

# The Creaky Voice Phonation And The Organisation Of Chinese Discourse

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## Abstract

The term voice quality or phonation types often come from studies of pathological speech. In normal speech speakers use different phonation types in some languages for linguistic distinction, prosodically as a boundary signal and in attitudes and emotions.

Our paper aims to describe the different phonation types that occur in Standard Chinese TV newscasts and the relationship between creaky voice phonation and the prosody structure of such corpus.

## 1. Introduction

### 1.1. Chinese language

The prosody of a spoken message can be manifested in a number of acoustic characteristics. Chinese is a tone language and like other languages, discourse is organized by intonation. A lot of works have now been done on the relationship between tone and intonation. And there is evidence that Chinese discourse is hierarchically organised by intonation. And that it exists a declination tendency along the utterance Furthermore this tendency is organised thanks to the discourse structure: proposition, sentence, paragraph. (Shih, Belotel-Grenié). As far as we know there is no study about the relationship between phonation types and discourse prosodic structure in Chinese.

Anatomical differences and a person's phonetic habits constitute the cues about the speaker's identity. Many languages of the world use differences in voice quality or phonation type to contain linguistic functions. For example, in some African languages creaky voice phonation is used for phonological contrast to distinguish types of consonants and vowels from sounds with normally voiced phonation (Laver 1994). Thus in certain languages or dialects, lexical items are differentiated solely on the basis of differences in voice quality, it is not the case in Chinese.

### 1.2. What we mean by creaky voice phonation

Creaky voice phonation contrasts lexically with modal voice in many languages (Chinese dialects for example) but not in Standard Chinese.

What we call phonation types is the different states of the glottis during phonation. It can be distinguished four types of phonation: modal voice, breathy voice, creaky voice, and whisper. Creaky voice phonation (or vocal fry) is typically associated with vocal folds that are tightly adducted but open along a portion of their length. The acoustic result is a series of irregularly spaced vocal pulses that give the impression of "a rapid series of taps, like a stick being run along a railing" (Catford, 1964). Relative to modal phonation creaky phonation is characterized by irregularly spaced pitch period and decreased acoustic intensity as well as a lowered fundamental frequency

Creaky phonation is characteristically associated with aperiodic glottal pulses. The degree of aperiodicity in the glottal source can be quantified by measuring the "jitter", the variation in the duration of successive fundamental cycles. Jitter values are higher during creaky phonation than other phonation types as it been found for Burmese (Maddieson, 1985) or Jalapa Mazatec (Kirl et al. 1993).

Another major acoustic parameters that reliably differentiate phonation types is spectral tilt. Spectral tilt can be quantified by comparing the amplitude of fundamental to that of higher frequency harmonics, e.g. the second harmonic or the harmonic closest to the first formant. Spectral tilt is characteristically more steeply positive for creaky voice vowel. In creaky voice vowel the amplitude of the second harmonic is greater than that of the fundamental.

### 1.3. Previous studies

In previous studies (Belotel-Grenié & Grenié, 1994, 1995) we have shown that creaky voice phonation in Chinese isolated syllables occurs more often for low vowels and that creaky voice is highly correlated with tone 3 and tone 4. This appears also for male and female speakers.

For other languages than Chinese it was found (Henton & Bladon, 1987) that creak was more likely in syllables at the end of utterances than elsewhere. Redi and Shattuck-Hufnagel (2001) also shown for American English utterances that normal speakers exhibit glottalised voiced quality in association with the boundaries of intonation phrases. Creak is used to mark the end of both paragraphs and sentences within paragraphs (Kreiman 1982, Lehiste, 1975). Creak can also occur at the end of a single sentence in isolation. Voice quality changes have also been observed at the edges of smaller prosodic units. In spontaneous speech creaky phonation is often associated with hesitations.

## 2. The aim of our study

The aim of the present study is to determine in Standard Chinese connected speech (real speech) if like in other languages special phonation types in relation to sentence intonation occurs. Furthermore, we have examined what kind of word is pronounced with a different phonation type than modal voice, we also have examined on which position in the sentence the creaky voice word or syllable occur and the differences in stress and unstressed syllables. Because this is an ongoing study, we present here the first results only for two corpuses produced by two female speakers.

## 3. Methods

The corpus served for this experiment consists of two TV newscasts pronounced by two different female speakers.

After recording, the speech materials were digitalized at a 22 KHz sampling rate and than were analyzed, segmented and hand-labelled using praat 4.1. The first corpus is composed of three paragraphs with a total of 12 sentences and many enumerations. The second one is more longer than the first with 8 paragraphs and about 26 sentences (about 3 minutes of speech).

### 3.1. Determination of the phonation type

Creaky voice phonation and modal voice phonation are readily differentiated from each other by looking at basic displays such as waveforms and spectrograms. At the first step we had analyzed the waveforms and spectrograms. In fact, the oscillographic analysis is a good way to determine whether or not a syllable is pronounced with or without creaky voice. Spectrographic analysis is also a good way because the formants are particularly clear during creaky voice vowels, and fairly evident during the modal voice. The higher frequencies tend

to be more clearly visible during creaky vowels (Ladefoged & al., 1988). Examples 1 and 2 hereafter show an example of waveform and spectrogram of two words pronounced with creaky voice phonation. As the second step we have quantified the phonation types. To do so, the best way quantifying the creaky voice phonation is to measure the spectral tilt *i.e.* the amplitude differences between H2 (second harmonic) and H1 (the first harmonic or fundamental frequency) or between fundamental frequency and the harmonic the more intense in the first formant. Spectral tilt is characteristically most steeply positive for creaky vowels than for modal ones. In order to determine these differences we have measured this difference at the beginning of the vowel, at the middle and at the end of it.

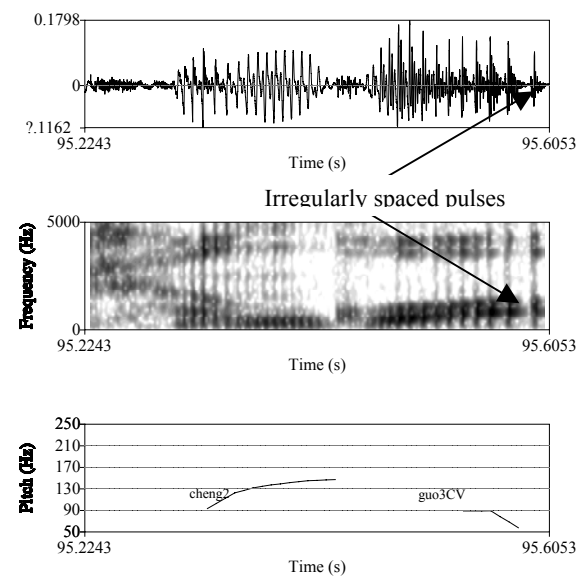
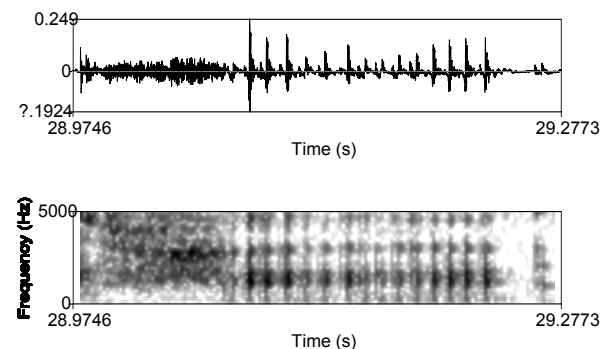


Figure 1: *oscillogram, spectrogram and F0 curve of the word cheng2gao3 (the second syllable is pronounced with creaky voice phonation) in the final position of sentence.*



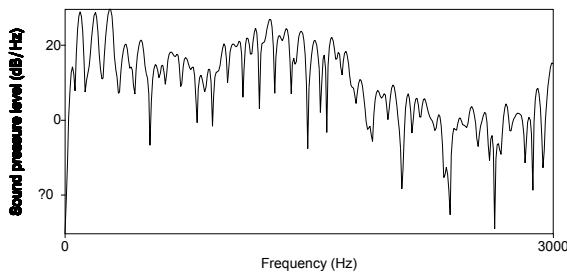


Figure 2: waveform, spectrogram and FFT spectrum of vowel /a/ in the middle of syllable ka3 (in the word xin4yong4ka3 “credit card”) pronounced with creaky phonation

After that we examine the relationship between creaky voice phonation and the vowel. We also examine the relationship between creaky voice phonation and the tone.

### 3.2. Tone and creaky voice

Professional female speaker pronounces both corpuses. In the first one, there are 28 syllables with creaky phonation. The Table hereafter shows the repartition of syllables with creaky phonation for the first corpus.

Table1: percentage of syllables pronounced with CV in regard to the total number of syllables, classed by tone categories

	Total	T0	T1	T2	T3	T'
Nb of syllables	298	17	55	40	64	121
Syllables with CV	28	06	0	01	17	04
% of CV	9.42	35	0	2.5	26.5	3.3

As it can be seen from Table 1, the syllables at tone 3 are more often pronounced (more than 50% of the total number syllables produced with creaky voice phonation) with creaky voice phonation than other. On the other hand no tone 1 syllables are associated with creaky voice phonation. We obtained similar results for the second corpus.

This result is not surprising because as we already shown in previous studies, creaky voice phonation is very well correlated with a lowered fundamental frequency values.

### 3.3. F0 and Creaky voice phonation

Creaky voice phonation occurs at the bottom of speaker’s pitch range. Creaky voice phonation always appears for very low F0 values, that is to say at the end of sentences, paragraphs. It can also appear at the end of prosodic group.

### 3.4. What kind of words are pronounced with creaky voice phonation

In table 2 we can see what kind of word or which syllable in the word is produced with creaky phonation.

Our results show that creaky voice phonation never occur on verbs At first glad it can be seen that more often this is the second syllable of dissyllabic word or the last syllable of trisyllabic words.

A little number of monosyllabic words is produced with creaky phonation. These syllables are unstressed ones. The monosyllabic words that are produced with creaky voice phonation are words without importance for the message comprehension. Most often they are grammatical particles at neutral tone placed at the end of utterances.

### 3.5. What is the position of these words in the sentence?

In the first corpus there are 12 sentences, seven of them are ending with a syllable pronounced with creaky voice phonation. Therefore, proposition and enumeration within sentences often ending with creaky voice phonation.

In the second corpus composed with 8 paragraphs and 26 sentences, all sentences end with creaky voice phonation. The creaky voice phonation that appears at the end of paragraphs is dispatched not only on the final syllable of the paragraph but very often at the penultimate one.

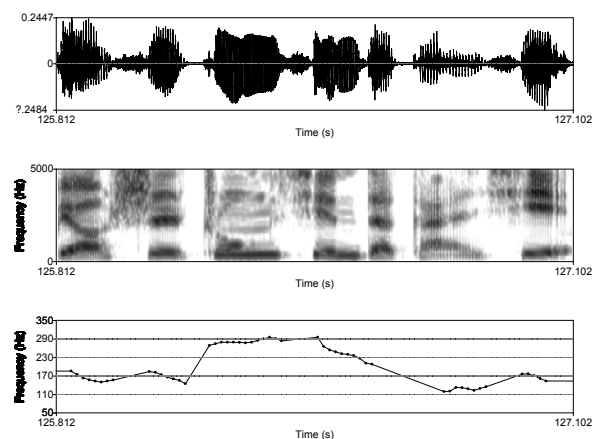


Figure 3: the last seven part of the sentence: xiang4 zhi1yuan2 san1xia2 gong1cheng2 jian4she4 de quan2guo2 ge4 zu2 ren2min2 xiang4 guan1xin1 san1xia2 gong1cheng2 jian4she4 de0hai3 nei4 wai4 ren2shi4 biao3shi4 zhong1xin1 de0 gan3xie4, last part of a paragraph, the two final syllables are pronounced with creaky voice phonation.

From this result, we can suppose as for other languages that prosodically creaky voice can be used

as a boundary signal, as an “end of utterance” phenomenon.

#### 4. Conclusion

The prosody of a spoken message can be manifested in a number of acoustic characteristics. In this ongoing research that have to be completed by the analysis of others corpuses, preminarily results show that creaky voice is used by speaker to mark the ends of both paragraphs, sentences within paragraphs and propositions within sentences.

It is possible that a paragraph is characterised by an overall intonation structure to which the intonation contours of its constituent is subordinated. Speakers use different voice quality variations with other phonetic cues *i.e.* drop in F0, decreased intensity, final lengthening and pausing to signal discourse structure.

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