

Features of Contracted Syllables of Spontaneous Mandarin

Shu-Chuan Tseng

Institute of Linguistics, Academia Sinica, Taipei

tsengsc@gate.sinica.edu.tw

Abstract

Mandarin is a syllable-timed language whose syllable structure is quite simple [1]. In spontaneous Mandarin, because of rapid speech rate the structure of syllable may be changed, phonemes may be reduced and syllable boundaries as well as lexical tones may be merged. This fact has long been noticed, but no quantified empirical data were actually presented in the literature until now. This paper focuses on a special type of syllable reduction in spontaneous Mandarin caused by heavy coarticulation of phonemes across syllable boundaries, namely the phenomenon of syllable contraction. Contracted syllables result from segmental deletions and omission of syllable boundary. This paper reports a series of corpus-based results of analyses on contracted syllables in Mandarin conversation by taking account of phonological as well as non-phonological factors.

1. Introduction

Mandarin has a simple syllable structure, either CV or CVC, where the final C must be the alveo-dental nasal or the velar nasal. Other Chinese dialects have consonants other than the nasals above in the end of a syllable such as stops in Southern Min or the bilabial nasal in Hakka. However, the syllable structure remains CVC in general. Regarding the prosody of Mandarin Chinese, lexical tones are considered as an autosegmental feature attached to each syllable. According to Chao [2] and Shih [3], lexical tones in Mandarin have four marked realizations in modern Mandarin: high level (the first tone marked by musical points 55), rising (the second tone, 35), contour (the third tone, 214) and falling (the fourth tone, 51) and the unmarked neutral tone (3). The neutral tone is often used for function words or unstressed content words in spoken Mandarin. Different Chinese dialects have different numbers of lexical tones with different melodic values. Syllable contraction in Chinese is one of the coarticulatory variations in spoken language use [4]. With the results presented in this paper, we hope to provide real data of syllable contractions for speech research community. One the other hand, we also try to connect Chinese phonology which has a very long tradition with the quantified method of corpus linguistics.

1.1. Phonological Constraints

Cheng commenced systematic studies on di-morphemic syllables in Southern Min, especially word sequences containing grammatical words [5]. To scold someone is expressed in Southern Min as *ka21* (to make) *lang13* (someone) *me33* (scold) and the steps of the reduction process is proposed to start with the underlying form *ka21 lang13 me33*, the intermediate form *ka21 ang13 me33* to the final reduced form *kang33 me33*. Cheng stated that in Southern Min two syllables are contracted into one syllable only when

the first syllable is an open syllable. Furthermore, syllable contractions occur more often when the initial of the second syllable is zero or is a voiced consonant than when the initial is a voiceless consonant. This proposal is in accordance with studies on Archaic Chinese phonology [6]. It has been argued that historically voiced consonants are more likely to be changed or dropped than voiceless consonants.

1.2. Non-Phonological Factors

As mentioned by Cheng, words found to be contracted in Southern Min are in general function words. This may have several reasons. Function words form only a small part of the vocabulary of a language. In comparison to content words, they are used more frequently and thus speakers may tend to utter function words more rapidly. Also, function words are usually weakly stressed and have less prominence in verbal production. Therefore, it is more likely that they are attached to the neighbouring content words which lead to a reduction of syllable structure. Function words in Chinese may include prepositions, discourse particles and grammatical particles [7]. Grammatical particles are those such as the structure particle *de* in the noun phrase *my house: wo214* (I) *de3 jia55* (house), and the aspect particle *le* in the sentence *I have had my meal: wo214* (I) *chi55 fan51* (have meal) *le3*. The function of discourse particles is to add pragmatic differences on the spoken utterances such as *en214* can be used for a prolonged hesitation without lexicalized meaning, like *uh* in English. In spoken Mandarin, particles (discourse and grammatical) form a large proportion of tokens. For this reason, we will also focus on the participation of particles in this aspect in later studies. Besides function words, the frequency of usage is also a factor for the consequence of contracted syllables. The more often a word sequence is produced, the less attention is required for the speaker and thus the more rapidly they will be uttered.

2. Methodology and Data

We have analyzed transcripts of eight hours of conversations produced by nine female and seven male speakers extracted from the Mandarin Conversational Dialogue Corpus [8]. In order to prevent human transcribers from identifying syllable contraction by subjective judgments, two operational definitions of syllable contraction were given: change of syllable structure and omission of syllable boundary. To identify occurrences of syllable contraction, these two conditions must be satisfied with the help of experimental acoustic tools. Waveform presented by Cool Edit Pro 2.0 was used, when the transcribers were not sure whether the boundary is omitted or not. The most apparent cases are deletions of syllables. When three syllables are reduced to either one or two syllables, it is clearly a case of syllable contraction. Under the circumstance that no syllable is essentially omitted, but the boundary of syllables is

disappearing, so that no clear acoustic cues for syllable boundary can be obtained, it is also a case of syllable contraction. For instance, segmental deletions may lead to a change of syllable structure such as a change from CV+CV *qi214 lai35* (get up) to CV+V *qi21 ai5*, where the lateral [l] is deleted and the tones are reduced, too. If the boundary of the syllables CV *qi21* and V *ai5* cannot be identified, it is classified as a syllable contraction, too.

3. Syllable Contractions

In total, 123,320 syllables (30,735 closed syllables and 92,585 open syllables) were produced in the overall data. Among them, 39,490 were perceived as contracted by human transcribers. On the basis of 4,923 combinations of syllable contractions identified in the corpus data, we mainly analyzed di- and trisyllabic contractions for the reason that di- and trisyllabic contractions involve 21% of the overall syllables produced in the data. Disyllabic contractions were most frequently found, totally 11,136 occurrences, making up approximately 74% of all the identified syllable contractions; trisyllabic contractions about 9%. We list some of the most frequent contractions below.

ran35hou51 (then) > [rao35],
dui51a3 (yeah) > [dua513],
zhe51yang51 (so) > [tciang51],
wo214men3 (we) > [om4]
yin55wei51 (because) > [iun51] and
dui51bu35dui51 (right?) > [du?dui5351]

3.1. Open Syllables are Preferred for Syllable Contraction?

As mentioned, open syllables are more likely to be contracted in Southern Min and in the studies of Archaic Chinese phonology, the issue of whether syllables of Archaic Chinese are all closed was discussed in terms of the unlikely contraction with closed syllables. Thus, in the following analyses we investigated the proportion of closed syllables in the overall syllable contractions, the top 100 syllable contractions, and the di- and trisyllabic contractions.

Table 1: Closed Syllables in Contraction

	s. c. type	s. c. token	closed syll.	syll.	% of closed syll.
overall			30,735	123,320	24.92%
all s. c.	4,923	15,033	7,119	39,490	18.03%
top 100 s. c.	100	8,138	3,271	16,541	19.78%
2-syll. c.	1,820	11,136	4,783	22,272	21.48%
3-syll. c.	789	1,367	779	4,101	19.00%

As shown in Table 1, closed syllables are less likely to be contracted in spontaneous Mandarin, as the participations of closed syllables in the top 100 syllable contraction combinations and in the di- and trisyllabic combinations of contractions are all clearly weaker than in the overall syllables. 21.48% of disyllabic contractions involve closed syllables, which is relatively close to the percentage of closed syllables in the overall data. The fact that disyllabic contractions mostly occur to high frequency word combinations may explain this

tendency. In order to gain further insight into the initial syllable in syllable contractions, we need to look at the syllable structure of the involved syllables. In Table 2 and 3, N, V and C represent nasals, vowels and all consonants except nasals, respectively. In Table 2, s1 and s2 represent the first and the second syllables in a disyllabic contraction. Likewise in Table 3, s3 is the third involved syllable.

Table 2: Final/Initial Phonemes in Disyllabic Contractions

final of s1	initial of s2	types	Tokens
N	C	361	1,587
N	N	20	75
N	V	173	719
V	C	764	4,787
V	N	73	909
V	V	429	3,059

From the point of view of the adjacent phonemes of the contracted syllables, the results on all disyllabic contractions clearly show that it is more likely to observe contracted syllables when the first syllable is an open syllable. The ratio of tokens over types is much higher in the case of V-C, V-N and V-V combinations than in the case of closed syllables in s1-s2 in disyllabic cases and s1-s2, s2-s3 cases in trisyllabic cases. Comparing disyllabic contractions with trisyllabic contractions, we found out that s2-s3 cases show more similar behaviour at the syllable boundaries to that of the disyllabic contractions than s1-s2 cases. Open syllables are more likely to be contracted with the following syllable.

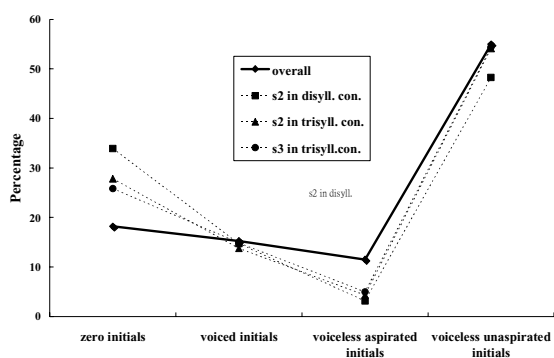
Table 3: Final/Initial Phonemes in Trisyllabic Contractions

final s1	initial s2	type	token	final s2	initial s3	type	token
N	C	139	193	N	C	114	154
N	N	11	14	N	N	12	12
N	V	52	105	N	V	38	45
V	C	344	696	V	C	371	719
V	N	60	84	V	N	84	118
V	V	183	275	V	V	170	319

3.2. Does Aspiration Prevent Contraction?

Voiced consonants are more easily to be dropped or changed is a well-known theory in Archaic Chinese phonology. In the history of Chinese phonology development, aspiration also plays a key role, because a number of minimal pairs are distinguished by aspiration. For the affricate [ts], the unaspirated and the aspirated variations are two phonemes in Chinese. Therefore, we classified the initials of the second syllable in disyllabic contractions and the initials of the second and the third syllables in trisyllabic contractions into four groups: 1) zero initials, 2) voiced initials, 3) voiceless aspirated initials and 4) voiceless unaspirated initials. The voiced consonants contain [l], [z], [m], [n] (l, r, m, n in Pinyin); voiceless aspirated initials [p^h], [t^h], [k^h], [tʃ^h], [tʃ^h], [ts^h] (p, t, k, q, ch, c); voiceless unaspirated initials [p], [t], [k], [tʃ], [tʃ], [ts], [f], [x], [s], [ʃ], [ʃ] (b, f, d, g, h, j, x, zh, sh, z, s). Pinyin is the transcription system used in China nation-wide. Throughout this paper, we use Pinyin, where Mandarin words are mentioned. A Pinyin-IPA mapping table can be found in [8].

Figure 1: Distribution of Initials in Non-First Syllables



The distribution of initials of non-first syllables normalized relative to the distribution found in the overall data is shown in Figure 1. The solid line marked by a filled square is the data of the overall syllables. The distributions of voiced and voiceless unaspirated consonants in the non-first syllables in contractions (s2 in disyllabic cases, s2 and s3 in trisyllabic cases) are similar to that of the overall syllables. No preference can be identified in these cases. Nevertheless, zero initials are more likely to be contracted with a preceding syllable, where the percentage of zero initials in all three cases is much higher than that in the overall data. On the opposite, voiceless aspirated initials are less likely to be contracted with a preceding syllable, where nearly 20% of the overall syllables begin with voiceless aspirated consonants; and less than 10% of di- and trisyllabic contractions contain voiceless aspirated initials in the non-first syllables.

3.3. The Fourth Tone in Syllable Contraction

To investigate whether tone sandhi rules have significant influence on the production of syllable contraction, we listed the frequency of all occurred tonal combinations in di- and trisyllabic contraction and found out that irrespective of types or tokens, tone sandhi combinations do not lead to more frequent tone contraction than other tonal combinations. Instead, disyllabic contractions with the fourth tone in the second syllable were more often produced than other combinations. The fourth tone effect can also be observed in trisyllabic contractions, but in a different way. The most frequent tone combinations are 4-2-4, 4-3-5, 1-4-3 and 4-4-4. They all contain the fourth tone, but in different positions. The combination 3-2-2 was often produced, but it is because some combinations are frequently produced, for instance the item *wo214jue35de3* (I think) occurred 47 times. Normally speaking, syllables are the shortest when associated with the fourth tone. Whether duration is an essential factor in the production of syllable contraction needs further investigations, which is out of the scope of this paper. However, syllables of the fourth tone are notably more frequently found in syllable contractions than the other ones.

3.4. Word Boundary vs. Syllable Contraction

In addition to phonological conditions, the segmentation of lexical components influences the formation of syllable contractions, too. A simple way to observe how lexical units interact with syllable contraction is to look at the positions of word boundaries within the produced syllable contraction. We

applied the syntactic tagger for Standard Mandarin, developed by CKIP at Academia Sinica, to tag the di- and trisyllabic contractions [9]. Results are shown in Table 4. # represents a word boundary.

Table 4: Word Boundaries within Syllable Contractions

disyll. con.		trisyll. Con.	
boundary type:	type-token	boundary type:	type-token
s1#s2#	1293 – 3953	s1#s2#s3#	238 – 359
s1s2#	527 – 7183	s1s2#s3#	332 – 530
		s1#s2s3#	180 – 294
		s1s2s3#	39 – 184

65% of disyllabic contractions occur in disyllabic WORDS. A large number of the disyllabic words are high frequency words in spoken Mandarin. According to Tseng [10] the majority of modern Mandarin words in spoken use are disyllabic words. A number of monosyllabic words are contracted together with other monosyllabic words, totally 1293 different combination, but contain only a relatively small number of tokens (3953 tokens). This fact indicates that occurrences of disyllabic contractions with disyllabic words may be a consequence of the frequent usage of disyllabic words, but when monosyllabic words are contracted together, there possibly exist other kinds of reasons for the contraction. Nevertheless, word frequency plays an important role. While contracted with different monosyllabic words, the second monosyllabic words are often frequent words such as *one* (yi55), *have* (you214), *is* (shi51), *say* (shuo55), *think* (xiang214) etc. Similar results were obtained while analyzing trisyllabic contractions.

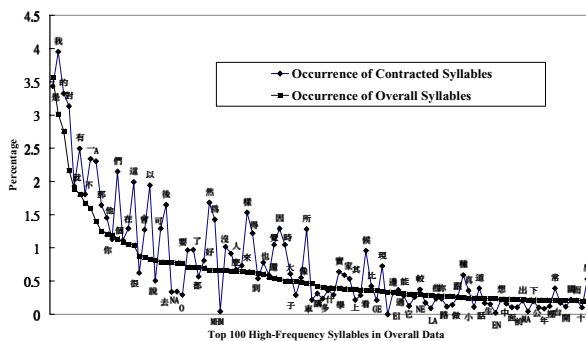
Cases of trisyllabic words (s1s2s3#) make up the smallest group in trisyllabic contractions. But they are all high frequency words, because their ratio of tokens over types is much higher than the other three combinations. For the other three large groups, no clear difference was observed across the mono-mono-mono (s1#s2#s3#), mono-bi (s1#s2s3#) and bi-mono (s1s2#s3#) combinations. However, the bi-mono combination is more likely to be found than the mono-bi combination, i.e. when the first two syllables form a lexical unit, the speaker may contract the lexical unit with the next syllable, while speaking fast.

3.5. Usage Frequency vs. Syllable Contraction

An analysis of word frequency related to occurrences of syllable contraction was done to investigate whether the production of syllable contraction directly depends on the frequency of syllables in the use of spoken Mandarin. We calculated the frequency of all syllables produced in our data and the frequency of all syllables which were identified contracted with other syllables. After comparing the percentage of individual syllables in the contracted syllables and in the overall syllables, we found out that the correlation between the distributions of percentage of both cases is very high ($r=0.9$). In Figure 2, the horizontal line marked by squares is the percentage of the top 100 most frequent syllables, compared with their percentage in contracted syllables. Words marked as discourse particles or discourse markers (they are written in capital letters, instead of Chinese

characters in the figure) are less likely to be contracted such as O, MHM, EI, NE, LA, EN, MA and NA GE. The only exception is A. This may be due to the relatively neutral usage of A, so A can practically be combined with any words. Second, the more frequently words are found, the more likely they will be contracted. This is supported by the data. In the first half of syllables (with a few cases of exceptions), the percentage in the contracted cases is higher than that of the overall cases, whereas the rest of syllables do not show clear tendency. This means that syllables which are used frequently in spoken Mandarin are more likely to be contracted than less frequently spoken syllables.

Figure 2: Frequency of Overall and Contracted Syllables



3.6. Use of Particles in Syllable Contractions

Two kinds of particles are differentiated: discourse particles and grammatical particles. The function of discourse particles is to adjust the atmosphere of the speaking situation to a stronger or weaker tune. Grammatical particles in Mandarin act like the morphological markings in English to represent tense, number and case. In our data, discourse and grammatical particles are all monosyllabic and were found to appear in the first, final or in the middle positions of di- and trisyllabic contraction.

Table 5: Occurrences of Discourse and Grammatical Particles in Di- and Trisyllabic Contractions

discourse particles			
disyll. con.	type-token	trisyll. con.	type-token
s1 in s1#s2#	6 - 12	s1 in s1#s2#s3#	1 - 1
s2 in s1#s2#	178 - 718	s2 in s1#s2#s3#	10 - 14
		s3 in s1#s2#s3#	13 - 15
		s1 in s1#s2s3#	1 - 1
		s3 in s1s2#s3#	17 - 24
grammatical particles			
disyll. con.	type-token	trisyll. con.	type-token
s1 in s1#s2#	24 - 183	s1 in s1#s2#s3#	7 - 7
s2 in s1#s2#	309 - 571	s2 in s1#s2#s3#	46 - 54
		s3 in s1#s2#s3#	10 - 10
		s1 in s1#s2s3#	3 - 3
		s3 in s1s2#s3#	43 - 59

However, as shown in Table 5, function words (grammatical and discourse particles), when contracted with other syllables,

are unlikely to be found in the first syllable. They appear rather in unstressed positions, namely after content words.

4. Conclusion

This paper reported a series of corpus-based studies on features of contracted syllables in spontaneous Mandarin. Phonological as well as non-phonological factors were investigated and we found out that both kinds of factors show effects on syllable contraction. Open syllables are more likely to be contracted with the following syllables than closed syllables. Aspiration is a feature which opposes contraction of syllable. We did not find any relationship between tone sandhi and syllable contraction, but the fourth tone seems to be favoured, when syllables are contracted. Monosyllabic words can be freely contracted with other words, whereas disyllabic and trisyllabic contracted words are almost all high frequency words. The notion that word frequency directly influences the possibility of syllable contraction is empirically supported by a clear preference tendency of the most frequent syllables to be contracted. Participation of particles in syllable contraction supports the notion that function words, usually unstressed, are attached to the preceding content word, rather than play the central role in syllable contraction. This paper provided real data of syllable contractions and tried to connect Chinese phonology with the quantified method of corpus linguistics. Acoustic measurements of contracted syllables such as F0, duration, intensity are currently in progress. With the results, we will be able to look at syllable contraction from the phonetic point of view.

5. Acknowledgements

The author would like to thank the National Science Council (NSC-91-2411-H-001-043) and the Ministry of Education (91-E-FA06-4-4) for their financial supports.

6. References

- [1] Peter Auer and Susanne Uhmann, "Silben- und akzentzählende Sprachen," *Zeitschrift für Sprachwissenschaft*, vol. 7, no. 2, pp. 214-259, 1988.
- [2] Yuen Ren Chao, *A Grammar of Spoken Chinese*, University of California Press, 1968.
- [3] Chi-Lin Shih, *The Prosodic Domain of Tone Sandhi in Chinese*, Ph.D. thesis, University of California, San Diego, 1986.
- [4] Hartmut Traunmüller, "Coarticulatory effects of consonants on vowels and their reflection in perception," in *Proceedings from the XIIIth Swedish Phonetics Conference*, 1999, pp. 141-144.
- [5] Robert L. Cheng, "Sub-syllabic Morphemes in Taiwanese," *Journal of Chinese Linguistics*, vol. 13, 1985, pp. 12-43, 1979.
- [6] Yu-Chun Lung, "A Discussion of the Theory that Yin-sheng Words End with Final Consonants," *Bulletin of the Institute of History and Philology*, vol. 50, no. 4, pp. 679-716. (in Chinese)
- [7] Charles Li and Sandra Thompson, *Mandarin Chinese: A Functional Reference Grammar*, University of California Press, 1981.
- [8] Shu-Chuan Tseng and Yi-Fen Liu, "Annotation Manual of Mandarin Conversational Dialogue Corpus," Tech. Rep. 02-01, CKIP, Academia Sinica, 2002.
- [9] K.-J. Chen, C.-R. Huang, L.-P. Chang, and H.-L. Hsu, "SINICA CORPUS: Design Methodology for Balanced Corpora," in *PACLIC 11*, 1996, pp. 167-176.
- [10] Shu-Chuan Tseng, "Highlighting Utterances in Chinese Spoken Discourse," in *PACLIC 15*, 2001, pp. 163-174.