

# FINAL RISING AND GLOBAL RAISING IN CANTONESE INTONATION

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## ABSTRACT

This study investigates the intonation in Cantonese. Previous studies showed that questions can be cued by final rising in Cantonese. Moreover, the presence of a large amount of sentence final particles suggests that a boundary tone may be an important part of the Cantonese intonation system, which is contrary to Mandarin in which the global raising of F0 is more important than the boundary effect. While previous studies focused on the tone-intonation interaction caused by the final rising, this study investigates the phonetic profiles of both final rising and the global raising in Cantonese questions. Results showed that final rising is an essential cue for Cantonese questions while significant global raising was not observed, indicating a boundary tone in Cantonese.

**Keywords:** intonation, Cantonese, final rising

## 1. INTRODUCTION

Intonation is “the use of suprasegmental features to convey ‘postlexical’ or sentence-level pragmatic meaning in a linguistically structured way” ([4]). Although it employs the same acoustic correlates as lexical tones, intonation is considered an independent system in tone languages. Universal prosodic effects such as declination and pitch range resetting were reported across Chinese dialects. The ToBI system transcribed both Mandarin and Cantonese with a boundary tone at the phrase boundary to cue a statement or a question, just like the ToBI convention for other languages. However, studies in Mandarin found that the global F0 curve could signal questions in the absence of a boundary tone ([12, 13]). The case in Cantonese is less clear. Given the presence of abundant sentence final particles (SFPs) and some pragmatic phrase-boundary intonation in Cantonese ([14]), it is possible that boundary tone is present in Cantonese. However, whether boundary effect dominates global effect still awaits further investigation.

### 1.1. Boundary tone in Mandarin

Mandarin Chinese has been extensively studied in terms of prosody. A Mandarin question would raise the global F0 curve of the utterance with a smaller declination slope and the intensity at the end of a question grows larger than a statement.

Previous literature has discussed boundary tone in Mandarin. While Ho ([3]) and Lin ([8]) claimed that boundary tone exists in Mandarin, many scholars argued the opposite. It was found that the shape and perception of the final tone were rarely affected by intonation ([1, 16]). Lee ([6]) found that the F0 rising of the final particle *ma* expanded to more than a syllable unit, concluding that *ma* might not carry the boundary tone, unlike what Mandarin ToBI assumed. Experiments using machine learning and computational modeling ([16]) also showed that boundary tone was not necessary for signaling questions in Mandarin.

### 1.2. Cantonese intonation

There are six lexical tones in Cantonese, see Table 1.

**Table 1:** The Six Lexical tones in Cantonese.

Category		1	2	3	4	5	6
Tone Shape		High level	High rising	Mid level	Low falling	Low rising	Low level
Tone Letter	Long	55	25	33	21	23	22
	Short	5		3			2

Questions in Cantonese are signalled differently from those in Mandarin. In Cantonese, the overall pitch level of questions is higher than statements. The declination slope of the intonation contour becomes less steep. Pitch range does not play an important role to distinguish questions from statements ([7, 9, 10, 15]). Moreover, the sentence final syllable in questions has significantly longer duration than its counterparts in initial or medial positions ([9]). Most interestingly, a final rise on the last syllable of a question was observed. The tone shapes of all six tones at the end of a question

are changed to a rising tone ([2, 5, 7, 9, 10]). Lee ([5]) discovered that sentence length could affect global F0 contour but not the final rising, and cautiously suggested that final rising was a more consistent cue for Cantonese question signalling. These results, together with a large amount of intonation-like sentence final particles in Cantonese indicates that, unlike Mandarin which mainly uses global F0 raising, the nature of final rising in Cantonese is intonation superimposition on lexical tones at the boundary. There might be a boundary tone in the Cantonese intonation system.

### 1.3. Summary

Studies in Mandarin showed that boundary tone is not necessary for question signaling, contradictory to the assumption of the ToBI transcription. However, few studies in other Chinese or Asian tone languages have further clarified the problem. Previous studies on Cantonese intonation have mainly focused on the interaction between the final rising and the identity of lexical tones. This study compares the importance of final rising and global raising for a better understanding of the structure of Cantonese intonation.

## 2. METHOD

### 2.1. Experiment 1: Testing the final rising

#### 2.1.1. Subjects and materials

Six native Hong Kong Cantonese speakers (three males, three females) were paid to participate in this experiment. They were either graduate or undergraduate students with no speech or hearing problems, aged between 18 and 24.

The participants were recorded reading some sentences with the target syllables embedded in a statement (1) and two questions (a yes/no question with no SFP (2), a.k.a. intonation question and a question with a SFP (3), a.k.a. particle question). The target syllables were (*ŋ*)*aa* and *jau*, each carrying the six lexical tones. The target syllables were placed either at the end of the sentence or in front of a SFP as shown below:

- (1) ne1 go3 zi6 duk6 \_\_\_\_\_. (This character is \_\_\_\_.)
- (2) ne1 go3 zi6 duk6 \_\_\_\_? (This character is \_\_\_\_?)
- (3) ne1 go3 zi6 duk6 \_\_\_\_ me1? (This character is \_\_\_\_ SFP?)

The purpose of the test is to investigate how final rising in a question is different from a statement ending, and whether a rising would occur before a question sentence final particle. The recording took place in a sound-treated room. The

subjects read the materials for at least three times, and they were recorded directly into disk with a sampling rate of 44100 Hz.

#### 2.1.2. Data analysis

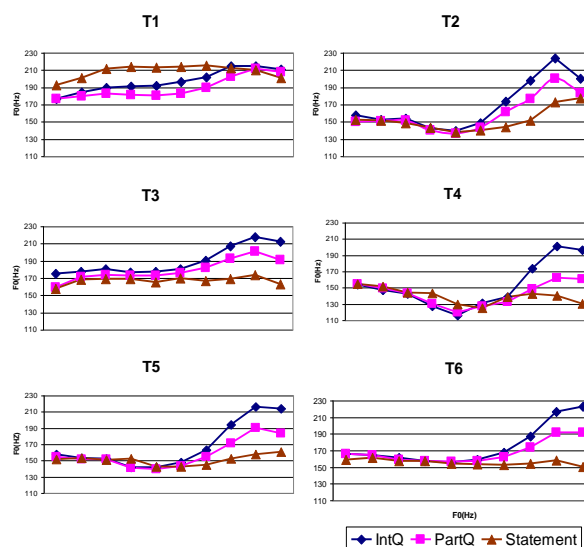
The target syllables were labeled manually in Praat. Because the chosen target syllables were all-sonorant syllables, the F0 curves of the whole syllables were used.

The duration of each syllable was automatically divided into ten equidistant points by a Praat script and the F0 value at each point was tracked by Praat. Manual checking of all the obtained F0 data was done to correct any anomaly.

#### 2.1.3. Results

The tone shape of the target tone in both questions appears to be rising, see Figure 1. For Tone 1, the final tones in questions started low and rose to the same height as the statement final tone. For the other lexical tones, the first half of the tone is very similar across statements and questions, while the second half of the question final tones rose higher than the statement final tones. Also, it is obvious that yes/no question always rose higher than the tone before a question SFP.

**Figure 1:** The averaged tone contours of the final syllables in intonation questions, particle questions and statements.



One-way ANOVAs were performed at eight of the ten equidistant points. The two boundary points (1<sup>st</sup> and 10<sup>th</sup>) were not included because (a) they might be affected by the context; (b) some F0 at these points could not be tracked accurately.

Intonation questions are significantly different from the other two types of sentences. Significant differences were only found at the last two measuring points (8<sup>th</sup> and 9<sup>th</sup>) between intonation question and statement, and also between intonation question and the tone before particle question for Tone 2 to Tone 6. There was no significant difference found in T1 at any time point, probably because the high level tone is already near the upper limit of the speakers' pitch range. There is only a limited scope for rising, which is often named as a ceiling effect ([9, 10]).

No significant difference was found between the statement ending and the syllable before a question SFP, although there appears to be a rising ending which may be a result of anticipatory effect from the final rising SFP. This indicates that the domain of the question intonation was probably limited to the SFP at the end of the particle question.

## 2.2. Experiment 2: Testing the global raising

### 2.2.1. Subjects and materials

A second experiment was conducted to examine the global raising in Cantonese questions. Four native speakers (two males, two females) were recorded. They were required to read single-tone statements and questions (both intonation and particle) as shown in Table 2.

**Table 2:** Stimuli of the global raising test.

T1	gam1 maan1   bou1   (gai1) tong1 . / ? / me1?
T2	siu2 ze2   (soeng2)   jam2 zau2 . / ? / me1?
T3	aa3 baa3   (heoi3)   fan3 gaau3 . / ? / me1?
T4	jan4 kwan4   (loi4)   jau4 haang4 . / ? / me1?
T5	lei5 lei5   maai5   haai5 (lau5) . / ? / me1?
T6	hok6 haau6   zou6   (waa6) si6 . / ? / me1?

For the particle questions ending with the SFP me1, in order to keep the same length for all utterances, the syllables in brackets were deleted while the utterances remained meaningful. The recording procedures followed the first experiment. The participants were encouraged to read out these sentences as naturally as possible, without focusing on any specific information in the sentences.

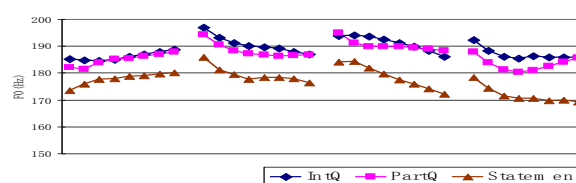
### 2.2.2. Data analysis

The segmentation followed the same criteria as the first experiment. Each syllable in every utterance was labeled. F0 values of ten equidistant points along the tone contours were tracked by Praat. The F0 contours of the first four syllables of the utterances were targets for investigation.

### 2.2.3. Results

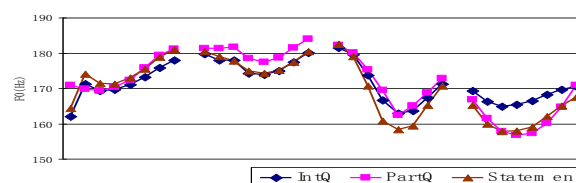
Figure 2 shows the global F0 curves in the T3 utterances. The two questions have higher F0 curves than statements throughout the utterances.

**Figure 2:** The averaged tone contours of the first four syllables in the three utterances with T3.

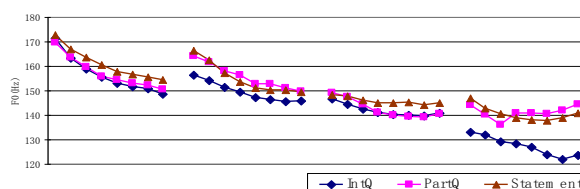


While Figure 2 reveals an intuitively expected result, only the utterances of T3 and T2 (almost) appear this way. For utterances with other tones, the F0 curves of the three sentence types often overlapped (Figure 3). Sometimes the F0 curves of questions in a certain tone are even lower than statements (Figure 4), showing that the global raising is largely inconsistent.

**Figure 3:** The averaged tone contours of the first four syllables in the three utterances with T5.



**Figure 4:** The averaged tone contours of the first four syllables in the three utterances with T4.



One-way ANOVAs confirm that no significant differences in F0 values are found between the same points of the syllable at the same position of the utterances with all six tones.

ANOVA tests were again carried out between female and male participants to see if female speakers would have a more obvious global

raising. However, no significant difference was found.

### 3. DISCUSSION

Two pieces of evidence in the current data show that final rising is a boundary effect in Cantonese. First, final rising only modifies the very end of the question-final lexical tone. This agrees with Mai ([11]), who stated that the question intonation which appeared as final rising was added to the end of the canonical tone. This impressionist claim was further supported by a perception test ([9]), as question-final T4, T5 and T6 had a higher risk than the other tones to be mistaken as T2, because T2 shared the low start with those tones at question-final position. The fact that final rising occur only at the end of the final syllable in a question indicates that this is a local event which is not able to expand its rising domain to previous tones. Second, as shown in the data, the lexical tone before a question SFP was not affected by the final rising, suggesting that for a particle question, the question intonation is also localized in the sentence final position.

The results show that there is no global event for question intonation in Cantonese. Ma et al. ([10]) found that the global curve is significantly higher in yes/no questions than in statements. However, because their stimuli were target syllables at the beginning and in the middle in a carrier sentence, the global raising they observed might be an effect of focus rather than question intonation. Further studies are needed to clarify this issue.

In comparison to the inconsistency and insignificance of the global raising, the final rising is a reliable and strong cue for Cantonese questions. Because no global effect for question intonation was detected, it is necessary to model Cantonese question intonation with a boundary tone, realized as final rising in intonation questions and carried by SFPs in particle questions.

### 4. CONCLUSION

This study has shown that while final rising is an essential cue for question signaling in Cantonese, global raising is not well-supported by the data.

The facts that final rising occurs only at the very end of the last tone and that the syllable before a question final particle is rarely affected by the question intonation show that in Cantonese,

question intonation probably locates at the very end of a sentence, posing as a boundary tone.

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