LANGUAGE AND LINGUISTICS 6.1:153-180, 2005
2005-0-006-001-000144-1

Contracted Syllables in Mandarin: Evidence from Spontaneous Conversations*

Shu-Chuan Tseng
Academia Sinica

Fast speech contains pronunciation reductions to different extents. This paper examines perceptually identified syllable contractions with a corpus of spontaneous Mandarin data. By means of quantitative analyses and acoustical measurements, we find that syllable contraction is a continuous process with a predictable target syllable. Our statistic analyses show that contraction forms of a given combination of syllables are more than one, but they are similar in the way that the extremely shortened form is targeting the same syllable. We also find that morphological distribution influences syllable positions in a contraction. Suffixes are more frequently contracted with a preceding syllable than a following syllable. Syllables with a zero initial are more likely to be contracted with their previous syllable and syllables with a voiceless aspirated initial consonant are the least likely syllables to be found contracted with their preceding syllables. Acoustic analyses show that consonantal effects on vowels are rarely found in the data, whereas the process of nuclei merging tends to be more essential. The back-front contrast seems to be a factor influencing the way vowels of different syllables are merged together. Using natural discourse data, we are able to validate claims made on the issue of syllable contraction and we also point to several new directions of study related to segmental changes in the process of contraction.

Key words: syllable reduction, spontaneous speech, Mandarin Chinese

1. Introduction

This paper discusses a special type of pronunciation reduction in spontaneous Mandarin spoken in Taiwan. Different pronunciation variations in colloquial speech may reflect sociolinguistic and idiolect characterizations (Chao 1976). But until now

* The study presented in this paper was supported by the National Science Council, grant NSC-92-2411-H-001-075 and by the Ministry of Education, grant 91-E-FA06-4-4. The author would like to thank two anonymous reviewers and the editorial board of the journal *Language and Linguistics* as well as Prof. Dah-an Ho, Prof. Ying-Chin Lin and Prof. Kathleen Ahrens for their comments on the various versions of this manuscript.

not enough attention has been paid to what segmental changes in rapid speech may look like due to the lack of data and the corresponding methodology to deal with the data (Engstrand 1992). The **Mandarin Conversational Dialogue Corpus** (*MCDC*) collected at the Institute of Linguistics, Academia Sinica, consists of 30 spontaneous conversations. Even though subjects were in a laboratory setting, they switched their formal speaking style to a relaxed and casual speech style about ten minutes after they had started their conversation. Therefore, we assume that the data we used for studies presented in this paper is almost natural and spontaneous.

Syllables in spontaneous Mandarin may be reduced to differing extents in favor of articulatory convenience or phonological naturalness. Sometimes, a contracted syllable may be conventionalized or lexicalized by a fixed character in the written form. In modern phonology, syllable boundaries may be merged together due to extremely heavy coärticulation of adjacent phonemes. The term "syllable merger" was used by Duanmu (2000:258) when two (or more) syllables are merged into one. Sometimes the merged syllable sounds like a monosyllabic word, sometimes like two syllables, depending on the number of merged syllables and their syllabic structures. The term "contraction of syllables" has also been used (Cheng 1985, Chung 1997) for this type of pronunciation variation. In conformity with *fǎnqiè*, the traditional Chinese syllable transcription, the process of syllable contraction in Chinese, also called the **edge-in theory**, starts with the initial part of the first syllable and ends with the final part of the second syllable. In principle, the resulting contracted syllables have to satisfy Chinese phonotactics. In written documents of Chinese, evidence has been found that merged syllables are lexicalized by a fixed character (Lung 1979, Feng 2002). The choice of a representative character may be determined by two conditions. The representative character and the resulting contracted syllable must be homophones. The candidate character and the original characters of the unmerged syllables should be used in different syntactic and semantic environments to avoid possible ambiguity within a language. In Mandarin and Chinese dialects such as Southern Min, a number of syllables, especially grammatical words such as grammatical particles and numeral-classifiers, are regularly contracted in a consistent phonological manner (Cheng 1985, Feng 2002). Modern phonological theories are also adopted trying to explain why and how syllable contractions are formed. Hsiao (2002) discussed the phenomenon of tone contraction in Mandarin, Southern Min, and Hakka, and Hsu (2003) proposed that a modified sonority hierarchy should be embedded into the edge-in model (cf. Chung 1997) in order to be able to explain more cases of syllable contractions in Southern Min. The topic of syllable contraction is not only interesting, because it deals with phonological conditioning, but also because in the field of speech processing, understanding and recognizing coärticulation in spontaneous speech is also one of the most challenging tasks for

speech engineers. Assuming that the formation of syllable contraction has phonological grounds and that we can obtain phonetic evidence from real spoken data, the contribution to automatic speech recognition is accordingly valuable.

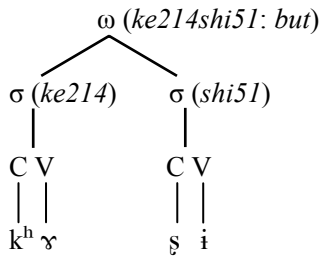
The focus of this paper is to study a body of perceptually identified data of syllable contractions extracted from the *MCDC* with respect to their distribution and their features in colloquial Mandarin. Corpus-based methodology has attracted tremendous attention recently and already showed the power of quantitative empirical analyses in explaining linguistic phenomena and validating theories. This paper attempts to investigate what syllable contraction looks like in real spoken data. Preliminary results of statistic analyses as well as acoustic evidence will be introduced and discussed. With this first empirical work on syllable contraction, we aim to illustrate how corpus-based investigations can accelerate studies of special phenomena in spoken language (such as syllable contraction) in a more precise way, relative to conventional methods on the one hand. On the other hand, a spoken corpus archives the synchronic use of a language and at the same time also provides materials for diachronic studies (such as sound change).

2. Syllables in Mandarin

Taiwan Mandarin is different from Beijing Mandarin with respect to rhyming, phonemics, and lexis. This paper deals only with Mandarin spoken in Taiwan, which is a syllable-timed language (Auer & Uhmann 1988). It has a very simple syllable structure, either the open syllable CV or the closed syllable CVC, where the final C must be either a denti-alveolar nasal [n] or a velar nasal [ŋ]. Other Chinese dialects such as Southern Min and Hakka have either stops [p], [t], and [k] or nasals [m], [n] and [ŋ] in the coda position. In addition, a Southern Min syllable can also end in glottal stop [ʔ]. However, the syllable structure remains CVC. Some may prefer the representation of CGVC/CGVG or CVX to assign glides an explicit position (Duanmu 2000, Chung 1997). This paper adopts the notion that the nucleus V includes glide + vowel combinations and the onset as well as the coda position can only be occupied by consonants. Tones are regarded as an autosegmental feature attached to each syllable (Chao 1968, Shih 1986, Ho 1996). Lexical tones 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). Different Chinese dialects have different numbers of lexical tones associated with different melodic values. In this paper, we use Pinyin to transcribe Mandarin words and for tones we adopt the convention of musical points, because the description of melodic content of tones needs to be specific in the discussion of syllable contraction. Where a phonetic transcription is necessary, International Phonetic

Alphabet (IPA) symbols are used. To take the word for 'but' as an example, as shown in (1): ω represents the phonological word tier, σ the syllable tier, then the CV tier.

(1)



Traditionally, a Chinese syllable is divided into an INITIAL (consisting of the onset consonant) and a FINAL (equivalent to the definition of rhyme and containing the medial, the nucleus, and the coda). Vowels in modern Mandarin are [ɿ], [i], [y], [u], [ɚ], [e], [ɤ], [o], and [a]. Diphthongs are [ai], [ei], [ou], and [ao]. Rising diphthongs such as [ia], [ie] and [uo] are considered combinations of a glide and a nucleus (Ho 1996). Triphthongs are regarded as combinations of a prenuclear glide and a diphthong, so they are not listed here. Mandarin has two semi-vowels or glides, the labiovelar [w] and the palatal [j] (Duanmu 2000, Ho 1996). In this paper, they are written as [u] and [i] respectively when they appear in the position of a glide. Consonants are ordered in terms of place of articulation as follows:

bilabial		[p]	[pʰ]	[m]	
labiodental	[f]				
denti-alveolar		[t]	[tʰ]	[n]	[l]
alveolar	[s]	[ts]	[tsʰ]		
retroflex	[ʂ]	[tʂ]	[tʂʰ]		[ʐ]
alveolo-palatal	[ɕ]	[tɕ]	[tɕʰ]		
velar	[x]	[k]	[kʰ]	[ŋ]	

The alveolo-palatal group [ɕ], [tɕ], and [tɕʰ] can only be followed by [i] or [y], including diphthongs starting with [i] or [y]. The alveolar group [s], [ts], and [tsʰ], the retroflex group [ʂ], [tʂ], [tʂʰ], and [ʐ] and the velars [x], [k], and [kʰ] can be followed by any vowel in Mandarin except [i] and [y]. Coda position can only be occupied by [n] or [ŋ], while [ŋ] never occurs in onset position.

2.1 Phonological issues of syllable contraction

Cheng (1985) began systematic study of di-morphemic syllables in Southern Min with a focus on the contraction of word sequences containing grammatical words. In (2), 'to scold someone' is expressed in Southern Min as *ka21* (to make) *lang13* (someone) *me33* (to scold) (Cheng 1985:20).

(2) ka21 lang13 me33=>ka21 ang13 me33=>kang33 me33 (to scold someone)

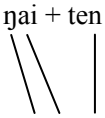
According to Cheng's analysis, in Southern Min two syllables are contracted into one only when the first syllable is open. Furthermore, syllable contractions occur more often when the initial of the second syllable is zero or is a voiced consonant than when the initial is a voiceless consonant. In studies of Archaic Chinese phonology, it has been proposed that historically voiced consonants are more likely to be changed (or dropped) than voiceless consonants (Lung 1979). Chung (1997) discussed the phenomenon of syllable contraction in Chinese dialects in terms of the edge-in association as shown in (3) based on the presumption of a CVX syllable structure for all Chinese dialects, where X is a glide or a consonant.

(3) syllable contraction CVX CVX => CVX

The target syllable of contractions must satisfy the CVX structure. The example in Hakka (4) mentioned by Chung (1997:216) illustrates this rule.

(4) CVX + CVX

ŋai + ten (I + suffix)



ŋ a n

C V X

In addition, the sonority scale of a>ɔ>e>o>i>u was proposed by Hsu (2003) to determine the priority of vowel association with the nucleus position. Not explicitly mentioning syllable contractions in Mandarin, Traunmüller (1999) discussed phonotactic restrictions and coärticulatory effects of syllable initial and final consonants on the Chinese schwa-like vowel, underlyingly the close-mid unrounded back vowel [ɤ] (Traunmüller 1999:142). Rounding effect of the labiovelar glide [w], the bilabial consonants [p], [p^h], [m] and the labiodental fricative [f] on [ɤ] can be observed (but the

effect will not be present if the final segment of the syllable is also rounded). [t], [t^h], [n], and [l] have a centralizing effect on the subsequent [ɤ]. Dentalizing effect of [s], [ts], and [ts^h] and rhoticizing effect of retroflex fricatives [ʂ], [tʂ], [$tʂ^h$], and [ʐ] are present. [x], [k], and [k^h] have a backing (opening) effect on the following [ɤ].

The edge-in theory, the preferences of syllable structure, and the segmental effect of initial consonants on vowels are all more or less phonological implications from a theoretical point of view. By means of corpus-based analyses, we shall examine whether these implications can be proven. Given a combination of syllables, there can be more than one produced form. Pronunciation can be reduced to different degrees in different speaking situations. Produced forms of a given syllable combination should be regulated individually according to their phonological environment. In our later analyses, we expect to observe different degrees of reduction with a fixed target syllable.

2.2 Non-phonological issues of syllable contraction

As mentioned in Cheng (1985), words found contracted in Southern Min are, in general, function words. There may be several reasons for this. Function words make up only a small part of the vocabulary of a language. In comparison to content words, they are used more frequently and thus speakers tend to utter function words more rapidly. The semantic content of content words is more concrete than that of function words, so it is unlikely that two content words are contracted and result in a reduced phonetic form. Also, function words are usually weakly stressed and have less prominence in verbal production. Therefore, it is more likely that they are attached to their preceding content words; i.e., it is more likely that function words appear in the second part of a contraction. Whether a syllable is stressed or not influences the position of that syllable in contraction. Function words in Chinese may contain prepositions, discourse particles, and grammatical particles (Li & Thompson 1981). Examples of grammatical particles include 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*. Grammatical particles are always written in fixed characters. With regard to discourse particles, the number of choices of characters varies. Their function is to add pragmatic differences to spoken utterances. For example, *en214* (written as EN in our transcription system) can be used for a prolonged hesitation without a lexicalized meaning, like *uh* in English. In spoken Mandarin, particles (whether discourse or grammatical) form a large proportion of tokens (Tseng 2001). In addition, word frequency also accounts for what syllable combinations are more likely to be contracted. The more often a word sequence is produced, the less attention is required for the speaker and thus the more rapidly they can be uttered.

3. Perceptually identified syllable contractions in Mandarin conversation

Human annotators marked up occurrences of syllable contraction identified in eight transcribed digitized Mandarin conversations (Barras et al. 2001) extracted from the *MCDC* by employing two operational criteria for syllable contraction: omission of syllables and omission of syllable boundary (Tseng & Liu 2002). The most apparent cases are deletions of syllables. When three syllables are reduced to one or two syllables, it is clearly a case of syllable contraction. Example (5) illustrates the contraction of syllables and their lexical tones. Three contour tones (214) result in a falling tone (41), when three syllables are merged into one syllable. Further investigations into the contraction are needed to make concrete claims of the tone contraction. However, due to lack of space, this paper will only focus on segmental contraction.

(5) suo214yi214 wo214 (so I) => [suiʔ41] (*MCDC*-78)

Under the circumstance that no syllable is completely omitted, but no clear perceptual cues for syllable boundary can be obtained, it is also considered a case of syllable contraction. For instance, segmental deletions may lead to a change of syllable structure such as a change from CV+CV to CV+V. If the boundary of the syllables cannot be identified, it is a syllable contraction as shown in (6). In (5) and (6), segmental deletions can be observed in syllable contraction and lexical tones are also merged.

(6) ru35guo214 (if) => [ruo352] (*MCDC*-02)

3.1 Most frequent forms of syllable contractions

123,320 syllables were produced in eight conversations; of these 39,490 syllables were perceived as contracted by human transcribers. That is, about 32% of the overall syllables were contracted. The most frequent occurrences of syllable contraction identified in our data are disyllabic contractions. Disyllabic contractions make up approximately 74% of all identified syllable contractions, 11,136 occurrences in total. Trisyllabic contractions are about 9%. We did not consider the remaining contractions, because they involve more than three syllables and it is difficult to analyze data with several continuous contractions. The most often identified disyllabic contractions with their typically produced forms are illustrated below. We transcribed the tonal variations using five-point musical points. Depending on the pitch contour and the syllable duration, the tonal transcription may contain more than three levels. One important thing to note is that the transcribed forms may not always have only one single nucleus,

because we also counted syllables with unidentifiable syllable boundaries as occurrences of syllable contraction. Therefore, in the transcribed forms there may be more than two vowels. In parentheses are sound file indices used within the *MCDC*.

ex1	然後 *ran35hou51*(then)	[ʔɑ̃35] (82)		
ex2	對啊 *dui51a3*(right)	[t^hɤa513] (142)	[tɤa513] (143)	
ex3	這樣 *zhe51yang51*(so)	[zɤaŋ51] (34)	[tɕiaŋ51] (119)	
ex4	我們 *wo214men3*(we)	[uom51] (77)	[om55] (94)	[m5](95)
ex5	因為 *yin55wei51*(because)	[in53] (11)	[iun 53] (23)	
ex6	所以 *suo214yi214*(therefore)	[suɤ53] (146)	[s^wɛ53] (85)	[suɤ42] (4)
ex7	沒有 *mei35you214*(has not)	[mɨo52]		
ex8	就是 *jiu51shi51*(that is)	[tɕiɤ53] (33)		
ex9	時候 *shi35hou51*(time)	[sou214] (37)	[ɨo5] (136)	[so53] (152)
ex10	覺得 *jue35de3*(think)	[dʒɤ55] (84)	[zʏɤ55] (137)	
ex11	現在 *xian51zai51*(now)	[ɕɪan:53](118)	[ɕɪain:55](46)	
ex12	他們 *ta55men3*(they)	[ʔam53] (147)		
ex13	可以 *ke214yi214*(can)	[kɤ3] (1)		
ex14	其實 *qi35shi35*(in fact)	[tɕ^{h}ɪ:35] (71)		
ex15	可是 *ke214shi51*(but)	[kɤ:241]		
ex16	那種 *na51zhong214*(that sort)	[nzoŋ5214] (112)		

On the whole, trisyllabic contractions have three different forms: 1) combinations of a frequent disyllabic word and a monosyllabic word, e.g. ex21 (because I), 2) V-not-V constructions, e.g. ex20 (BE not BE; yes or not) and 3) trisyllabic words, e.g. ex24 (so, this way).

ex17	對對對 *dui51dui51dui51*(yes yes yes)	[tuei:524] (8)
ex18	對不對 *dui51bu35dui51*(right or not)	[tueʔtue52524] (19)
ex19	我**覺得** *wo214jue35de3*(I think/feel)	[uotɕɤʔ21452] (84)
ex20	是不是 *shi51bu35shi51*(yes or not)	[sɤ:p55] (79)
ex21	**因為**我 *yin55wei51wo214*(because I)	[in:uo5214] (58)
ex22	**就是**說 *jiu51shi51shuo55*(that is to say)	[tɕisuo5155] (33)
ex23	**所以**我 *suo214yi214wo214*(so I)	[suiʔ41] (78)
ex24	這樣子 *zhe51yang51zi3*(so)	[tɕiaŋts513] (47)

Most of the words or syllables involved in syllable contraction are function words. This corresponds to the proposal made by Cheng (1985). Moreover, 74% of syllable contractions involved exactly two syllables. The majority of disyllabic words in

contractions may be a direct consequence of the characteristic of spontaneous conversation. As mentioned in Tseng (2001), in spoken Mandarin conversations almost all high-frequency words are function words and discourse particles. The average number of syllables of a spoken word in spontaneous Mandarin is 1.68 and the majority of words in spoken use are disyllabic.

3.2 Morphological preferences of syllable contraction

All di- and trisyllabic contractions are divided into two main categories: 1) the contracted syllables form exactly one polysyllabic word and 2) the contracted syllables are composed of parts of more than one word. What role morphological conditions play in syllable contraction can be answered by looking at positions of word boundaries within syllable contractions. We used the automatic word segmentation system, developed for standard Mandarin at Academia Sinica, to tag di- and trisyllabic contractions (Chen & Huang 1996). The purpose of this experiment is to allocate word boundaries, not to obtain precise syntactic categories of components of syllable contractions. We categorized the results into two groups for disyllabic contractions and four groups for trisyllabic contractions, as illustrated in Table 1 (# designates a word boundary).

Table 1: Word segmentation in contracted syllables

	Disyllabic Contractions	Trisyllabic Contractions
Morphological Words	**disyllabic word**	**trisyllabic word**
	σ1σ2#	**σ1σ2σ3#**
Types–Tokens	**527–7183**	**39–184**
(% in total tokens)	**(64.5%)**	**(13.5%)**
Examples	**ex 1, ex 3, ex 4, ex5, ex6, ex7, ex8,ex9, ex10, ex11, ex12, ex13, ex14, ex15**	**ex24**
Non-morphological Words	**mono-mono**	**di-mono**
	σ1#σ2#	**σ1σ2#σ3#**
Types–Tokens	**1293–3953**	**332–530**
(% in total tokens)	**(35.5%)**	**(38.8%)**
Examples	**ex2, ex16**	**ex21, ex22, ex23**
Non-morphological Words		**mono-di**
		σ1#σ2σ3#
Types–Tokens		**180–294**
(% in total tokens)		**(21.5%)**
Examples		**ex19**

Non-morphological Words		**mono-mono-mono** **σ1#σ2#σ3#**
Types–Tokens (% in total tokens)		**238–359** **(26.3%)**
Examples		**ex17, ex18, ex20**

As shown in Table 1, 64.5% of the disyllabic contractions occur in disyllabic words. And most of the disyllabic words are high-frequency words in spoken Mandarin. For the remaining disyllabic contractions, a large number of monosyllabic words are contracted with other monosyllabic words, making up 1,293 different combinations, but only 3,953 tokens. Among the occurrences, individual combinations of monosyllabic words may be different, but the second monosyllabic word is often a frequent function word such as 'one', 'have', or 'is'.

Similar results were obtained for trisyllabic contractions. Contracted trisyllabic words are mostly high-frequency words (the ratio of tokens over types is very high). But the proportion of trisyllabic contracted words (13.5%) is clearly smaller than that of disyllabic contracted words (64.5%). This supports the notion that disyllabic words are preferred over trisyllabic words in contraction. Furthermore, no significant difference was observed across the mono-mono-mono, mono-di and di-mono combinations. However, di-mono combinations tend to be more likely than mono-di combinations. Similar to the preference of function words found in the second contracted syllables, when the first two syllables form a lexical unit, more semantic weighting is located in the first part of the contraction than in the second part. Therefore, it is unlikely that a disyllabic lexical unit is contracted with a preceding syllable.

Contracted syllables identified more often than 100 times both in the first and the second syllable positions in mono-mono disyllabic contractions were analyzed; they are listed below. However, we did exclude fixed word patterns that are used extremely frequently in spoken Mandarin, such as *jue35de3* (think), as they cannot offer variation in phonological combination.

Position: First Syllable

(1) Pronouns:

我 *wo214*(I)

他 *ta55*(he)

(2) Determiners:

這 *zhe51*(this)

那 *na51*(that)

(3) Verbs:

Position: Second Syllable

我 *wo214*(I)

人 *ren35*(man)

家 *jia55*(home/house)

有 *you214*(have)	**有 *you214*(have)**
是 *shi51*(BE)	**是 *shi51*(BE)**
	會 *hui51*(can/will)
	來 *lai35*(come)
	要 *yao51*(want/will)
	像 *xiang51*(like)
(4) Negations:	
不 *bu51*(not, no)	
(5) Adverbs:	
就 *jiu51*(then)	也 *ye214*(also)
都 *dou55*(all)	
還 *hai35*(still)	
(6) Adjectives:	
大 *da51*(big)	對 *dui51*(right)
好 *hao214*(good/fine)	
(7) Particles (gr):	
的 *de3*(structure particle)	**的 *de3*(structure particle)**
	了 *le3*(aspect particle)
(8) Classifiers:	
	個 *ge3*
	種 *zhong214*
(9) Prepositions:	
	在 *zai51*(in, at)
(10) Suffixes:	
	們 *men3*(plural suffix)
(11) Numerals:	
	一 *yi55*(one)
(12) Particles (discourse):	
	啊 *a3*

As the above results show, morphemes (in boldface) such as *wo214* (I), *shi51* (BE), *you214* (have) and *de3* (structure particle) appear frequently both in first and second position in mono-mono disyllabic contractions. These monosyllabic morphemes are used in a relatively wide range within their morphological context. To take *de3* as an example, *wo214de3jia55* (my house) may be pronounced with a short break before or after *de3* to express the focus of this phrase. However, some other morphemes preferably appear in the second position and some in the first position. Suffix-like morphemes were exclusively identified in the second position such as classifiers (*ge3*

and *zhong214*), the plural suffix (*men3*), the discourse particle (*a3*), and the aspect particle (*le3*), whereas determiners (*zhe51* and *na51*) only appear in the first position of syllable contractions. This indicates the fact that not only fixed word pattern and high word frequency play a role in the production of syllable contractions, but that morphological preferences can also be found. Determiners precede classifiers and nouns. Thus, when syllables are contracted, determiners are more likely to be combined with a following than a preceding syllable. The same behaviour can be observed in plural suffixes. The plural suffix *men3* is used after a noun to mark the plural form; and suffix syllables are usually weakly stressed. Therefore, when syllables are merged, the plural suffix is more likely to stick to the preceding noun.

3.3 Initials and finals of contracted syllables

With respect to adjacent phonemes in contracted syllables, the results of disyllabic contraction clearly show that it is more likely to find contracted syllables when the first syllable is an open syllable. This is shown in Table 2, where N, V, and C represent nasals, vowels, and all consonants except nasals. The ratio of tokens over types is much higher in the cases of V-C, V-N, and V-V combinations than in the case of closed syllables.

Table 2: Final and initial phonemes in disyllabic contractions

final of σ1	initial of σ2	types	tokens	tokens/type
N	C	361	1,587	4.4
N	N	20	75	3.8
N	V	173	719	4.2
V	**C**	**764**	**4,787**	**6.3**
V	**N**	**73**	**909**	**12.5**
V	**V**	**429**	**3,059**	**7.1**

Comparing disyllabic contractions with trisyllabic contractions, we found that the second syllable (σ2) and the third syllable (σ3) show similar behaviour at syllable boundaries to that of the disyllabic contractions, as shown in Table 3. Open syllables are more likely to be contracted with the next syllable. Among all syllable contractions having an open first syllable, the V-C group is the largest in both Tables 2 and 3.

Table 3: Final and initial phonemes in trisyllabic contractions

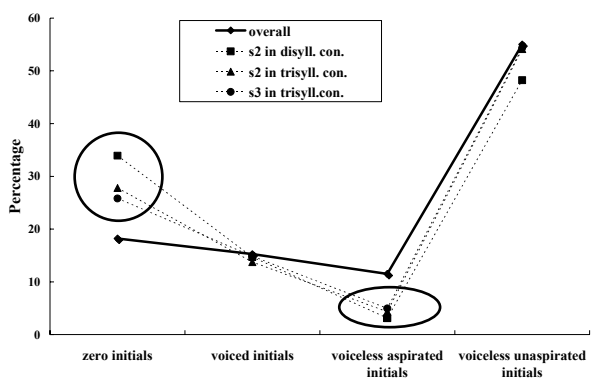
final of σ1	Initial of σ2	types	tokens	tokens/type	final of σ2	initial of σ3	types	tokens	tokens/type
N	C	139	193	1.39	N	C	114	154	1.35
N	N	11	14	1.28	N	N	12	12	1
N	**V**	**52**	**105**	**2.02**	N	V	38	45	1.18
V	**C**	**344**	**696**	**2.02**	**V**	**C**	**371**	**719**	**1.94**
V	N	60	84	1.40	**V**	**N**	**84**	**118**	**1.41**
V	**V**	**183**	**275**	**1.50**	**V**	**V**	**170**	**319**	**1.88**

The fact that voiced consonants are more easily changed is well-known in Archaic Chinese phonology (Lung 1979). In the history of Chinese phonology, voiced consonants became unvoiced, flat tones became aspirated and oblique tones became unaspirated. Due to the important role aspiration plays, we take into account both features *voiced* and *aspirated* in our classification of initials. We grouped the initials of the second syllable in disyllabic contractions (the dotted line marked by squares in Figure 1) and the initials of the second (the dotted line marked by triangles) and the third (the dotted line marked by circles) syllables in trisyllabic contractions into four categories:

1) zero initials
2) voiced initials ([l], [z̧], [m], [n])
3) voiceless aspirated initials ([p^h], [t^h], [k^h], [$tɕ^h$], [$tʂ^h$], [ts^h])
4) voiceless unaspirated initials ([p], [t], [k], [tɕ], [tʂ], [ts], [f], [x], [s], [ɕ], [ʂ])

Their distributions (dotted lines) relative to the distribution found in the overall data (the solid line) are shown in Figure 1.

Figure 1: Initials in the second syllable in contraction



The percentage of voiced and voiceless unaspirated initials in the non-first syllables in contractions is similar to that of the overall syllables. It implies that no clear preference for voiced or voiceless unaspirated consonants in the initial position of the second syllable can be found. But zero initials in the second syllable were more likely, as the percentage of syllables with zero initials in the overall data is clearly lower than that of the other three cases. On the other hand, voiceless aspirated initials in the second syllable were less likely found contracted with a preceding syllable. This may imply that aspiration is a distinctive feature possibly preventing syllable contraction in rapid speech. The complex articulatory effort required for aspirated consonants and the phonemic contrast of aspiration in the Mandarin sound system may be factors that prohibit drastic reduction or deletion.

3.4 Syllable structure of four frequent non-word contractions: *wo shi you de*

Word frequency is also a factor influencing production of syllable contraction in colloquial speech. This section is concerned with frequent combinations of syllable contractions which are not words in and of themselves, but composed of parts of several words. We chose this group of contraction occurrences, because on the one hand, we would like to observe samples of sufficient size. On the other hand, we would like to exclude the factor of highly frequent use of fixed words. We chose four monosyllabic words: *wo214* (I), *shi51* (BE), *you214* (have) and *de3* (structure particle) from §3.2 which occurred more than 100 times both in the first and the second positions of contracted syllables. Results are illustrated in Table 4.

Table 4: Syllable structure in disyllabic contractions

Disyllabic Contractions	First Syllable	Second Syllable	First Syllable	Second Syllable
Initial Consonants	wo214- I- [uo]-	[p](1), [t](19), [x](29), [tɕ](30), [l](1), [m](384), [ʂ](22), [t^h](1), [ɕ](3) total = 490	[p](3), [ts^h](1), [$tʂ^h$](1), [t](14), [f](1), [k](47), [x](3), [tɕ](4), [k^h](2), [l](6), [m](5), [n](25), [p^h](1), [$tɕ^h$](4), [ʐ](3), [ʂ](9), [t^h](4), [ɕ](11), [ts](6), [tʂ](4) total = 154	-wo214 -I -[uo]
Zero Initials		[a](1), [i](9), [iao](15), [ie](74), [iou](8), [o](1),	[e](2), [iou](1), [ue](4), [uei](1), [uo](1), [ye](1)	

		[ua](1), [uo](1) total = 110	total = 10	
Initial Consonants	shi51- BE- [ʂɪ]-	[p](8), [x](25), [l](3), [m](1), [n](9), [ʂ](5), [ts](1), [tʂ](1) total = 53	[p](57), [t](94), [f](1), [k](4), [x](45), [tɕ](288), [k^h](140), [m](2), [n](7), [s](5), [ʂ](3), [t^h](7), [tʂ](38) total = 691	-shi51 -BE -[ʂɪ]
Zero Initials		[a](2), [i](38), [iao](13), [io](2), [iou](5), [uo](4) total = 64	[ie](8), [uo](18) total = 26	
Initial Consonants	you214- have- [iou]-	[t](8), [k](3), [l](3), [m](1), [z̩](4), [x](2) total = 21	[p](1), [t](18), [k](2), [x](65), [tɕ](7), [k^h](1), [m](297), [n](5), [$tɕ^h$](1), [s](6), [ʂ](8), [t^h](11), [ɕ](1), [ts](1), [tʂ](19) total = 443	-you214 -have -[iou]
Zero Initials		[a](7), [ai](1), [i](97), [ia](1) total = 106	[iao](4), [io](1), [iou](3), [ie](5), [uo](7), [ye](1) total = 21	
Initial Consonants	de3- str. part.- [tɤ]-	[x](25), [tɕ](1), [l](1), [m](1), [n](2), [z̩](43) total = 73	[p](26), [ts^h](8), [$tʂ^h$](18), [t](50), [f](7), [k](15), [x](27), [tɕ](34), [k^h](10), [l](25), [m](14), [n](16), [p^h](5), [$tɕ^h$](25), [z̩](3), [s](4), [ʂ](28), [t^h](40), [ɕ](21), [ts](22), [tʂ](103) total = 501	-de3 -str. part. -[tɤ]
Zero Initials		[a](44), [ai](8), [e](1), [i](25),	[i](3), [iao](2), [ie](2), [iou](5),	

	[ia](2), [ie](3), [iou](1), [o](7), [uo](1) total =92	[ua](3), [uei](3), [uo](18), [ye](3) total = 39

According to Table 4, the following results are observed. First of all, there are more restrictions on the initial consonant of the second contracted syllable than on that of the first contracted syllable. As mentioned at the beginning of §2, there are in total 21 consonants in Mandarin. Table 4 shows that *wo214* (I), *shi51* (BE), *you214* (have) and *de3* (structure particle) are found contracted in the first syllable position followed by syllables with 9, 8, 7, and 6 different initial consonants respectively, whereas when they are found in the second contracted syllable, they are preceded by syllables having 20, 13, 15, and 21 different initial consonants.

Secondly, results demonstrated in §3.3 are proven once again. Syllables with zero initials are more likely to be contracted with their preceding syllables. The same applies to the voiced group ([l], [m], [n], [ʐ]). Only one single aspirated initial consonant was found in Table 4 (wo214-, [t^h]). This strengthens the proposal of a possible prohibitory effect of the distinctive feature *aspiration* in the merging of syllables in Chinese. The proportion of zero initials in the second contracted syllable is clearly smaller than that of zero initials in the first contracted syllable.

Third, back vowel ending syllables prefer front vowel starting syllables and vice versa. Mid vowels can be combined with both front and back vowels. This complementary combination tendency is observed in the case of *wo214*- ending with a back vowel [o]. [o] is followed by 110 zero initial syllables, 107 staring with front vowels (106 [i] and 1 [a]), and 3 starting with back vowels (1 [o] and 2 [u]). Similarly, *you214*- ending also with a back vowel [u] is contracted with syllables starting with [i] 98 times and [a] eight times. The close-mid centralized back vowel [ɤ] in cases of *shi51*- and *de3*- is followed both by front and back vowels, but with a preference for [i] and [a]. To analyze the complementary effect from the other direction, -*wo214* starting with a back vowel [u] is preceded by syllables ending with eight front vowels (7 [e] and 1 [i]) and two back vowels (1 [u] and 1 [o]). Starting with a front vowel, -*you214* follows 15 back vowels ending syllables (12 [o] and 3 [u]) and six syllables ending with a front vowel [e]. Similar to the *shi51*- and *de3*- cases, [ɤ] in cases of -*shi51* and -*de3* is also found following both back and front vowels.

Fourth, zero initial syllables starting with the rounded high front vowel [y] are only found in the first contracted syllables, not in the second contracted syllables. *Roundedness* may, like *aspiration*, also be a distinctive feature prohibiting syllable contraction.

4. Some observed segmental changes in Mandarin syllable contraction

When a syllable $C_1V_1X_1$ is contracted with another syllable $C_2V_2X_2$, the resulting syllable CVX will undergo the following process: 1) deletion of C_2, 2) retention of X_2, 3) spreading of X_1 (nasals [n] and [ŋ]) in some cases, 4) V_1/V_2 reduction, and 5) reduction of C_1. Note that X and X_n designate the coda consonant only. As we have seen in §3.3 and §3.4, syllables with aspirated voiceless initial consonants are less likely to be contracted with a preceding syllable, and zero initial syllables are, by contrast, more likely to be contracted with preceding syllables. Initial consonants in the second contracted syllable will usually be dropped within the process of syllable contraction in the above cases and in the case of voiced initials and unaspirated voiceless initials.

Differing from initials, the ending consonant [n] and [ŋ] in the first syllable will sometimes leave a trace by spreading nasality to the newly created nucleus, where the ending nasals in the second syllable always stay unreduced. Furthermore, according to the edge-in theory, C_1, like X_2, should remain. However, in our data it is not always the case. We can still observe different reduction types of initials of the first contracted syllable, which will be introduced in §4.2 and §4.3. On the basis of our data, a number of initial consonants in the first contracted syllable clearly keep their original pronunciation: the lateral [l], the bilabial phonemes [m], [p], [p^h], the nasal [n], the velar stop [k], the labiodental fricative [f], and the alveolar fricative [s].

Reduction of initial consonants may also interact with reduction of nucleus, namely V_1 and V_2. The following sections are concerned with a number of observed V_1/V_2 and C_1 reductions in terms of their acoustic features. Some special initial consonants that are realized differently from their original pronunciation when combining with the new nucleus due to syllable contraction are also considered.

4.1 Vowel deletion/preservation/neutralization

Based on analyses in §3.4, it seems that [±backness] has an effect on the merging of nuclei of the first and the second syllables in contraction. Starting from this contrast, preliminary investigation of our data supports the notion that the merging of the nuclei in syllable contraction is likely to be grouped into contrasting and non-contrasting pairs of backness/frontness. Contrasting pairs have a non-mid contrast of the beginning vowel of the second syllable in contraction and the ending vowel of the preceding syllable, such as a front-back contrast where the ending vowel of the first syllable is a front vowel and the beginning vowel of the second syllable is a back vowel. In such cases, preferences of preservation of the representative contrasting vowels were observed. The merging process of nuclei does not seem to be influenced by the initial

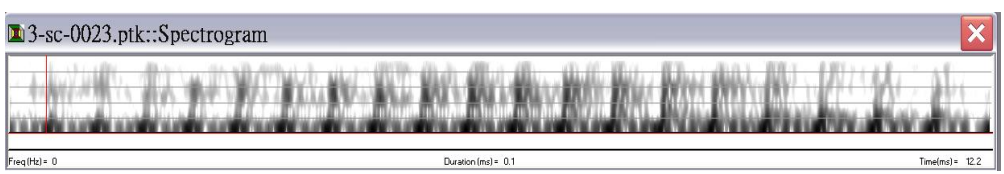
consonant. Segmental influences as suggested by Traunmüller (1999) are not present in the case of syllable merging and remain at the level of allophonic variation. It is important to note here that with respect to vowel contrast the contraction data we examined contains very few diphthongs or triphthongs. So, we are currently not able to make claims as to whether the domain of contrast is exactly related to the vowels around the syllable boundary (i.e., including the glides) or to the main vowels of each syllable only.

4.1.1 Front-back pairs

The merging starts with preserving the ending front vowel of the first syllable and the beginning back vowel of the second syllable. Then all other vowels will either be deleted or neutralized in favor of the new nucleus. In extremely shortened cases, one of the front-back contrasting vowels will be deleted, too. In ex1, [ʔɑ̃] is an extremely shortened form of [zn̩an35 xou51] resulting from the influence of the back vowel [o] on the preceding front vowel [a]. The average duration of one syllable produced by this speaker is 152 msec, but the duration of two syllables in ex1 is heavily reduced to 82 msec. In ex5, ex9, and ex16, the above-mentioned process can be observed with different realization forms of contraction. For instance, in Figures 2 and 3, *yin55wei51* shows two different realization forms due to different degrees of contraction. In Figure 2, both [i] from the first syllable and [u] from the second syllable are present; F1/F2 values of the peak of [i] and [u] are 306Hz/2283Hz and 281Hz/927Hz, respectively. However, due to heavy reduction, we can only observe [i] in Figure 3, where its F1/F2 values are 365Hz/2622Hz.

ex1	然後	*ran35hou51*	[zn̩an35 xou51] => [ʔɑ̃35]
ex5	因為	*yin55wei51*	[in55 uei51] => [iun53], [in53]
ex9	時候	*shi35hou51*	[ʂɿ35 xou51] => [sou214], [so53], [io5]

Figure 2: Spectrogram of [iun] and FFT of [i] and [u], respectively



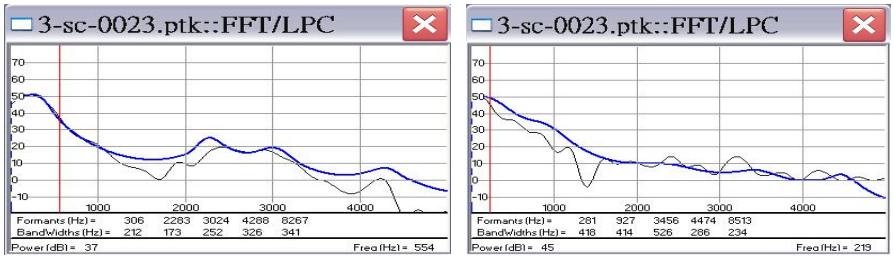
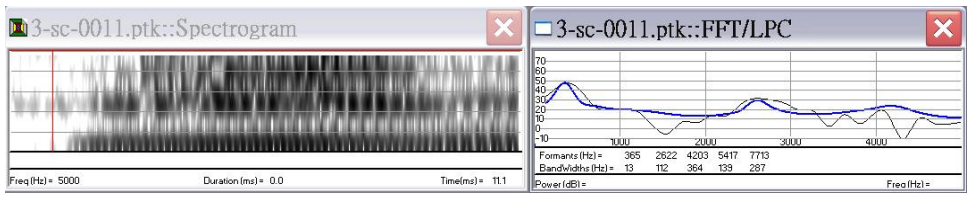


Figure 3: Spectrogram of [in] and FFT of [i]



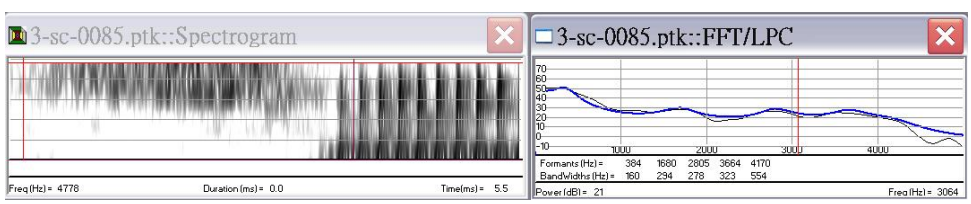
It is clearly shown here that syllable contraction is a continuous process. That is, the merged syllables may have different forms resulting from different levels of reduction.

4.1.2 Back-front pairs

The back-front pairs behave similarly to the front-back pairs. The realization forms of ex2, ex4, and ex6, as listed below, show contractions to different degrees. The spectrogram for ex6 is illustrated in Figure 4. The back vowel [o] is neutralized in the way of lifting the F2 value and becomes a mid vowel [ɛ].

ex2	對啊	*dui51a3*	[tuei51 a3] => [t^hɤa 513], [tɤa513]
ex4	我們	*wo214men3*	[uo214 mɤn3] => [uom51], [om55], [m5]
ex6	所以	*suo214yi214*	[suo214 i214] => [suɤ53], [s^wɛ53]

Figure 4: Spectrogram of [s^wɛ53] and FFT of [ɛ]



4.1.3 Non-contrasting pairs

When the neighboring vowels do not have a backness contrast, i.e., front-front/ back-back combinations, the resulting main nucleus in most cases will be front in front-front cases and back in back-back cases. All other vowels will be neutralized in favor of the new nucleus. Examples are given below.

ex3	這樣	*zhe51yang51*	[tʂɤ51 iaŋ51] => [zɤaŋ51], [tɕiaŋ51]
ex10	覺得	*jue35de3*	[tɕye35 tɤ3] => [dʒɤ55], [zʏɤ55]
ex11	現在	*xian51zai51*	[ɕian51 tsai51] => [ɕɪain:55], [ɕɪan:53]
ex13	可以	*ke214yi214*	[k^hɤ214 i214] => [kɤ3]
ex14	其實	*qi35shi35*	[$tɕ^h$i35 ʂɪ35] => [$tɕ^h$ɪ:35]

In Figure 5, the back mid-vowel [ɤ] in [tʂɤ51 iaŋ51] disappears and the disyllabic word results in a new syllable [tɕiaŋ51] with [ia] as its main vowel. As [tʂ] cannot be followed by vowels starting with [i] after the deletion of [ɤ] (otherwise, this will violate Mandarin phonotactics) and both *zhe51* and *yang51* have falling tone, the contraction form naturally adopts the existing legal syllable [tɕiaŋ51] with a falling tone, as shown in Figure 5.

Figure 5: Spectrogram of [tɕiaŋ] variation of [tʂɤ51 iaŋ51]

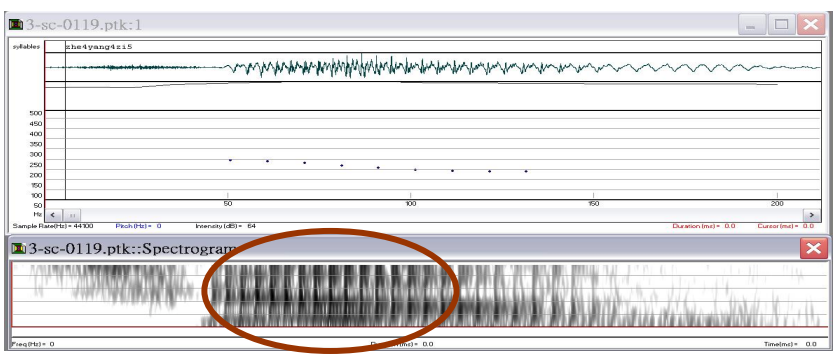
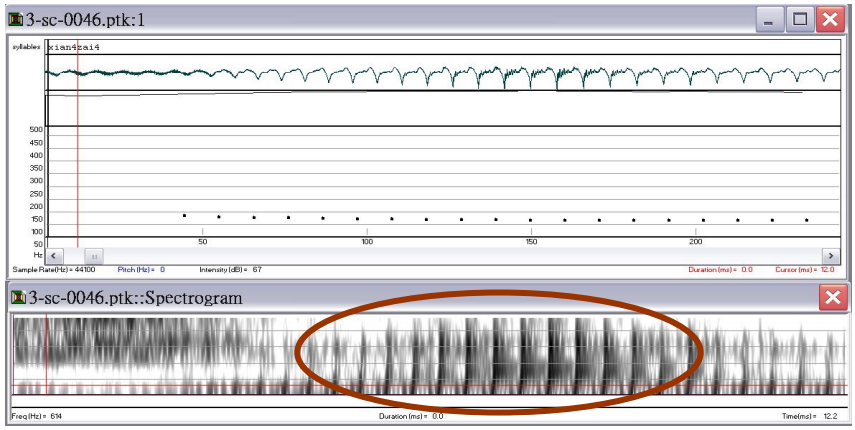


Figure 6 shows the new [ɪai] nucleus resulting from the contraction of [ɕian51 tsai51]. The front vowels [ia] and [i] are merged together resulting in [ɕɪain:] with a prolonged ending nasal ([a] is attached to the first [i] rather than the second [i] both in perceptual and acoustic judgments). The even more shortened form of [ɕian51 tsai51] is [ɕɪan:]. The merging of non-contrasting nuclei varies, but front-front combinations remain front in this case.

Figure 6: Spectrogram of [ɕɨain:] variation of [ɕian51 tsai51]

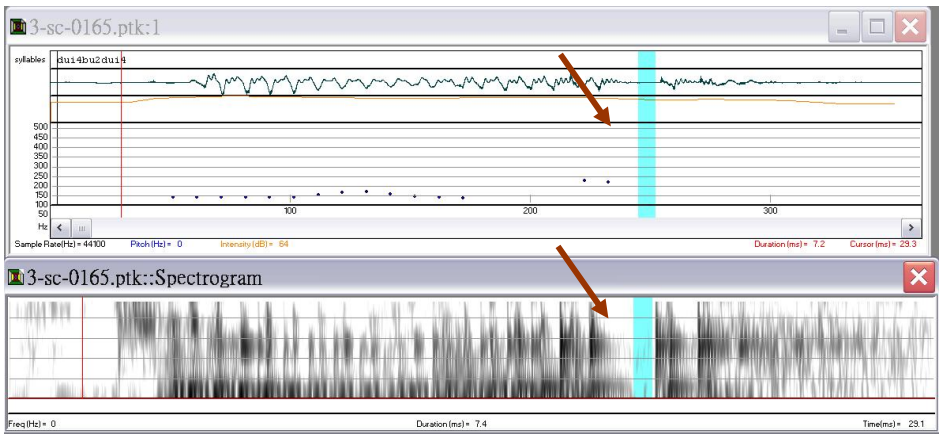


4.2 Glottalization/palatalization

In our data, the initial phonemes of the first syllable are produced as a glottal stop [ʔ] instead of their original pronunciation in cases of [z̩], [t^h], [p], and [t]. These consonants do not form a natural class in Chinese phonology. However, for [t^h], [p], and [t], [+anterior] might be the common feature. For the retroflex consonant [z̩], its following vowel seems to be a factor influencing the reduction, because only [z̩] preceding [a] was observed to reduce to a glottal stop. Currently, we are looking for more plausible cues for glottalization by examining acoustical measurements. Examples of glottalization are as follows. Figure 7 exemplifies the phenomenon of glottalization, where [pu35] between two [tuei51] is reduced to a glottal stop.

ex 1	然後	*ran35hou51*	[z̩an35 xou51] => [ʔɑ̃35]
ex12	他們	*ta55men3*	[t^ha55 mɤn3] => [ʔam53]
ex18	對不對	*dui51bu35dui51*	[tuei51 pu35 tuei51] => [tueʔtue52524]
ex19	我覺得	*wo214jue35de3*	[uo214 tɕye35 tɤ3] => [uotɕɤʔ21452]

Figure 7: Glottal stop in [tuei51 pu35 tuei51]



The other kind of consonantal change is palatalization; the retroflex affricate [tʂ] will be produced as an alveolo-palatal affricative [tɕ].

ex3 這樣 *zhe51yang51* [tʂɤ51 iaŋ51] => [tɕiaŋ51]

One thing to note with this example is that *zhe51yang51* is a word used very frequently in spoken Mandarin. When a dramatic reduction is necessary, the easiest way is to use an existing syllable instead of two syllables. As predicted in §4.1, [i] and [a] from the second syllable remain unchanged after neutralizing the mid vowel [ɤ] from the first syllable, because the syllable [tʂiaŋ] is not available in Mandarin, but [tɕiaŋ51] does exist. In our corpus, this way of pronunciation of *zhe51yang51*, as illustrated in Figure 5, is consistent across most of the speakers. Even in the writing, [tɕiaŋ51] representing *zhe51yang51* in sentences is written in 將 or 醬. In addition, the way of pronunciation of [tʂ] in colloquial Mandarin is usually the voiced [z] or the affricate [ts]. Figures 8 and 9 show that different from [z] and [ts], the palatalized [tɕ] has almost no energy under 2000 Hz (Petursson and Neppert 1991).

Figure 8: FFT illustration of [z] and [ts] variations of [tʂ], respectively

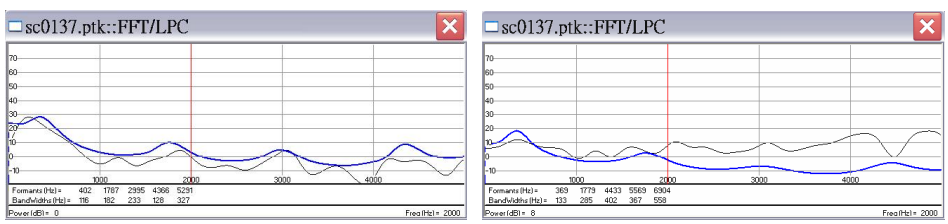
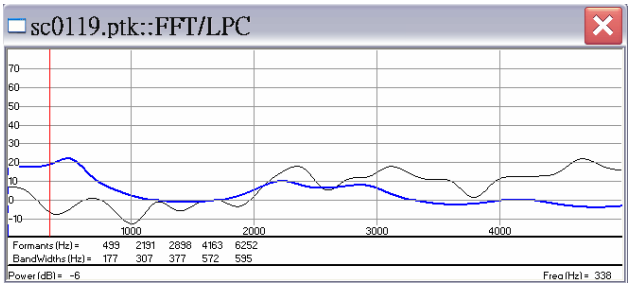


Figure 9: FFT illustration of [tɕ] variation of [tʂ]



4.3 Voicing

Also observed in our data, voiceless consonants may be pronounced voiced in favor of the nucleus. In ex10, in order to retain [ɤ] of the second syllable and the rounded front vowel [y] of the first syllable, the duration of the vowel part is prolonged and the voicing is shifted earlier. Therefore, [tɕ] is voiced and pronounced with [dʒ], as shown in Figures 10 and 11. This is the hypothesis we are now working on to investigate further the voicing phenomenon.

ex10　　覺得　　*jue35de3*　　[tɕye35 tɤ3] => [dʒɤ55]

Figure 10: Spectrogram of [tɕ] in [tɕye35]

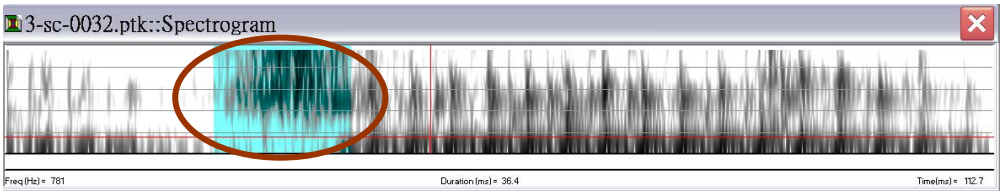
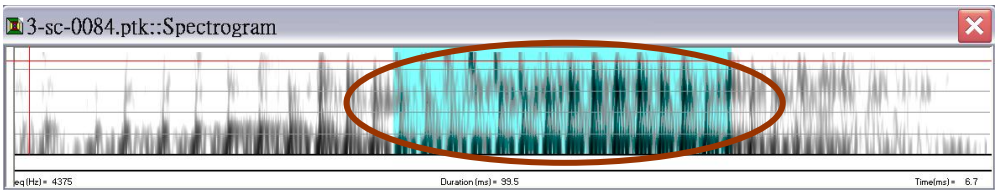


Figure 11: Spectrogram of [dʒ] Variation of [tɕye35]



4.4 New coda consonant [m]

The new syllable resulting from syllable contraction needs to satisfy the Mandarin

phonotactics. There are some exceptions found in our data. Most clearly, we observed that some contracted syllables have a clear coda consonant [m] (often lengthened), which is a reduced form of the plural suffix *men3*. [m] in the coda position is a phenomenon often discussed in historical Chinese phonology (Feng 2002). Although [m] is not allowed to occupy the coda position in modern Mandarin, it can be found in Chinese dialects such as Southern Min and Hakka. Plural pronouns *ta55men3* 'they' and *wo214men3* 'we', which are used very frequently in spoken Mandarin, demonstrate this phenomenon. Figure 12 shows an ending consonant [m] with energy in low frequency domain in the contraction of *ta55men3* ([t^ha55 mɤn3]). In some extreme cases, the first syllable may completely disappear and the only speech sound left is the initial consonant of the second syllable [m], not the nucleus. For instance the pronunciation of *wo214men3* may be [um] (Figure 13) or merely [m] (Figure 14). Despite the violation of Mandarin phonotactics, CVm is a possible syllable structure in Mandarin often identified in our data. But other violation cases, such as contracted [nzoŋ5214] (ex 16) and [ɕɪain:55] (ex 11) are observed in a very restricted cases in our data, and do not often occur in Mandarin.

ex12 他們 *ta55men3* [t^ha55 mɤn3] => [ʔam53]
ex4 我們 *wo214men3* [uo214 mɤn3] => [uom51], [om55], [m5]

Figure 12: Waveform and spectrogram of [ʔam] variation of [t^ha55 mɤn3]

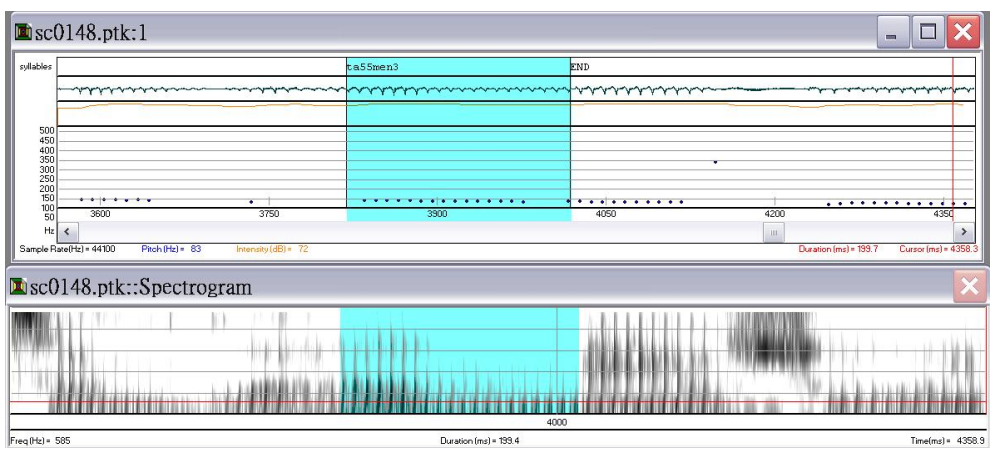


Figure 13: Spectrogram of [um] variation of [uo214 mɤn3]

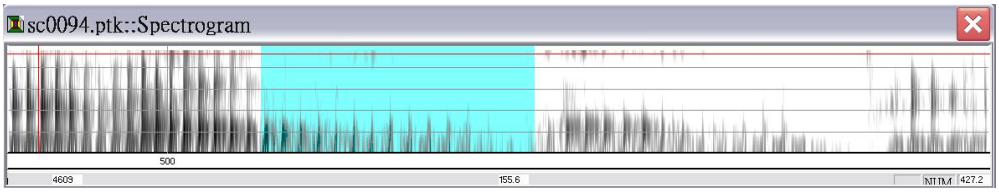
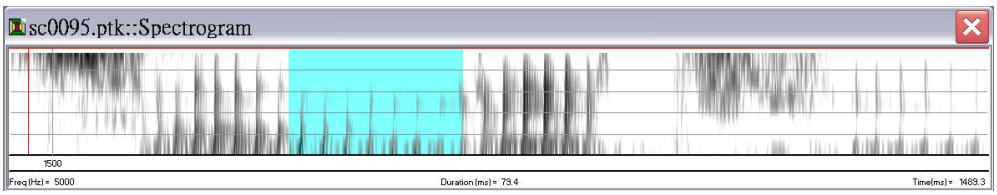


Figure 14: Spectrogram of [m] variation of [uo214 mɤn3]



4.5 Other segmental changes

A number of segmental changes in rapid Mandarin speech were not discussed above because they are typically reduced forms in both contracted and non-contracted cases. Vowel nasalization may result from the ending nasal of the first contracted syllable. With respect to consonant reduction, Taiwan Mandarin normally uses [ts], [ts^{h}], [s], and [z] instead of [tʂ], [tʂ^{h}], [ʂ], and [ʐ]. Similarly, aspirated consonants may be reduced to unaspirated in rapid speech as well.

5. Conclusion

This paper provides empirical data of syllable contractions and demonstrates the importance of quantitative corpus-based analyses of spoken data. Not only can empirical investigation validate theoretical considerations and predictions, they also point to areas for further theoretical investigation. Syllable contraction is at the same time a phonological and phonetic issue. Given a combination of syllables, different degrees of reduction lead to different forms of contractions, depending on the speaking tempo of the speaker and the phonological environment of the syllables. In our syllable contraction data, different phases of reduction have been observed. The edge-in theory is a fundamental basis for discussion of syllable contraction. However, the occurrences of syllable contraction discussed here illustrate the fact that the predicted result of the edge-in theory is not unique, as contraction is a continuous process. Sonority does not play a central role in merging nuclei in Mandarin as it does in Southern Min. Instead,

the vowel front/back contrast seems to be an important factor determining the final form of the contracted nucleus. Initial consonantal reductions/changes can be directly and sometimes indirectly, observed. Sometimes it has to do with phonological conditions, as in the case when the voiced fricative [z̩] is pronounced with the glottal stop [ʔ] when preceding [a]. Sometimes it has to do with the vocabulary of a language. For instance, [tʂ] in *zhe51yang51* 'this' is pronounced with [tɕ] because no legal Mandarin syllable [tʂiaŋ] is available while the frequent and legal syllable [tɕiaŋ] is available. The hypotheses concerned with nuclei merging and changes in initial consonants need to be examined further with more data. One vision we have is that we may find phonetic clues for some sound changes that took place in the history of Chinese phonology and one day we might be able to predict what sound changes will happen in the future.

References

Auer, Peter, and Susanne Uhmann. 1988. Silben- und akzentzählende Sprachen. *Zeitschrift für Sprachwissenschaft* 7.2:214-259.

Barras, Claude et al. 2001. Transcriber: development and use of a tool for assisting speech corpora production. *Speech Communication* 33:5-22.

Chao, Yuen Ren. 1968. *A Grammar of Spoken Chinese*. Berkeley: University of California Press.

Chao, Yuen Ren. 1976. *Aspects of Chinese Sociolinguistics*. Stanford: Stanford University Press.

Chen, Keh-Jiann, and Chu-Ren Huang. 1996. SINICA CORPUS: Design Methodology for Balanced Corpora. *The Proceedings of the Eleventh Pacific Asia Conference on Language, Information and Computation*, 167-176.

Cheng, Robert L. 1985. Sub-syllabic morphemes in Taiwanese. *Journal of Chinese Linguistics* 13.1:12-43.

Chung, Raung-Fu. 1997. Syllable contraction in Chinese. *Chinese Languages and Linguistics III: Morphology and Lexicon*, ed. by Feng-fu Tsao and H. Samuel Wang. Taipei: Institute of History and Philology, Academia Sinica.

Duanmu, San. 2000. *The Phonology of Standard Chinese*. Oxford: Oxford University Press.

Engstrand, Olle. 1992. Systematicity of phonetic variation in natural discourse. *Speech Communication* 11:337-346.

Feng, Chun-Tian. 2002. Contraction of numerals. *Linguistic Research* 2:38-44. (in Chinese)

Ho, Dah-an. 1996. *Some Concepts and Methodology of Phonology*. Taipei: Da-An Press.

(in Chinese)

Hsiao, Yuchau E. 2002. Tone contraction. Paper presented at the 8th International Symposium on Chinese Languages and Linguistics. Taipei: Academia Sinica.

Hsu, Hui-chuan. 2003. A sonority model of syllable contraction in Taiwanese Southern Min. *Journal of East Asian Linguistics* 12.4:349-377.

Lung, Yu-Chun. 1979. A discussion of the theory that *yin-sheng* words end with final consonants. *Bulletin of the Institute of History and Philology, Academia Sinica* 50.4:679-716. (in Chinese)

Petursson, Magnus, and Joachim Neppert. 1991. *Elementarbuch der Phonetik*. Hamburg: Helmut Buske Verlag.

Shih, Chi-Lin. 1986. *The Prosodic Domain of Tone Sandhi in Chinese*. San Diego: University of California dissertation.

Traunmüller, Hartmut. 1999. Coarticulatory effects of consonants on vowels and their reflection in perception. *The Proceedings from the XIIth Swedish Phonetics Conference*, 141-144.

Tseng, Shu-Chuan. 2001. Highlighting utterances in Chinese spoken discourse. *The Proceedings of the Fifth Pacific Asia Conference on Language, Information and Computation*, 163-174. Hong Kong.

Tseng, Shu-Chuan, Yi-Fen Liu. 2002. *Annotation of Spontaneous Mandarin*. Technical Report No.02-01. Taipei: Chinese Knowledge Processing Group, Academia Sinica. (in Chinese)

[Received 3 October 2003; revised 1 March 2004; accepted 2 March 2004]

Institute of Linguistics
Academia Sinica
130, Sec. 2, Academia Road
Nankang, Taipei 115, Taiwan
tsengsc@gate.sinica.edu.tw

現代漢語音節縮讀

曾淑娟
中央研究院

自然語流包含不同程度的語音縮讀。本文運用現代漢語連續語音語料庫檢視與分析自然語音中的縮讀現象。量化分析與聲學測量的結果發現語音縮讀原應是一個連續過程，並且所指引到的最終縮讀形式是可預期的。因爲語料顯示出同一組音節會有多種縮讀結果，但都是演化至某一特定音節。另外，構詞分布也對縮讀音節位置有影響。如同後綴則是較常出現在縮讀的後面位置。零聲母音節較常與前置音節縮讀；帶送氣聲母音節則較不可能出現在後置音節。聲學測量結果顯示在縮讀時輔音不至於影響元音的連併，反而是來自各個音節的元音之間的差異性（諸如前後元音對比）影響較大。有時前置縮讀音節的聲母也發現有顎化等變化。利用自然語流材料，本文不僅實證有關縮讀的理論，更對自然語流的語音變化研究提出新的方法。

關鍵詞：音節弱化，自發性口語，現代漢語