

DELETION PHENOMENON OF PHONEMES IN SPONTANEOUS TAIWANESE MANDARIN

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ABSTRACT

This study presents acoustic and perceptive results on deleted phonemes of 15 minutes of spontaneous Taiwanese Mandarin. Acoustic results show that only 3% among 8580 phonemes are deleted, in which 75% belong to grammatical words. Furthermore, the deletion concerns less vowels than consonants (1.6 % versus 5.1% deleted). Perceptive results show that deleted vowels are more often perceived than deleted consonants (40% versus 13.8%). It seems that in acoustic and perception, the vowel is much more preserved than the consonant in spontaneous Mandarin, this suggesting that the structure of the syllable in Mandarin is based on the vowel, in which the tone is to be found.

1. INTRODUCTION

This study is part of a larger program aiming to compare spontaneous speech phenomena in related and unrelated languages. Spontaneous speech phenomenon is the object of growing interest. Most of the studies concern Indo-European languages, like English [8], German [4], French [2], and Finnish [14]. Our concern is to investigate the deletion phenomena of phonemes in spontaneous Taiwanese Mandarin, a Sino-Tibetan mono and disyllabic tone language, intending to compare the phenomena with other languages (this study is a continuation of [13]).

Our investigation is based on a spectrographic and perceptive analysis.

We firstly investigate spectrographic results of our data in spontaneous Taiwanese Mandarin. We examine: (i) the influence of the words' category (lexical or grammatical) on the deletion of phonemes. (ii) the deletion of vowels versus deletion of consonants.

We then investigate perceptive results on the deletion of vowels versus deletion of consonants.

2. ACOUSTIC EXPERIMENT

2.1. Method

The corpus consists of 15 minutes of continuous dialogue in Taiwanese Mandarin uttered by three native-speakers of about 30 years old (two male and one female), recorded in a sound-proof room.

The 15 minutes of speech were then transcribed in Chinese, with a total of about 4100 characters. Signals were segmented on spectrogram, phonetically transcribed (whenever possible) and prosodically annotated on a computer. The criterion of deletion is based on spectrographic analysis: a phoneme is considered deleted when it is apparently not visible on the spectrogram.

2.2. Results

2.2.1. Percentage of deleted phonemes

Table 1 shows deleted phonemes versus total number of phonemes in our data. Only 3% among all phonemes were deleted.

total	deleted	%
8580	260	3

Table 1. Total versus deleted phonemes

2.2.2. Lexical words versus grammatical words

We firstly investigate the influence of the words' category on the deletion of phonemes. It seems quite universal that reduction or deletion affect more frequently grammatical words (or function words) than lexical words and familiar words than unfamiliar words [6] [11] [14].

We have divided all the phonemes of our data into two categories, depending on whether they belong to grammatical or lexical words. Grammatical words are pronouns, articles, auxiliaries, conjunctions, prepositions, postpositions and particles. Nouns, adjectives, verbs and adverbs belong to the lexical words' category. Table 2 shows that most of the deleted phonemes belong to grammatical words (74% in grammatical words versus 26% in lexical words). In addition, Table 3 shows that phonemes are more likely to be deleted in grammatical words than in lexical words (4.6% versus 1.5%). Our results confirm therefore the conclusions of the studies mentioned above.

Deleted	260	%
Grammatical	193	74
Lexical	67	26

Table 2. Deleted phonemes in grammatical words and in lexical words

	total	deleted	%
Grammatical	4220	193	4.6
Lexical	4360	67	1.5

Table 3. Deleted phonemes in grammatical words versus in lexical words

2.2.3. Vowels versus consonants

Table 4 shows the percentage of deleted vowels, glides and consonants. Vowels are less likely to be deleted than consonants (only 1.6% of vowels deleted versus 5.1% of consonants deleted).

As far our results are concerned, the deletion of consonants leads to a great number of succession of vowels but to a rare formation of clusters.

	total	deleted	%
Vowel	4186	69	1.6
Consonant	3106	157	5.1
Glide	1288	34	2.6

Table 4. Total versus deleted vowels, consonants and glides

2.2.4. Vowels

Table 5 illustrates which vowels were deleted. Some points can be observed:

- i) Few vowels are concerned by deletion, these being mainly central and close vowels.
- ii) Oral close vowels tend to be deleted but not open vowels. Thus, the tendency that close vowels are less resistant than open vowels [12] seems quite systematic in Taiwanese Mandarin.
- iii) Deletion of central vowel schwa is frequent in many languages. Similarly, the schwa in our data, nasalised or not, was deleted (7.3% nasalised and 2.8% oral).
- iv) [i] is both central and close. This vowel is the most deleted one (7.8%).
- v) The nasalised vowels [ən] and [en] are deleted only when they are preceded by a nasal consonant, which has a strong vocalic character. In addition, all deleted [ən] belong to the word [womən] « we », a frequent word that Bally [1] would call « worn out ». In our data, two productions were found: [womən] and [wom]. Here we follow the suggestion made by Ohala [9] that more than one entry may exist for very frequent words.

Deleted / Total (%)			
i 6/410(1.7)	y1/79(1.3)	ɨ 26/334 (7.8)	u 3/188 (1.6)
e 0/141		ə 14/503 (2.8)	o 0/396
		ɚ 0/8	
		a 0/293	
in/ŋ 0/130		ən 18/248 (7.3)	oŋ 0/99
en1/158(0.6)		an/ŋ 0/377	
ei 0/208	ai 0/170	au 0/141	ou 0/303

Table 5. Deleted versus total number of vowels

2.2.5. Glides

Table 6 shows deleted versus total number of glides.

j	20/597 (3.4%)
w	13/616 (2.1%)
ɥ	1/75 (1.3%)

Table 6. Deleted versus total number of glides

2.2.6. Consonants

The results of deleted versus total number of consonants are shown in Table 7. We may notice the following elements:

- i) The deletion phenomenon is quite scattered. Almost all modes and places of articulation are concerned.
- ii) Regardless of the scattered tendency of consonants in Taiwanese Mandarin, surprisingly none of labial consonants was deleted, this confirming Straka [12] who showed that labial [p] is less likely to be deleted than dental [t] and velar [k].
- iii) The most deleted consonant is [x] (19.4% deleted).
- iv) The only voiced fricative of Mandarin [z] has a high percentage of deletion: 10.3%. It is known that voiced fricatives have weaker frication than unvoiced fricatives because of aerodynamic constraints [10] (conflict between frication and voicing). As a result they may tend to be deleted.

The deletion phenomenon of consonant was also mentioned by Lien [5] in Taiwan Southern Min, a tone language as well, where consonants such as lateral [l] can disappear. For example, [khillai] « go up » becomes [khiiai]; [tokhi] « go back » becomes [toi].

		Deleted / Total (%)							
		labial		dental		retroflex	palatal	velar	
stop	not aspirated	p	0/167	t	28/442 (6.3)			k	9/187 (4.8)
	aspirated	ph	0/21	th	3/111 (2.7)			kh	0/84
affricate	not aspirated			ts	6/110 (5.5)	tʂ	10/170 (5.9)	tɕ	10/178 (5.6)
	aspirated			tsh	0/20	tʂh	1/35 (2.9)	tɕh	1/127 (0.8)
fricative	voiceless	f	0/51	s	1/61 (1.6)	ʂ	16/376 (4.3)	ç	1/226 (0.4)
	voiced					ʐ	9/87 (10.3)	x	50/258 (19.4)
nasal		m	0/145	n	6/129 (4.7)				
lateral				l	6/121 (5)				

Table 7. Deleted consonants versus total number of consonants (%)

3. PERCEPTIVE EXPERIMENT

As noted in [7] «lenitions are less complete than they first appear», an apparent deleted phoneme may leave a trace somewhere. Deletions may be the effect of gestures' overlapping rather than them being omitted just like argued Browman and Goldstein [3]. As showed in Table 8 there are four categories in which a phoneme can be represented according to whether it is visible on spectrogram and whether it is perceived. For example, if a phoneme applies to both the two conditions (visibility and perception), it belongs to category nb. 1; if it is invisible but perceived it will belong to category nb. 2, and so forth.

	1	2	3	4
visible on spectrogram	+	-	+	-
perceived	+	+	-	-

Table 8. The four categories adopted to classify phonemes

In order to examine which phonemes may have residual effect in perception (phonemes in category nb. 2), a perception test is performed in this section.

3.1. Method

Signals of 260 disyllabic syntagms in which one phoneme appeared to be deleted on the spectrogram were extracted from the original corpus and presented to 3 native-listeners. We asked them to transcribe what they hear and then obtained a total of 780 responses (=260 x 3).

One inconvenience is that two syllables can easily form a word in Mandarin. Consequently, context could become an important factor to influence the results. However, since the effect of context is equal for vowels just like for consonants, the comparison of vowels versus consonants perception should be valid.

3.2. Results

Table 9 shows the number of deleted versus perceived phonemes.

- i) Vowels not visible on the spectrogram are quite often perceived (40%), hence, tending to cue in the consonant, and are often not completely deleted.
- ii) Consonants not visible on the spectrogram are often not perceived (only 13.8% perceived). It seems that consonants are more likely to be deleted entirely. Furthermore, listeners perceived only one syllable instead of two, leading to a syllable merger. For example, in [pau~~x~~an] "contain" where [x] is deleted, the disyllabic word is perceived as a monosyllabic one [pan].

	deleted	perceived	%
Vowel	207 (=69x3)	83	40
Consonant	471 (=157x3)	65	13.8
Glide	102 (=34x3)	8	7.9

Table 9. Deleted versus perceived phonemes

Table 10, 11 and 12 respectively show the percentage of perceived vowels, glides and consonants. We noticed that the most deleted consonant [x] is surprisingly quite often perceived (20% perceived). However, context seems to be an important factor for

perception of deleted vowels, glides and consonants.

Deleted / Total (%)			
i	6/18 (33)	y	0/3
e		ɨ	34/78 (44)
		ə	11/42 (26)
		ə̃	
		a	
in/ŋ		ən	27/54 (50)
en	0/3	an/ŋ	oŋ
ei		ai	ou
		au	

Table 10. Perceived versus deleted vowels

j	0/60
w	8/39 (21%)
ɥ	0/3

Table 11. Perceived versus deleted glides

Deleted / Total (%)				
p	t	13/84 (15)	k	3/27 (11)
ph	th	0/9	kh	
	ts	0/18	tʂ	1/30 (3)
	tsh		tʂh	0/3
			tʂh	0/3
f	s	1/3 (33)	ʂ	5/48 (10)
			ʂ̥	2/27 (7)
			ç	0/3
			x	30/150 (20)
m	n	2/18 (11)		
	l	3/18 (17)		

Table 12. Perceived versus deleted consonants

4. DISCUSSION

Our previous study [13] showed that in spontaneous French, on the contrary of spontaneous Taiwanese Mandarin, vowels are more likely to be deleted than consonants (5.3% of vowels versus 1.9% of consonants deleted in 15 minutes of continuous dialogue). This suggests that the syllabic structure is different in the two languages. The vowel seems to play a much more important role in Mandarin than in French.

5. CONCLUSION

According to the acoustic and perceptive investigations, in spontaneous Taiwanese Mandarin, phonemes are more likely to be deleted in grammatical words than in lexical words, as in other languages. Moreover, consonants are much more likely to be deleted than vowels. The second phenomenon indicates that the vowel is much more important than the consonant in Mandarin, and confirms that the structure of the syllable in Mandarin is based on the vowel, in which the tone is to be found.

We argue that, on the one hand, the fact that tones are only to be found in vowels may lead to them being less frequently deleted; on the other hand, a mono or disyllabic language may preserve its vowels in case they are the basis of the syllabic structure of this language. It would be interesting to examine more tone languages as well as mono and disyllabic languages to test these arguments.

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