Tones and Intonation in Declarative and Interrogative Sentences in Mandarin

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Abstract

This study investigates three modal variations in Mandarin Chinese: 1) declarative ("D"); 2) interrogative ended with the interrogative marker "ma" ("I-ma"), and 3) interrogative without "ma" (or "Rhetoric Question" - "RQ", demand of confirmation). The acoustic comparison of these variations shows precedence on the realization of modal intonation on any of the four tones in sentence-final position.

The instrumental analysis reveals that: 1) interrogative intonation (with or without the interrogative marker "ma") has a higher sentence-final melodic curve than the declarative counterpart; 2) the duration of the last syllable in the interrogative is shorter than that in the declarative. These results prove that even with the presence of the interrogative marker "ma", the interrogative is characterized with a specific prosodic melodic pattern, different from the ones used in the other modality variations.

1. Introduction

Some "Yes-No Questions" in Mandarin Chinese do not need the interrogative marker *ma* normally placed at the end of the sentence. In those cases, a specific prosodic variation is necessary to distinguish them from other modalities not marked by any modal markers, such as the Declarative. This kind of interrogative modality without *ma* is called "Rhetoric Question" ("RQ").

The difference between declarative and interrogative intonation has been much studied since 1950 by many linguists, but have never reached an agreement on this question.

Chao [1] for instance stated that the algebraic sum of tone and intonation accounted for the actual pitch movement in the sentence, which affects the actual falling and rising endings of any of the four Mandarin tones. Later, Garding [5,7] applied her "grid model" on Mandarin in order to describe the pitch range as a function of time. According to her, the difference between declarative and interrogative is marked by different grids used by the speakers.

Some researchers disagreed with this model which was thought to be too constrained for a complete description of the varied tonal configurations in Mandarin Chinese. Ho [9] [10] investigated the intonation acoustic correlates for exclamatory modality as well. His studies showed that 1) both intonation and word position influenced the fundamental frequency, tone range, and peak amplitude of syllable nuclei, and 2) the four tones in the sentence-final position are influenced by the intonation and despite these modifications, the basic characteristic of the tones remains very close to that of the ones found in isolated words. Shih and her colleagues [14], using the Stem-ML model to compare declarative and interrogative intonation in Mandarin, claimed that the difference between them resulted from an overall higher phrase melodic curve in the interrogative intonation, although the two intonation types are said to have parallel melodic curves.

In these perspectives, our study is also concerned with the interaction between tone and intonation in Chinese, interaction which is supposed to be maximal on the last syllable of a sentence for the various modalities. In this case, if there really appears a global variation on the rest of the sentence before the last syllable, it will be considered to be of minor importance.

The role of the interrogative intonation in sentences marked by the modal marker *ma* (tone 1, level high) is also of interest. Even if *ma* is necessary to mark the interrogative modality, it may not be the only marker, as there may be a specific prosodic pattern on the sentence before *ma*. If this is true, if *ma* is removed by some speech editing program, the sentence modality may still be correctly perceived as interrogative by listeners.

All the above assumptions were tested in the experimental analysis of a corpus designed with all the 4 tones located on the last syllable of every utterance (with the *ma* particle eventually removed). The sentences were read by five native speakers of Mandarin and recorded digitally. An auditory test was performed on natural sentences as well as on re-synthesized speech (prosodic morphing was done with the software program WinPitchPro [15]).

2. Corpus

Since the system of lexical tones in Mandarin Chinese uses four tones (1: high flat; 2: rising; 3: falling-rising; 4: falling), the sentences of the corpus present all possible combinations of ending tone for each sentence. These tonal variations are located either on the last word of the declarative sentences and the rhetoric questions, or on the penultimate word of the interrogative sentences with *ma*.

3 syllables:
1) Xĭao lì laí jīng. / ? NP-to come-Beijing?
2) Xĭao lì laí liáo. / ? NP-to come-Liaoning?
3) Xĭao lì laí shĕn. / ? NP- to come -Shenyang?
4) Xĭao lì laí hù. / ? NP- to come -Shanghai?

4 syllables:
1) Xĭao lì maì shū./ ? NP-to sell-book?
2) Xĭao lì maì yáng. / ? NP- to sell –goats?.
3) Xĭao lì maì wăn. / ? NP- to sell –bowl?
4) Xĭao lì maì shù. / ? NP- to sell –plant?

5 syllables:
1) Xĭao lì laí Bĕijīng. / ? NP-to come-Beijing?

2) Xĭao lì laí Héféi. / ? NP- to come -Hefei.
3) Xĭao lì laí Shànghăi. / ? NP- to come –Shanghai?
4) Xĭao lì laí Wŭhàn. / ? NP- to come –Wuhan?

6 syllables:
1) Xĭao lì xĭ huān gŭ zhēng. / ? NP-to like-harp ?
2) Xĭao lì xĭ huān zhōng wén. / ? NP- to like –Mandarin?
3) Xĭao lì xĭ huān dé yŭ. / ? NP- to like –German?
4) Xĭao lì xĭ huān huà jù. / ? NP-to like-theater?

8 syllables:
1) Xĭao lì xĭ huān xué xí gŭ zhēng. / ?
NP-to like-to learn-harp?
2) Xĭao lì xĭ huān xué xí zhōng wén. / ?
NP- to like-to learn –mandarin?
3) Xĭao lì xĭ huān xué xí dé yŭ. / ?
NP- to like-to learn –German?
4) Xĭao lì xĭ huān xué xí huà jù. / ?
NP- to like-to learn –theater?

10 syllables:
1) Xĭao lì kāi shĭ xĭ huān xué xí gŭ zhēng. / ?
NP-to start-to like-to learn-harp?
2) Xĭao lì kāi shĭ xĭ huān xué xí zhōng wén. / ?
NP- to start-to like-to learn –Mandarin?
3) Xĭao lì kāi shĭ x ĭhuān xué xí dé yŭ. / ?
NP-c to start-to like-to learn –German?
4) Xĭao lì kāi shĭ xĭ huān xué xí huà jù. / ?
NP- to start-to like-to learn –theater?

The corpus is composed of 72 sentences read by 5 speakers (3 females and 2 males), from North and South of China. The total number of sentences obtained is 360, which were subdivided into 4 groups according to the type of tone.

All the sentences, presented in random order to the speakers, were ended with the punctuation markers: "." or "?". The recording of each sentence was repeated three times, with a randomization of the reading order different at each time.

3. Experimental analysis

3.1 Auditory test

The test had two objectives: 1) verify the recorded declarative sentences and the rhetoric questions, and 2) establish the perception of the interrogative sentences where *ma* has been intentionally removed.

Ten listeners were invited to participate in the test. They were asked to judge the modality between "D" and "RQ" on a five-degree scale. The subject listened twice to all sentences, which were presented every time in a random order.

All the responses were analysed with Excel® and an ANOVA test was executed with the statistical analysis program StatView®. The test results confirmed the importance of the prosodic features. Firstly, the type "D" and type "RQ" sentences were differentiated with a high certainty. Secondly, the *ma* truncated interrogative sentences provoked a great uncertainty in the listeners' judgments. Although the response of most subjects showed a certain bias toward type "D", a significant difference from the other two types was revealed by the ANOVA test. This seems to demonstrate the primacy of the morpho-syntactic structure when the prosody is atypical, as it was confirmed later by the instrumental analysis.

3.2 Instrumental analysis

The fundamental frequency and duration of the last syllable nuclei (or of the penultimate syllable in the interrogative sentences with *ma*, which is an identical syllable when compared to the "D" and the "RQ" cases) were measured for the 360 sentences, and the data were then transferred on Excel.

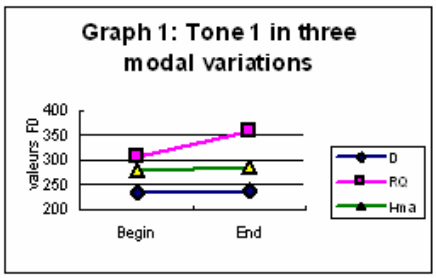
Statistic analysis revealed the existence of three groups that were different in a significant way, not only for the F0 analysis but also for the duration analysis, as shown in the figures below.

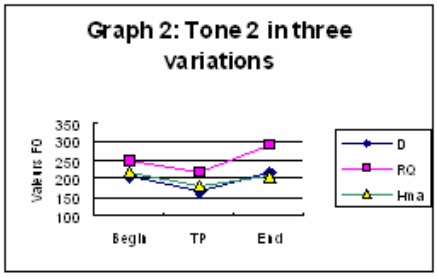
3.3 Fundamental frequency

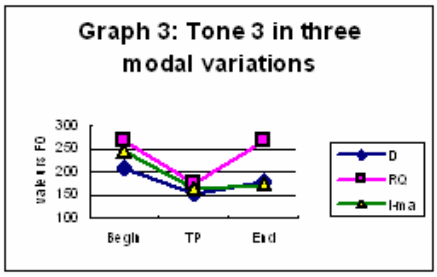
The comparative F0 analysis for the three modalities was performed in terms of the tonal contour and global register.

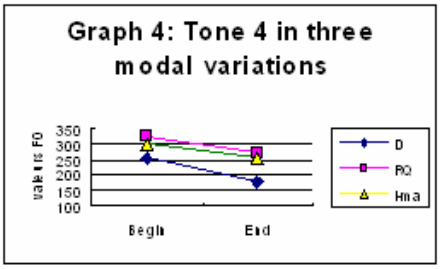
In this case, the analysis could not neglect the actual tonal realisations in different tonal contexts. Indeed, four tones were classified into two groups according to the shape of the F0 contour: flat contours (Tone 1 and tone 4) and modulated contours (Tone 2 and Tone 3).

We obtained the following results:









TP: Turning Point

Figure 1. *Fundamental frequency of the last tone for declarative, rhetorical question and ma interrogative sentences.*

The acoustical analysis showed that:

1. The four interrogative sentences tones, with or without *ma*, are placed on a higher register than the declarative counterparts. The register was the highest in rhetoric questions.

2. The tonal realisations were modified in a significant way according to the type of utterance. Tone 1, "flat", became ascending in rhetoric questions; Tone 4, "descending", was characterised by a less accentuated slope; Tone 3, "descending-ascending", and Tone 2 which was realised in the same manner because of the contextual assimilation, weren't much affected by the modality, except that they possessed a higher register, and the second part of the contour (the re-ascending part) ascended much higher in rhetoric questions.

3. Despite the significant difference between "D" and "RQ" for four tones, "D" wasn't significantly different from "I-ma" in the case of Tones 2 and 3. Therefore, another acoustic parameter, duration had to be also considered.

3.4 Duration

The analysis consisted of two steps: a) the analysis of the "absolute duration" (the duration of the syllable nuclei in milliseconds); b) the analysis of the "relative duration" (the duration of the syllable nuclei compared to the duration of the whole sentence). The first step helped us to understand the acoustic differences for different modalities; the second step allowed us to verify the results of the first step in the re-synthesis.

The results were:

1. The "absolute duration" in "I-ma" was notably the shortest compared to that in "D" and "RQ"; the "absolute duration" in "RQ" was shorter than that in "D";

2. On the sentence-final position, the "relative duration" of Tones 1, 2, and 3 was the same for "D" and "RQ", but much shorter for "I-ma", regarding Tone 4, the relative duration was longer for "RQ";

3. A special case for Tone 2 and 3 in the rhetoric questions was that the "relative duration" of the ascending part of the contour was much longer than that of the descending part (shown as follows in graphs below).

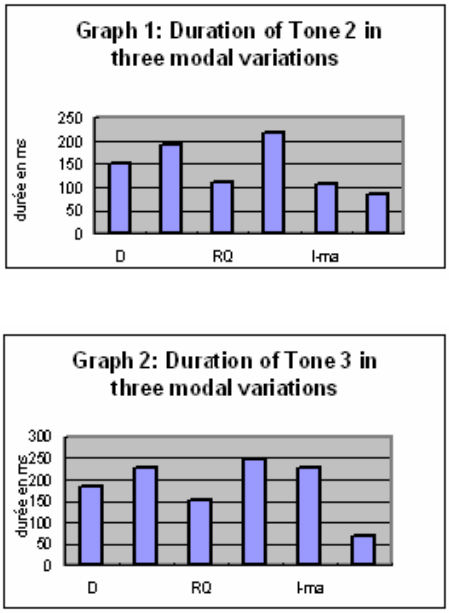


Figure 2. *Results of the auditory tests for declarative, rhetorical question and ma interrogative sentences.*

We can then conclude that both fundamental frequency and duration are used to distinguish between "Declarative", "Rhetoric Question" and "Interrogative with *ma*".

3.5 Re-synthesis

The prosodic morphing done by re-synthesis did confirm the acoustical analysis results. The original Fo and duration values of segments of the sentences were modified with WinPitchPro, and the re-synthesized sentences went again through a perceptive test.

Three types of the manipulations were performed:

1. Stylization of different typical realizations that would be recognized as they were through the perceptive test;

2. Variation, in a progressive way, of the contour of the final tone, and of the register if necessary, in order to put in evidence not only a typical pitch-pattern of the two modalities "D" and "RQ", also their category frontier;

3. Variation of the duration in the pertinent cases that were anticipated by the instrumental analysis.

Compared to "D", "RQ" sentences were characterized by a higher register and an upward tendency even for the descending tone 4 on the sentence-final position. Controlling F0 an duration with re-synthesized speech, we could obtain target values which were recognized as well as the perceptual boundaries between the two categories.

4. Conclusion

This investigation in different modalities confirmed the results of a great number of the precedent studies (see references), which declared that the tonal languages, like Chinese and Vietnamese, possessing a rich system of modal morphemes, are also characterized by a dimension "intonation" which plays an important role on the syntactical-pragmatic level.

This paper attempts to demonstrate that the interrogative modality involves a rotation of the overall fundamental frequency with the penultimate syllable of the sentence as the rotation axis, rather than an overall higher shift of F0 or a higher realization of the sentence last tone.

5. References

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