

# Prosodic Differences between Rhetorical Questions and Information-seeking Questions in Mandarin

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## 1 Introduction

Successful communication requires speakers to accurately interpret linguistic information carried by the sentence but also the para-linguistic information encoded in human speech (Ladd 2008; Fujisaki 2004). A good example would be the use of rhetorical questions (RQs). RQ is considered as a question because its syntactic structure belongs to the category of interrogative sentences (Haan 2002), but it does not require an informative answer from the hearer or fill in a knowledge gap (Athanasiadou, 1991; Han, 2002; Sadock, 1974; Špago, 2017). Rather, it is used to “commit utterers to the opposite view from what is asked” (Sadock, 1974, p. 125), give an assertive feel (Caponigro and Sprouse 2007), and signal speakers’ attitude towards a mutually accepted answer (Biezma and Rawlins 2017). On the contrary of RQs, information-seeking questions (ISQs) are defined as “genuine questions” and used to express ignorance (Bartels 1999). The “incompatibility” of function and form of RQ has been observed in many languages, as shown in Table 1.

**Table 1** Examples of RQ and ISQ uses in English, German, and Mandarin

Yes/no Question	Wh-question
(English) <i>Does anyone like limes?</i>	(English) <i>Who likes limes?</i>
(German) <i>Mag den jemand Limonen?</i>	(German) <i>Wer mag den Limonen?</i>
(Mandarin) 有人喜欢柠檬吗?	(Mandarin) 谁喜欢柠檬?
(Pinyin) <i>yǒu rén xǐ huān níng méng ma?</i>	(Pinyin) <i>shuí xǐ huān níng méng?</i>
ISQ reading: The speaker is asking whether someone would like some limes	
RQ reading: The speaker indicates an obvious fact that nobody likes limes.	

NOTE: The English and German examples are from Braun et al. (2019)

A limited number of studies discusses the prosody and acoustic features from the perspective of speech acts (Repp 2020; Dehé and Braun 2019; Braun et al. 2019; Kharaman et al. 2019). Besides, the previous languages under study include Xhosa (Jones, Louw, and Roux 1998), German (Wochner et al. 2015; Braun et al. 2019), English (Dehé and Braun 2019), and Icelandic (Dehé, Braun, and Wochner 2018), but only one paper discusses Mandarin (Zahner et al. 2020). The present study aims to investigate the prosodic differences of two illocution types (the ISQ and the RQ) in Mandarin in terms of two sentence types (yes/no questions and wh-questions). Especially, it will examine whether RQ realization varies among different syntactic structures (zenme and shenme in WHQ; shi and neng in YNQ).

## 2 Research Background

**2.1 Form and Function of RQ** Sadock (1974, 125) discusses two non-canonical questions where the question form does not match with pragmatic function: the “requestions”—the special use for the word please in a question to request answers eagerly, and the “queclaratives” which resemble RQ and “commit their utterers to the opposite view from what is apparently asked.” Athanasiadou (1991) claims that the speaker of an RQ does not receive but provides para-linguistic information. Li (1990) argues that the format of RQ is the deviation from the interrogative point of the sentence. If the speaker is not asking about the value of Q, hence form an RQ. Functionally, RQ has the illocutionary force of a question and the perlocutionary effect of a statement, and conveys the speaker’s commitment to an implicit answer (Ilie, 2015).

Since RQ and ISQ can be identical in the string, the role played by prosody is important in verbal communication. For YNQs, RQ tends to be realized in H-H% or L-L% edge tone, and for WHQ in L-L% (Bartels, 1999), which is shared by Banuazizi and Creswell in their corpus-based study (1990). In another corpus-based study, Hedberg et al. (2014) reported that “non-genuine” yes/no questions tend to have H\*L-L% and L\*H-L%.

Wochner et al. (2015) further reported the inconsistent pattern that YNQ-RQs are more likely to use H-%, and WHQ-RQs are more likely to be realized in nuclear L\*+H accents. Braun et al. (2018) found in German that polar RQs are realized with H-%, while yes/no ISQs with a high-rise H-^H%. Wh- RQ is ended with a low edge tone and wh-ISQ has several tonal variants (Braun et al., 2018). In English, the intonation terminus was found distinctive only for polar questions (Dehé & Braun, 2019).

Phonetically, RQs tend to have longer constituent durations and a breathy voice quality (Braun et al. 2018; Wochner et al. 2015). The initial pitch is significant for both YNQ and WHQ, but the pitch range is only significant for WHQ. Kharaman et al. (2019) found that pitch accent type had the strongest effect on participants' interpretations, while duration and voice quality does not differ in relative importance.

**2.2 Interrogative Intonation in Mandarin** In many languages, high/rising F0 marks questions, doubt and uncertainty and low/falling F0 marks statement, finality and assertion (Ohala 1984; Ladd 1996, 6). With respect to Mandarin, where the phonology is described as the “algebraic sum” of lexical tones and sentence intonation (Chao, 1968), F0 marks both four lexical tones as well as question/statement distinction. There have been two f0 patterns descriptions of question intonation: a global description and a local description.

Under the global description of intonation, the difference between question and statement occurs through the entire sentence instead of any single syllable in the sentences. Shen studied six sentence types from the aspects of the starting point, the highest f0 peak and the ending point (as cited in Chan 1993). In Shen's study, f0 of YNQ is higher than declaratives throughout the sentence. The f0 height difference is not limited to the boundary tone or any single syllable but applies to the entire sentence.

The local view of intonation considers the question differs from statement toward the end of the utterance. Wu (1981) claims that statement has a slow falling end, and syntactically identical unmarked questions retain a statement contour except for its rising end. Particle question is similar to statement and will not have a rising end. Liu et al. (2016) argues local parameters are more reliable than global parameters. For example, in wh-interrogatives, the pitch range of wh-words is higher, the boundary tonal shapes become a rising H% and the F0 difference between wh-words and the boundary tone is smaller. Besides, question also features a rising contour in the sentence-final position (Ho 1977), nonlinearity increasing toward the end of the sentence (Liu et al., 2006). Apart from F0, duration difference may correlates with the tone of the ending syllable (Yuan 2012), word positions (Ho 1977), focus (Liu et al., 2016).

**2.3 RQ as an ironical tone of speech** A large body of research evidenced that different emotions can successfully get encoded by the voluntarily manipulating the size or length of larynx (Ohala, 1984; Xu et al., 2013). Regarding ironical speech, the previous acoustic results were highly inconsistent in F0 pitch. Specifically, the overall F0 increases in Cantonese (Cheang and Pell 2009), French (Loevenbruck et al. 2013) and Mandarin (Gu and Fujisaki 2011) but decreases in German (Niebuhr 2014; Scharrer and Christmann 2011). English ironic prosody has opposite F0 observations (Cheang and Pell 2008; Bryant and Fox Tree 2005). One of the reasons may be the poor cross-language similarity of ironical speech and context-dependency (Cheang and Pell 2011).

### 3 Hypotheses

Based on previous literature on RQ in other languages and statement/question distinction in Mandarin, the present study proposes the following hypotheses:

Hypothesis 1 (H1): RQ in Mandarin will features a higher f0, faster tempo and greater intensity, resembling ironical prosody in Mandarin. Since RQ is an effective means to express stronger emotion, normally expressing irony and impatience, it is reasonable to assume that the prosody of Mandarin RQ will resemble ironical prosody and realized in an overall higher f0, and faster tempo.

Hypothesis 2 (H2): The prosodic realization of RQ in Mandarin will vary with question types and syntactic structures. Based on previous studies, RQ patterns may differ in YNQ and WHQ. Furthermore, the syntactic markers containing in the sentence, such as wh-words, copula, and modal verbs, may also bring subtle adjustment to f0, syllable, and intensity.

### 4 Method

A production study was designed to investigate the prosody of two illocution types (RQ and ISQ) in terms of YNQs and WHQs. Participants uttered simple SVO sentences. The target sentence is embedded at the end of the discourse so that they can be induced by speakers naturally. Each target sentence contains 6 syllables. Global and local duration, f0, and intensity were analyzed before carrying out a linear mixed effect analysis.

**4.1 Participants** Participants were 20 Mandarin-speaking college students from Nanjing University of Aeronautics and Astronautics. 10 female and 10 male students are at the age of 20-24 (mean = 22.95,  $SD = 1.572$ ). All participants mastered a good Standard Mandarin without obvious regional accents (none of them speak Min, Yue, or Wu dialects) and passed the Standard Mandarin Test Rank II. All speakers entered for this experiment voluntarily.

**4.2 Materials** The materials include 16 sentences, including 2 interrogative types— 8 YNQs and 8 WHQs. For each interrogative type, there are 2 illocution types—4 RQs and 4 ISQs. As for YNQ, the sentence structures are all simple SVO sentences. The target sentence is set at the end of a carefully designed context so that the RQ and ISQ intonation can be naturally induced during speaking.

**Table 2** Two examples of ISQ-RQ pair in terms of YNQ and WHQ

	ISQ	RQ
W H Q	爷爷看到我新买的 VR 眼镜，好奇地问我：“亮亮，这是什么东西？”	经理把报表扔在地上说：“给了你这么几天的时间，你就搞了这种东西？来！你自己看看，这是什么东西？”
	Your 80-year-old grandpa just saw the VR hamlet that you brought. He was very curious, and he asked you— What is this thing?	Your boss threw your report on the ground. He said: “How many days I gave you to finish this? Is that what you did? Here, take a look and tell me—What is this stuff.
	这是什么东西 zhe shi <b>shenme</b> dongxi This is <b>what</b> thing	
Y N Q	您好！我是《今日观察》的记者，今天来是想了解一下这种工艺品的制作流程。请问，你是负责人吗？	你一个看门保安，大字不识一个，居然跑到我鼻子前面说产品不合格，要举报我？你是领导吗？你是负责人吗？
	Hello! I am a reporter from “Today Observation,” and I came here today to learn about the production process of this kind of handicraft. Are you the person in charge?	An illiterate janitor dares to come around and tell me the product was substandard? You wanna report me? Who do you think you are? Are you the manager? Are you the person in charge?
	你是负责人吗 ni <b>shi</b> fuze ren ma? You <b>are</b> charge person PARTICLE	

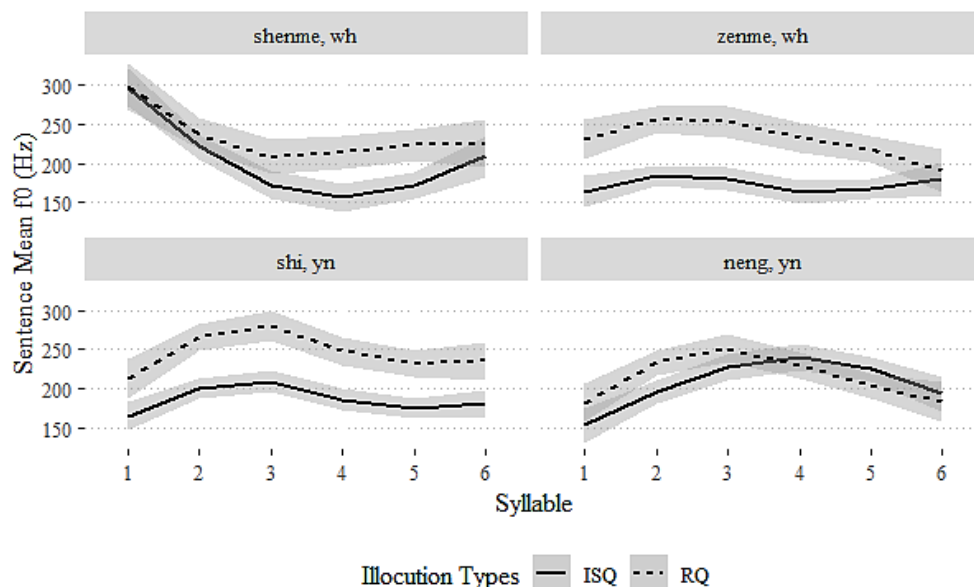
**4.3 Data processing** *Praat* (Boersma and Weenink 2020) was used for sound annotation and parameter extract. *ProsodyPro 5.7.8.4* (Xu, 2013) was used to carry out an interactive annotation and extract a group of acoustic data. R (R Core Team, 2012) and *lmeTest* (Kuznetsova, Brockhoff, and Christensen 2017) were used to perform a linear mixed-effects analysis of the relationship between acoustic parameters, illocution types and syntactic markers (labelled as “keywords” in the following). Fixed effects are illocution types (2 levels: ISQ and RQ) and keywords (2 levels in WHQ: *zenme* and *shenme*; 2 levels in YNQ: *shi* and *neng*) with their interaction term into the model. The random effects are subject and item. These considered altogether  $8 * 2 * 20 = 320$  sentences. Each sentence contains 6 syllables, which makes  $320 * 6 = 1920$  tokens in total.

## 5 Results Analysis

**5.1 Global and local F0** This section will overview the global and local F0 for YNQ and WHQ. Firstly, the results of linear mixed regression model of sentence mean f0 (Hz) of YNQ show the significant main effect of the illocution types ( $\beta = -16.98$ ,  $SE = 2.183$ ,  $t = -7.781$ ,  $p = 1.47e-12$  \*\*\*) and the interaction effect between illocution and keyword ( $\beta = -12.01$ ,  $SE = 2.183$ ,  $t = -5.502$ ,  $p = 1.75e-07$  \*\*\*). The keywords containing in the YNQ do not have significant main effect ( $\beta = 2.426$ ,  $t = 1.112$ ,  $p = 0.268$ ). A post-hoc comparison shows that the overall mean f0 of ISQ is 34 Hz lower than RQ (contrast ISQ-RQ:  $\beta = -34$ ,  $SE = 4.41$ ,  $t.ratio = -7.697$ ,  $p < .0001$  \*\*\*). Table 3 summarizes the linear mixed-effects results of mean f0 of both RQ and ISQ in four sentence types. The baseline estimate refers to an ISQ containing copula *shi*, which is 210 Hz. The identical string will be positively adjusted by 34 Hz (2 times of 16.98) in the RQ use.

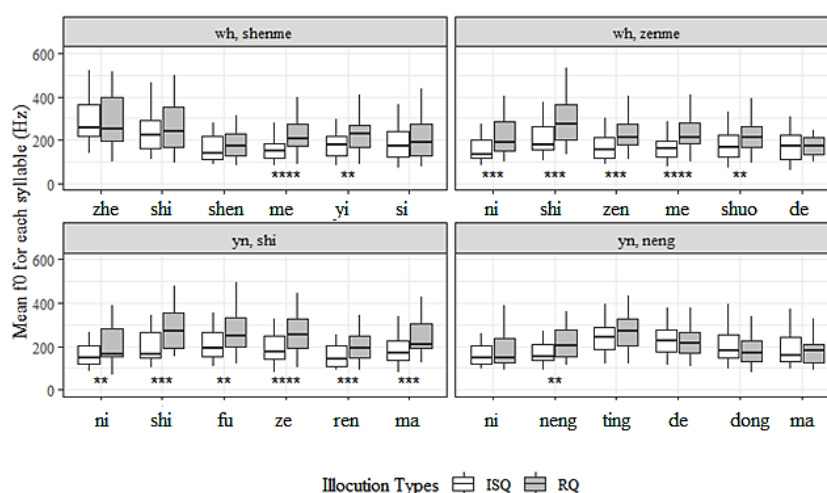
Similar to YNQ, the results of linear mixed regression model of sentence mean f0 (Hz) of WHQ illustrate the significant main effect on mean f0 of the illocution types ( $\beta = -21.89$ ,  $SE = 2.414$ ,  $t = -9.057$ ,  $p = 9.51e-16$  \*\*\*) the keyword ( $\beta = 8.636$ ,  $SE = 2.414$ ,  $t = 3.578$ ,  $p = 0.000475$  \*\*\*) and the interaction effect between these two factors ( $\beta = 7.409$ ,  $t = 3.07$ ,  $p = 0.002569$  \*\*). The keywords containing in the YNQ do not have significant main effect ( $\beta = 2.426$ ,  $t = 1.112$ ,  $p = 0.268$ ). The post-hoc comparison show that the contrast ISQ-RQ in WHQ is 43.8 Hz ( $t.ratio = -8.961$ ,  $p < .0001$ ).

Figure 1 illustrates the  $f_0$  contour patterns for ISQ and RQ in four types of sentences, from which two observations can be drawn. Firstly, RQ has an overall higher pitch register than ISQ, at least from the initial syllable through the 3<sup>rd</sup> syllable. In other words, the two illocution patterns are parallel in the beginning to the middle across the sentence structures. The height difference is decreasing toward the end of the sentence, as shown in *shenme*, *zenme* and *neng* sentence. Secondly, despite the fact that the main effect of keyword is statistically significant in YNQ, the  $f_0$  contours in all four sentences with different keywords are not the same with one another.



**Figure 1** Sentence Mean  $f_0$  (Hz) for two illocution types in terms of YNQ and WHQ in a 6-syllable sentence

In terms of local mean  $f_0$  for each syllable in 4 types of sentences, significant differences between RQ and ISQ exist in certain syllables after an ANOVA test. For WHQs, the wh-words in all two sentences are significantly different between ISQ and RQ. They are the 4<sup>th</sup> syllable *me* in *shenme* ('what') sentence, the 3<sup>rd</sup> and 4<sup>th</sup> syllables in *zenme* ('how') sentence. These two wh-words in RQs are remarkably higher in mean  $f_0$  than the corresponding ones in ISQs. In *shenme* sentence, except for the penultimate syllable *dong* (the first syllable in the word *dongxi* 'stuff'), no significant difference is found in other positions. In *zenme* sentence, only the last syllable does not show a significant difference. As for YNQ, keywords *neng* ('can/could') and *shi* (be/copula) have higher mean  $f_0$  in RQ as in the WHQ. What differs from *shi* and *neng* sentence is that every syllable in *shi*-RQ has higher  $f_0$  than the corresponding syllables in *shi*-ISQ, but only keyword syllable in *neng*-RQ is statistically higher than *neng*-ISQ.



**Figure 2** Mean  $f_0$  (Hz) for each syllable in YNQ and WHQ

In summary, illocution types have a significant main effect on both YNQ and WHQ across the board at the level of sentence. RQ has an overall higher mean of  $f_0$  than ISQ. Syntactic markers or the keywords that sentences contain will be increased in an RQ intonation. The other syllables in the sentence have inconsistent changes. It is difficult to conclude the change of initial syllable or the ending syllable between ISQ and RQ.

**5.2 Global and local duration** With respect to YNQ, the results show the significant main effect of the illocution types ( $\beta = 13.245$ ,  $SE = 4.433$ ,  $t = 2.988$ ,  $p = 0.00296$  \*\*), the main effect of the keyword ( $\beta = 22.859$ ,  $SE = 4.437$ ,  $t = 5.152$ ,  $p = 3.81e-07$  \*\*\*) and the interaction effect between illocution and keyword ( $\beta = -26.388$ ,  $SE = 4.434$ ,  $t = -5.951$ ,  $p = 5.25e-09$  \*\*\*). A post-hoc comparison show that the sentence duration of ISQ is 26.5 ms longer than RQ regardless of keywords (contrast ISQ-RQ:  $\beta = 26.5$ ,  $SE = 8.9$ ,  $t.ratio = 2.978$ ,  $p = 0.0031$  \*\*). The interaction effect of brings different results to the sentence duration. With duration of ISQ being baseline, corresponding RQ will be 79 ms longer in *shi* sentence but 26.29 ms shorter in *neng* sentence. This indicates that illocution type is not the only factor that influences the duration of sentence, the linguistic structure of the sentence is also important. Results of WHQ likewise show the significant main effect on sentence duration of the illocution types ( $\beta = 14.459$ ,  $SE = 4.197$ ,  $t = 3.445$ ,  $p = 0.000596$  \*\*\*), and the interaction effect between these two factors ( $\beta = 31.890$ ,  $t = 7.599$ ,  $p = 7.23e-14$  \*\*\*) but not the keywords containing in the sentence ( $\beta = -7.45$ ,  $p = 0.076$ ). The local duration shows a similar pattern as in the  $f_0$  analysis. The keywords are sure to vary. Except for *shi*, keywords *shenme*, *zenme* and *neng* are all lengthened in RQ. The initial syllable duration is shortened significantly in *shenme*, *zenme* and *shi* sentence. The ending syllable duration does not show any distinct difference.

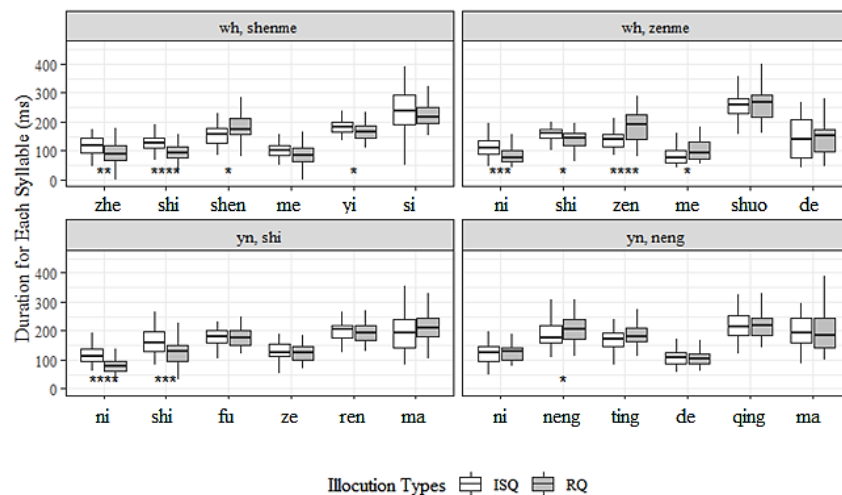


Figure 3 Mean duration (ms) for each syllable in YNQ and WHQ

In conclusion, illocution type does change the sentence duration length, but different sentences do not have a consistent response. For both YNQs and WHQs, sentence duration is likely to increase or decrease depending on the keywords it contains. However, the initial duration of RQ is more likely to decrease while the keywords tend to increase. The ending syllable, including the sentence-final particle in unmarked questions, show no differences.

**5.3 Global and local intensity** As for the overall intensity of both YNQ and WHQ, the results of linear mixed model of sentence intensity (dB) show the significant main effect of the illocution types ( $\beta_{YNQ} = -1.21$ ,  $t = -6.849$ ;  $\beta_{WHQ} = -1.8926$ ,  $t = -10.658$ ) and of the keyword ( $\beta_{YNQ} = -0.5513$ ,  $t = -3.114$ ;  $\beta_{WHQ} = -1.8926$ ,  $t = -10.658$ ) but not the interaction effect between illocution and keyword ( $p_{YNQ} = 0.082$ ,  $p_{WHQ} = 0.311$ ). For YNQ, the RQ is 2.43 dB louder than ISQ ( $\beta = -2.43$ ,  $SE = 0.354$ ,  $t.ratio = -6.849$ ,  $p < 0.0001$ ). This shows that RQ has a higher intensity than ISQ does, except for *neng* sentence does not statistic significance. It means the degree of force for each sentence that speakers exerted when producing the RQ and the degree of emotional arousal varies with the acoustic arousal.

Locally, all keywords in four types of sentences are increased in intensity, but only two *wh-* sentences have statistical meaning. In YNQ, neither *neng* or *shi* change significantly from RQ to ISQ. The NP in *shi* sentences (the 3<sup>rd</sup> to 5<sup>th</sup> syllables *guanlire*, ‘the manage person’) and the sentence-final particle *ma* become louder in the RQ setting.

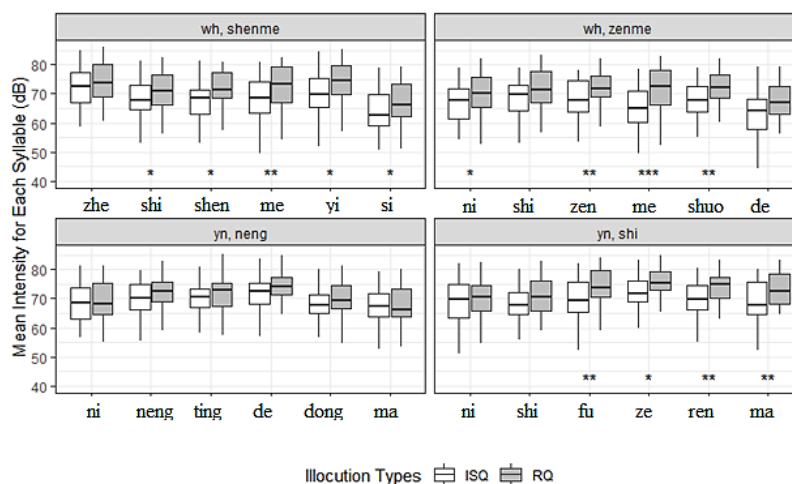


Figure 4 Mean intensity (dB) for each syllable in four sentences

## 6 Discussion and Conclusion

The present paper aims to investigate the prosodic difference between ISQ and RQ in terms of WHQ (*zenme* ‘how’ and *shenme* ‘what’ structures) and YNQ (copula *shi* and modal verb *neng*). Based on the previous literature, two hypotheses concerning the global and local parameters are formulated.

H1 proposes that RQ in Mandarin will differ from ISQ and features a higher overall  $f_0$  and faster tempo due to the ironic quality carried by RQ. Affective studies report that ironic speech in Mandarin will be higher and faster. Our results support this hypothesis. The results show that illocution types have the main effect on global  $f_0$ , duration, and intensity. RQ will be 34 Hz higher than ISQ in YNQ and 42 Hz higher than ISQ in WHQ. This result is opposite to the previous studies in German (Braun et al., 2018) and English (Dehé & Braun, 2019). One of the reasons may be the poor cross-language similarity in ironic verbal expression reported by Cheang & Pell (2011). Secondly, the results are also opposite with the Mandarin RQ reported by Zahner et al. (2020), who reported that overall RQs have a lower mean  $f_0$  than ISQs and longer duration. The difference is possibly due to: first, the target sentences of two studies are of different syntactic structures (containing different syntactic markers and syllable numbers); second, the context designed are subtly different. The function of RQ in the present study is used to signal the obviousness of the self-evident answer and to retort. In this case, further studies are worth being conducted. Thirdly, although we did not take count of the intonational terminus, four types of sentence in Figure 1 illustrates a plateau or a falling at the end of the sentence, which is similar to Banuazizi & Cresswell (1999), who suggest the falling end in RQs signals speaker’s presumption about the proposition value of the non-genuine question.

H2 suggests that syntactic markers are likely to bring local modification. At this point, we share the conclusion of Zahner et al. (2020) who claim that  $F_0$  is locally modified. The present study further believes modification is not limited to the initial and ending constituent to mark illocution type but the position of the syntactic markers. In other words, compared with the initial or ending syllable, the wh-words and copula (labeled as ‘keyword’ in this study) will have a stronger response to the RQ use. This is also supported by the results from local prosodic parameters. It is found that the keywords have a stronger response to RQ use and increase syllable  $f_0$  more significantly. The ending syllable, which would have shown remarkable  $f_0$  change in statement/question distinction, proved to increase in YNQ but change insignificant in WHQ. This result is consistent with Braun et al. (2018) and Dehé & Braun (2019), who report the intonational terminus is only distinctive for polar questions.

Apart from  $f_0$ , Mandarin RQ sentence length is shorter than ISQ, but the specific keyword containing in the sentence may give rise to erratic results. Both YNQ and WHQ have a chance to be longer or shorter. In addition to the keywords, the initial syllable duration of RQ is shorter than the corresponding syllable duration of ISQ, which is consistent with Wochner et al. (2015). The ending syllable still no obvious change in duration. Besides, RQ use will have a higher mean intensity than ISQ.

As a conclusion, the present study reported that RQ and ISQ differ from overall mean  $f_0$ , duration, and intensity. Since RQ are used to being ironical and to retort, the emotional arousal directly varies with the acoustic arousal, featuring a higher pitch, faster tempo, and stronger force. It is possible that the illocution type influences the prosodic realization at the level of the sentence since all three parameters are significant for the entire sentence. Some local variation can also be observed at the position of syntactic makers, such as wh-words, copula, and modal verbs. It is found that wh-RQs are stabler than yes/no RQ. The intonation terminus, syntactic structures,



global duration changes, and local intensity of yes/no RQ are highly dependent on the specific sentence type and the position of syntactic markers. Whether the sentence contains a modal verb, a copula, and whether the sentence ends with an NP or a VP, seems to influence the local acoustic parameters to a large extent. Part of the reason is that compared with WHQs, YNQs have much more syntactic choices and variants. Due to this cause, future studies should pay much closer attention to the YNQs.

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