

# Duration as a prosodic marker of contextual factors in Mandarin positive polar questions

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## Abstract

This study investigated how Mandarin speakers use duration to mark contextual factors, namely epistemic bias, evidential bias, and the presence of antecedent, in their production of Mandarin positive polar questions, ending with either the particle *-ba* (PPQ-*ba*), *-ma* (PPQ-*ma*), or a prosodic pitch rise (PPQ-H%). Thirty native Mandarin speakers participated in a discourse completion task, producing sentences with a Subject-Verb-Object structure in response to different discourse scenarios. We designed 14 conditions, each encompassing four discourse prompts, to elicit sentences with all felicitous combinations of the contextual factors. Syllable duration was analyzed. Our findings revealed that contextual factors significantly influenced the syllable duration of PPQ-*ba* sentences but not that of PPQ-*ma* or PPQ-H% utterances. In PPQ-*ba*, the lengthening was localized to the verb in stimuli with negative evidence or a negative antecedent. We conclude that Mandarin speakers utilize duration to mark pragmatic functions in PPQs, but only to a limited extent, suggesting that duration is unlikely to be the primary prosodic cue in PPQ production.

**Index Terms:** polar question, epistemic bias, evidential bias, antecedent, Mandarin

## 1. Introduction

Human languages offer a range of strategies for interlocutors to exchange not only the propositional content of a message but also its source and factual status (reference). Taking Mandarin Chinese as an example, speakers may use lexical items or particles to signal varying degrees of commitment to the truth value of a proposition (i.e., epistemic information) or to indicate the source of evidence supporting the proposition (i.e., evidential information). Furthermore, they might articulate the same string of words in distinct prosodic patterns to convey such semantic and pragmatic nuances (reference).

This paper investigates further the prosody-meaning interface through the lens of Mandarin positive polar questions (PPQs). PPQ refers to a question in a positive form that allows for either an affirmative or a negative response [1]. We focus on three types of Mandarin PPQs: two with a sentence-final question particle *-ma* (PPQ-*ma*; 吗) or *-ba* (PPQ-*ba*; 吧), and one without any particle but signaled with a rising f0 pitch contour (PPQ-H%) [2]. The particle *ma* is considered a typical question particle, while *ba* is considered ambiguous between a declarative or interrogative interpretation [3].

There has been an increasing number of reports on the f0 patterns of the three types of Mandarin PPQs. Briefly speaking, both PPQ-*ma* and PPQ-H% are produced with a rising contour, but the global pitch register of PPQ-H% is higher than PPQ-*ma* [4], [5], [6], [7]. By contrast, PPQ-*ba* usually shows a global f0 fall [8], [9].

We know that intonation, in its broad sense, may also involve other prosodic cues such as duration [10], [11]. For instance, compared to declarative sentences, the final syllable in Mandarin questions shows longer duration [12], [13], [14]. Not much, however, is known about whether, and if so, how duration may serve as a cue to mark different types of PPQs.

The realizations of PPQs may be further modulated by contextual factors, given the possible interpretations of PPQs based on introspective data. Sudo [15], for example, has argued, with data from English and Japanese PPQs, that epistemic and evidential information play important roles in PPQ interpretation. As mentioned, epistemic information stems from the speaker's private belief about the proposition encoded in a PPQ. Evidential information refers to the contextual evidence available to the speaker and the listener in a conversation. Both types of information can be positive, negative, or neutral. In the same line, Shao [16] affirms the significance of epistemic bias in interpreting Mandarin PPQs, where PPQ-*ma* encodes non-positive epistemic bias, PPQ-H% involves negative epistemic bias, and PPQ-*ba* is compatible with positive epistemic bias. Importantly, Shao introduces a third parameter for Mandarin PPQs, that is, the presence or absence of an antecedent. In other words, whether a PPQ is uttered as a response to an antecedent sentence or not could have an effect on listeners' interpretation.

Yuan and Li [17] took a further step and conducted an acceptability judgment task of reading material, where Mandarin speakers rated the felicity of PPQs varying in the three contextual factors (i.e. epistemic and evidential information and antecedent condition) and their combinations. Their results are summarized in Table 1. Briefly speaking, PPQ-*ma* and PPQ-H% can be neutral in all three factors. If any bias is encoded, only negative epistemic bias and/or positive evidential bias are allowed. Regarding the antecedent condition, if the antecedent exists, it can only be negative. In contrast, PPQ-*ba* is never neutral, as it must encode a positive epistemic bias. However, PPQ-*ba* can allow for any type of evidential bias. Different from PPQ-*ma* and PPQ-H%, if the antecedent is present, it should be negative.

In short, from the perspective of PPQ comprehension based on written text [17] or the researchers' introspective meta-knowledge [15], [16], at least three factors are important for

Mandarin PPQs: epistemic bias, evidential bias, and the presence of antecedent.

Table 1: *Mandarin PPQ patterns as a function of epistemic bias, evidential bias, and antecedent condition.*

Pattern	Epistemic	Evidence	Antecedent
<i>PPQ-ma</i>			
ma_NEU	No	No	No
ma_EVI	No	Positive	No
ma_EviEpi	Negative	Positive	No
ma_EPI	Negative	No	No
ma_ANT	Negative	No	Positive
<i>PPQ-H%</i>			
H%_NEU	No	No	No
H%_EVI	No	Positive	No
H%_EviEpi	Negative	Positive	No
H%_EPI	Negative	No	No
H%_ANT	Negative	No	Positive
<i>PPQ-ba</i>			
ba_NoEvi	Positive	No	No
ba_PosEvi	Positive	Positive	No
ba_NegEvi	Positive	Negative	No
ba_ANT	Positive	No	Negative

Thus far, there is no research on whether, and if so, how different types of PPQs are produced by native Mandarin speakers and how the three types of contextual factors may affect the prosodic realization of the PPQs. In this study, we report durational data that we have collected (other prosodic features, such as pitch, will be reported in a separate paper). A full factorial design of the three factors would result in a large experiment, and some of the conditions are not felicitous (as suggested in the reading task of Yuan & Li 2019). Therefore, the inclusion of the three factors and their combinations was guided by the results in Table 1.

Two specific research questions were addressed:

RQ1: Do epistemic and evidential biases affect speakers’ production of syllable duration in Mandarin PPQs?

To answer this question, we will compare the baseline condition to the rest of the conditions. For PPQ-*ma* and PPQ-H%, *ma\_NEU* and *H%\_NEU* are set as baseline as they do not encode any bias. For PPQ-*ba*, the baseline is *ba\_NoEvi*, because this condition does not encode contextual evidence. All the other conditions, except for ANT, are to be compared with the baseline condition. If significant differences are found between the baseline and a specific condition, this means that the pattern identified in Yuan and Li’s perception experiment is indeed prosodically meaningful in spoken Mandarin.

RQ2: Does the presence of antecedent affect speakers’ production of syllable duration in Mandarin PPQs?

To answer this question, we set ANT as the comparison condition and *EviEpi* as the reference condition for PPQ-*ma* and PPQ-H%. As for PPQ-*ba*, we compared *ba\_ANT* to the reference *ba\_NegEvi*. The reasons are as follows. First, the reference conditions have the same epistemic status as the ANT conditions. Second, the reference conditions contrast with ANT in that ANT is a response to an antecedent. Importantly, the truth condition of the evidential bias in the reference conditions is consistent with the truth condition of the antecedent preceding ANT. Therefore, by making these comparisons, we could assess whether the antecedent would make a durational difference, or if it is merely a substitution of the contextual

evidence. If any significant differences are found between the reference conditions and ANT, it would suggest that the introduction of the antecedent condition in interpreting Mandarin PPQs is necessary.

## 2. Methods

### 2.1. Speech elicitation

Thirty native Mandarin speakers (15 females,  $M_{age} = 27.1$ ) participated in a discourse completion task where they were presented with 84 scenarios and instructed to orally produce subject-verb-object sentences. These scenarios specified the speaker’s expectation (positive, negative, or no epistemic bias), contextual evidence (positive, negative, or no evidence), and the presence or absence of an antecedent. Participants responded to the scenarios orally, imagining themselves in the conversation context. The scenarios were designed to always elicit one of the target sentences in Table 2. Each target sentence was elicited under one of the 14 conditions listed in Table 1, yielding a total of 56 target scenarios (4 target sentences  $\times$  14 conditions). In addition, we designed 28 filler scenarios, similar to the target scenarios but eliciting irrelevant sentences, to introduce some variance in the task. In total, there were 84 scenarios. All target sentences followed the same SVO structure, with a dissyllabic person’s name as the subject, a monosyllabic word as the verb, and a dissyllabic noun as the object. The first four syllables of the target sentences consistently had Tone 1 (a level tone), while the fifth syllable varied in lexical tones, with each of the four sentences carrying one of the four lexical tones (i.e., Tone 1–4). To ensure the accurate production of the intended PPQ type, participants were given interrogative particles (*ma* for PPQ-*ma*, *ba* for PPQ-*ba*,  $\emptyset$  for PPQ-H%), while the target sentence itself was not provided. Example (1) illustrates an English-translated trial.

You and your colleague see Zhou Gang’s English speech competition trophy, but you remember that Zhou Gang doesn’t speak English. You feel strange and ask your colleague: \_\_\_\_\_ *ma*? (1)

In this example, both *you* and the interlocutor have available evidence strongly suggesting that Zhou Gang speaks English (positive evidence). However, based on your knowledge, *you* privately believe that Zhou Gang does not speak English (negative epistemic), prompting the need for verification. After understanding the scenario, participants were expected to ask, “Does Zhou Gang speak English?” in Mandarin, using the provided question marker “*ma*” (see Table 2 for the target sentence written in Romanized Chinese). This corresponds to the *ma\_EviEpi* outlined in Table 1.

The 84 scenarios were presented in randomized order using Microsoft PowerPoint, and the participants’ oral production was recorded using a professional recording device.

### 2.2. Analysis

The second author screened and annotated the oral productions of all participants. A total of 2,519 sentences were recorded (84 trials  $\times$  30 participants – 1 missing trial). After excluding 840 fillers (28 fillers  $\times$  30 participants) and 11 instances of incorrect production, we analyzed the remaining 1,668 qualified sentences, including 600 PPQ-*ma*, 591 PPQ-H%, and 477 PPQ-*ba*.

Table 2: The target sentences for PPQ-*ma*, PPQ-H%, and PPQ-*ba* to be elicited under the pragmatic patterns identified by Yuan and Li [17]

Subject	Verb	Object	Q-particle	English gloss
Zhāng Tāo	chī	xiāng jiāo	ma/∅	Does Zhang Tao eat banana?
Kāng Juān	hē	huā chá	ma/∅	Does Kang Juan drink jasmine tea?
Zhōu Gāng	shuō	Yīng yǔ	ma/∅	Does Zhou Gang speak English?
Sūn Huī	kāi	Bēn lì	ma/∅	Does Sun Hui drive Bentley?
Pān Dōng	kāi	fēi jī	ba	Pan Dong flies a plane, right?
Sūn Zhēn	hē	fēn dá	ba	Sun Zhen drinks Fanta, right?
Fāng Xīn	shuō	Xī yǔ	ba	Fang Xin speaks Spanish, right?
Jīn Jīng	chī	shān yào	ba	Jin Jing eats yam, right?

Note. The four target sentences in the PPQ-H% were identical to those in PPQ-*ma* with the sole distinction being the omission of the interrogative particle -*ma* (∅ indicates no particle). The lexical tones are marked with diacritics: T1=ā, T2=á, T3=ǎ, T4=à.

All qualified sentences were segmented and annotated at the syllable level using PRAAT [18]. We extracted the duration of each syllable. Since PPQ-H% has 5 syllables, while PPQ-*ma* and PPQ-*ba* each have 6 syllables, our dataset comprised a total of 9,417 data points.

To check the potential influence of contextual factors on syllable duration along the sentence, for each PPQ type, we conducted a Linear Mixed Model (LMM) using the lme4 package [19] in R, with syllable duration as the dependent variable. The fixed effects included syllable (six levels for PPQ-*ma* and PPQ-*ba*, and five levels for PPQ-H%), condition (five levels for PPQ-*ma* and PPQ-H%, and four levels for PPQ-*ba*), and their interaction. As syllable structure can largely affect duration, we included this variable as a fixed effect as suggested by an anonymous reviewer. However, we will not discuss this variable in the results section as it is not the primary focus of this study. Finally, we included a by-participant intercept as random factor.

In all three LMMs, the significance of the fixed effects was calculated with Type II Wald *Chi*-squared tests using the car package [20]. Post hoc comparisons were conducted using the emmeans package [21]. Bonferroni was applied to adjust the *p*-values of multiple comparisons.

To answer RQ1, we will only report post hoc comparisons between the biased conditions (EVI, EviEpi, and EPI) and the baseline condition (NEU) in PPQ-*ma* and PPQ-H% and comparisons between the evidentially biased conditions (PosEvi and NegEvi) with the baseline of no evidence condition (NoEvi) in PPQ-*ba*.

To answer RQ2, we will only report post hoc comparisons between the antecedent condition (ANT) with the reference conditions, namely ma\_EviEpi, H%\_EviEpi, and ba\_NegEvi.

### 3. Results

#### 3.1. PPQ-*ma*

The LMM for PPQ-*ma* revealed significant main effects of syllable ( $\chi^2 = 619.9, p < .001$ ), condition ( $\chi^2 = 15.2, p = .004$ ), and syllable structure ( $\chi^2 = 323.8, p < .001$ ). Post hoc analysis revealed the following results. First, the particle -*ma* was significantly longer than all other syllables (all *ps* < .001), which indicates a final lengthening at the end of PPQ-*ma*, regardless of the pragmatic functions. Second, the subject had significantly longer duration than the second syllable of the object. Third, compared to the baseline condition ma\_NEU, the

biased conditions (ma\_EVI, ma\_EviEpi, and ma\_EPI) did not show significant differences in syllable duration (all *ps* > .05). Fourth, no significant difference was observed in syllable duration between ma\_ANT and ma\_EviEpi (*p* = .999).

We did not find a significant two-way interaction of Syllable  $\times$  Condition ( $\chi^2 = 24.5, p = .221$ ). Thus, the differences in syllable duration across the six syllables of all the target PPQ-*ma* sentences did not significantly vary across the pragmatic functions. Figure 1 plots the mean duration of each syllable under all five conditions.

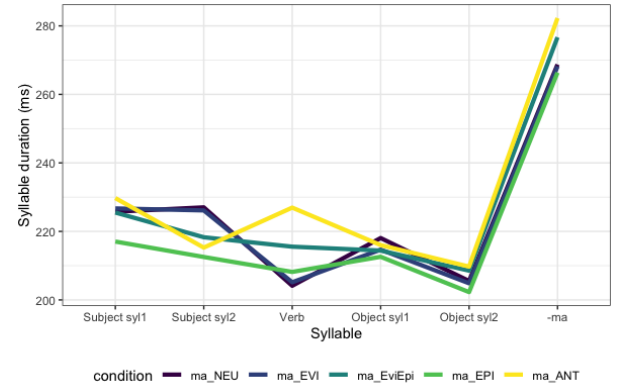


Figure 1: Mean syllable duration of PPQ-*ma* divided by condition.

#### 3.2. PPQ-H%

The LMM for PPQ-H% revealed significant main effects of syllable ( $\chi^2 = 1312.1, p < .001$ ), condition ( $\chi^2 = 33.9, p < .001$ ), and syllable structure ( $\chi^2 = 208.8, p < .001$ ). Post hoc comparisons yielded the following results. First, the second syllable of the object was significantly longer than all other syllables (all *ps* < .05). Given its position as the sentence-final syllable in PPQ-H%, this finding is due to the effect of final lengthening. Second, the two syllables of subject were produced with longer duration than the verb (all *ps* < .05). Third, compared to the baseline condition H%\_NEU, the biased conditions (H%\_EVI, H%\_EviEpi and H%\_EPI) did not show significant differences in syllable duration (all *ps* > .05). Fourth, when comparing H%\_ANT with H%\_EviEpi, the duration difference was not significant (*p* = .052).

Similar to PPQ-*ma*, we did not observe a significant two-way interaction of Syllable  $\times$  Condition ( $\chi^2 = 14.8, p = .538$ ).

This indicates that the differences in duration among the five syllables of the target PPQ-H% sentences did not vary across the five pragmatic conditions. Figure 2 plots the mean duration of each syllable across all five conditions.

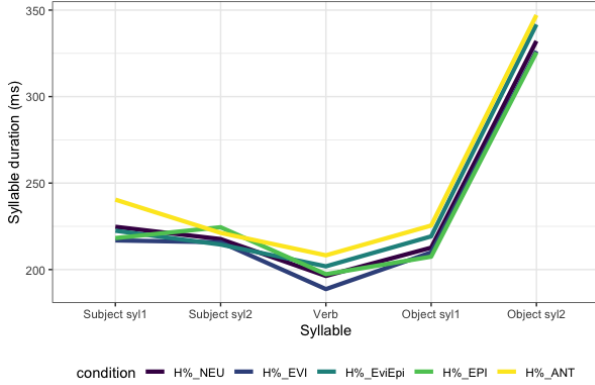


Figure 2: Mean syllable duration of PPQ-H% divided by condition.

### 3.3. PPQ-ba

The LMM for PPQ-ba revealed significant main effects of syllable ( $\chi^2 = 91.5, p < .001$ ), condition ( $\chi^2 = 123.1, p < .001$ ), and syllable structure ( $\chi^2 = 246.3, p < .001$ ), along with a significant two-way interaction of Syllable  $\times$  Condition ( $\chi^2 = 32.2, p = .006$ ). Due to this significant interaction, reporting post hoc comparisons for the main effects could be misleading. Therefore, we exclusively report post hoc pairwise comparisons of the two-way interaction.

First, the syllables in ba\_PosEvi did not show any significant differences from those of the baseline ba\_NoEvi (all  $ps > .05$ ). Second, the verb produced under the ba\_NegEvi condition was significantly longer than that of the baseline condition ba\_NoEvi ( $p < .001$ ). This means that the presence of negative contextual evidence led native Mandarin speakers to lengthen the verb. Third, similar to ba\_NoEvi, the verb in ba\_ANT was significantly longer than in ba\_NegEvi ( $p = .006$ ). This indicates that PPQ-ba uttered as a response to a negative antecedent statement is prosodically different from its counterpart with negative contextual evidence. Figure 3 plots the mean duration of each syllable across different conditions.

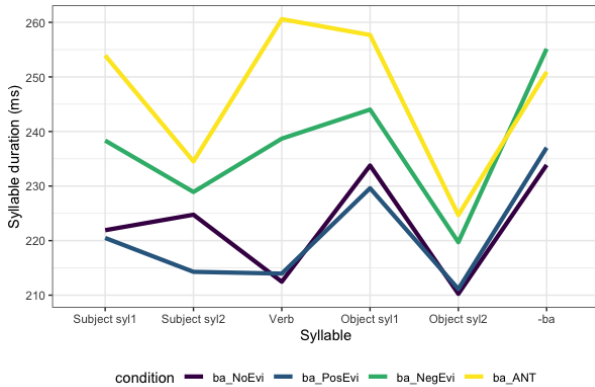


Figure 3: Mean syllable duration of PPQ-ba divided by condition.

## 4. Discussion

This study investigates how contextual factors (epistemic bias, evidential bias, and the presence of antecedent) are prosodically encoded in Mandarin PPQ using duration. For PPQ-ma and PPQ-H%, neither epistemic and evidential biases, nor the presence of an antecedent, affected syllable duration. However, for PPQ-ba, both evidential bias and the presence of an antecedent influenced the syllable duration of Mandarin PPQs.

Our first research question examined the influence of epistemic and evidential biases on the syllable duration of Mandarin PPQs. Both elements are documented as influential factors affecting the pitch configurations of polar questions, with crosslinguistic evidence in intonation languages (e.g., [1], [22], [23], [24]). Our study provided further evidence from a tonal language, Mandarin, and focused on duration. Duration seems to play a marginal role in prosodically marking epistemic and evidential biases. First, Mandarin speakers may not use duration to encode epistemic bias (EPI vs. NEU in PPQ-ma and PPQ-H%). Second, Mandarin speakers do not seem to vary syllable duration to encode positive evidence, which is consistent across all three PPQ types (ma\_EVI, H%\_EVI, and ba\_PosEvi). Third, the combination of epistemic bias and positive contextual evidence is not specifically marked by syllable duration (ma\_EviEpi and H%\_EviEpi). However, Mandarin speakers use duration to mark negative evidence with the prolonged verb. This is evidenced by the significant contrast in verb duration between ba\_NegEvi and ba\_NoEvi.

Our second research question examined whether the presence of an antecedent can influence the syllable duration of Mandarin PPQs. This research question was only partly answered by the data from PPQ-ba. It seems that contextual factors contrasting with the speaker's private belief, neither a positive antecedent statement nor publicly available negative evidence, are not marked by duration in PPQ-ma and PPQ-H%. But this distinction is evident in PPQ-ba. Therefore, with the data from PPQ-ba, it can be concluded that introducing the antecedent condition as a contextual factor to interpret Mandarin PPQ is necessary.

Taking the answers to both research questions together, duration is a prosodic marker for evidential bias and the presence of an antecedent in Mandarin, at least in the case of PPQ-ba. In addition, our production data only partially aligns with the felicity judgment experiment on the contextual biases of Mandarin conducted by Yuan and Li [17], as duration does not seem to be a prosodic marker for epistemic bias. However, these results should be interpreted with caution because duration might not be a primary cue for Mandarin prosody. Other suprasegmental features such as pitch may play a more important role. Future research would advance this topic by going beyond duration.

## 5. Conclusion

To conclude, this production study demonstrated the importance of epistemic bias, evidential bias, and the presence of an antecedent in interpreting Mandarin polar questions. In a tonal language, while Mandarin speakers vary syllable duration to mark these contextual factors, it appears that duration may not serve as the primary cue.

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