0.001$) in the first-generation group. The examination on stressed vowels produced by the first-generation Paiwan speakers indicates that phonetic correlate of pitch tends to be the prominence of stress, consistent with the results found in native Paiwan villages [2]. Higher pitch on the penultimate syllable is due to stress effect, and stressed vowels tend to have higher pitch. Stressed vowels tend to be longer than unstressed vowels in the tokens produced by first-generation Paiwan speakers in urban migration communities. No significant intensity differences were found between stressed and unstressed vowel in the first-generation group.

Yet, phonetic variation was attested among the second-generation speakers. Stressed vowels produced by the second-generation group did not show significantly higher pitch than unstressed vowels. The durations between a stressed vowel and unstressed vowel produced by the second-generation group were not significantly different.

Frequent contact with traditional Paiwan hometown village members may facilitate the retrieval of the aboriginal Paiwan lexicon, phonological phonemes, and prosodic features. First-generation speakers' contact and social connections with their native hometowns enhanced their prosodic familiarity and appropriate assignment of stress or word-level prosody in their Paiwan speech.

4. DISCUSSION

First-generation Paiwan speakers in the urban migration communities also need to understand the phonological variants among the Paiwan dialects for better intelligibility in communication. Results show that palatal and uvular stop phonemes produced by the second-generation Paiwan speakers were undergoing extensive mergers. Palatal stop /c/ was produced as /t/ and uvular stop /q/ was produced as /k/ by second-generation Paiwan speakers who were born in urban migration communities. On the other hand, stressed syllables produced by the second-generation Paiwan speakers did not show higher pitch and longer duration, indicating the phonetic innovations spreading in the migration communities.

First-generation Paiwan speakers were aware of the phonological variants in the urban migration communities but held positive attitudes towards the use of the Paiwan language. Second-generation Paiwan speakers frequently implemented phonological mergers in their mixture pronunciation with other Paiwan speakers. The overlapping of Voice Onset time (VOT) measured from voiceless velar and uvular stops was attested among the second-generation speakers. It was also reported by native Paiwan speakers that second-generation Paiwan speakers in urban migration communities alternated voiceless stops /ʔ/ with /q/ or /ʔ / with /k/ in various contexts, due to the contact with Paiwan speakers from other hometowns. The investigation of the Voice Onset Times (VOTs) is to support the description of consonantal phoneme mergers between the generations. The VOTs of voiceless stops were examined in an effort to see how VOTs vary according to places of articulation among the Paiwan speakers in the urban migration communities.

5. CONCLUSION

In the present study, phonetic correlates of voiceless stops and word-level prosody in Paiwan in urban migration communities were investigated. Phonological variations such as phoneme mergers and stress shift were attested in elicitations and spontaneous speech. The results presented here indicate that phonetic variation of the minority language is part of the social practices in urban migration communities for both first and second-generation Paiwan speakers. The second-generation Paiwan speakers showed more awareness on their phonological mergers with willingness to use the Paiwan language.

This study investigates the phonetics of voiceless stops and stress variation of the Paiwan language in urban migration communities. Second-generation Paiwan speakers produced different variants of voiceless stops and prosodic patterns from their parents. It is suggested that positive attitudes towards generational pronunciation differences of the aboriginal language in urban migration communities relies on appropriate linguistic support. Phonetic innovations could be resources for the production of the Paiwan language and the perception of their own values as individuals in the migration communities.

6. REFERENCES

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