# Pitch shape modulates the time course of tone vs. pitch accent processing in Mandarin Chinese

**Zhaohong Wu zhw39@pitt.edu and Marta Ortega-Llebaria mao61@pitt.edu**

***Department of Linguistics, University of Pittsburgh***

## Tone and pitch accent (PA) in Mandarin Chinese

- Tones in Mandarin Chinese differentiate meaning: *ma*1 “mother” vs. *ma*3 “horse”.
- Four tones in Mandarin Chinese: static high-level Tone1 (55), dynamic rising Tone2 (35), dynamic falling and rising Tone3 (214), and dynamic falling Tone4 (51).
- In a tone language such as Mandarin Chinese, the same pitch contour -- e.g., an ascending F0 -- conveys information about both lexical meaning via tones -- e.g., Tone 2 -- and sentence-level meaning -- e.g., question – via PA.
- Which information (tone vs. pitch accent) is processed earlier?
- Li, Yang, and Hagoort (2008) showed that tone violations elicited an N400 effect 90ms earlier than pitch accent violations during spoken discourse comprehension.
  - However, they did not control for specific tone shapes (i.e. the flat pitch of Tone 1, the ascending pitch of Tone 2, etc.).
  - Moreover, as they have suggested, to empirically establish the relative moments in time that tone and pitch accent perception take place, there is the need for a gating task, which we undertook in the present study.

## Methods

***Participants:*** 40 native Mandarin Chinese speakers, recruited at Nankai University in Tianjin, China

***Materials:***

- 12 sets of short conversations
- Target word either sentence-initially or sentence-finally.
- Tonal variations of Target words: Tone1, Tone2, Tone4
- Pitch accent variation: either appropriate (PA when narrow-focus or no PA when broad-focus) or inappropriate (no PA when narrow-focus or PA when broad-focus)

Table 1. Two examples items with target words (underlined and in bold) either at the beginning or the end of the sentence, consisting of a question by Interlocutor A and a response by B.

| Interlocutor A (broad focus context): | Interlocutor A (narrow focus context): |
|---|---|
| 他 说 什么？ | 他 正在 欣赏 什么？ |
| *“What did he say?”* | *“What is he enjoying?”* |
| Interlocutor B (target word at the beginning of the sentence; Tone1): | Interlocutor B (target word at the end of the sentence; Tone4): |
| **花** 很 漂亮。 | 他 正在 欣赏 **画**。 |
| **hua1** hen piaoliang | ta zhengzai xinshang **hua4** |
| ***flower*** *very beautiful* | *he is enjoy* ***picture*** |
| *“**Flowers** are very beautiful.”* | *“He is enjoying **pictures**.”* |

***Procedure:***

- The auditory gating paradigm (Grosjean, 1980, 1996) run on E-Prime.
- Two responses per trial were collected: (1) decide either which tone the target word was or whether the target word was correctly pitch-accented or not, and (2) confidence-rating (on a 1-7 Likert Scale).
- Sentence-initial target words were segmented in 50ms increments starting from its end, and sentence-final target words from its beginning.

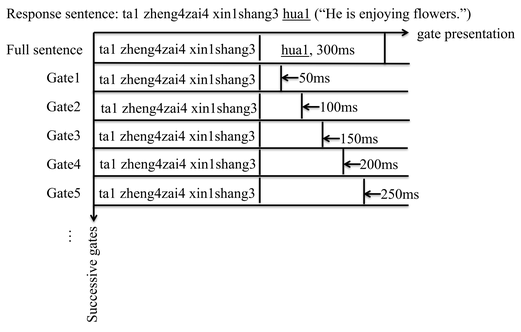


Figure 1. Illustration of how target words were segmented and presented incrementally.

- List 1: sentence-initial & List 2: sentence-final
- Orthogonally varied (1) whether List 1 and then List 2,or the opposite, and (2) whether tone and then pitch accent, or the opposite
- The order of the short dialogues within each block was randomized for each participant.

## Results

Percentage.F0: how much pitch information in time (# of gates) was needed by a participant for correct isolation of tone or pitch accent, divided by the total # of gates of the target word with regard to pitch

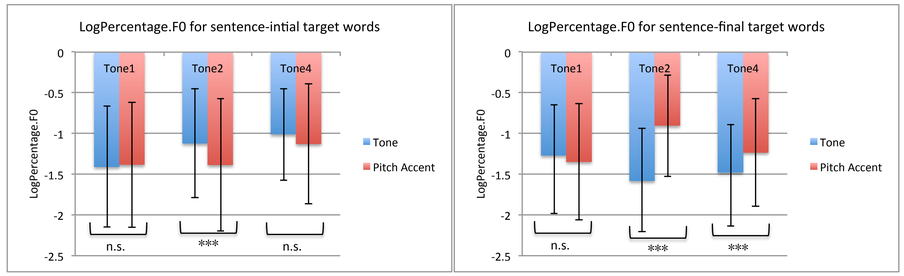


Figure 2. Mean log-transformed Percentage.F0 per condition for sentence-initial and sentence-final target words; a higher value indicates more percentage needed for isolation

## Discussion

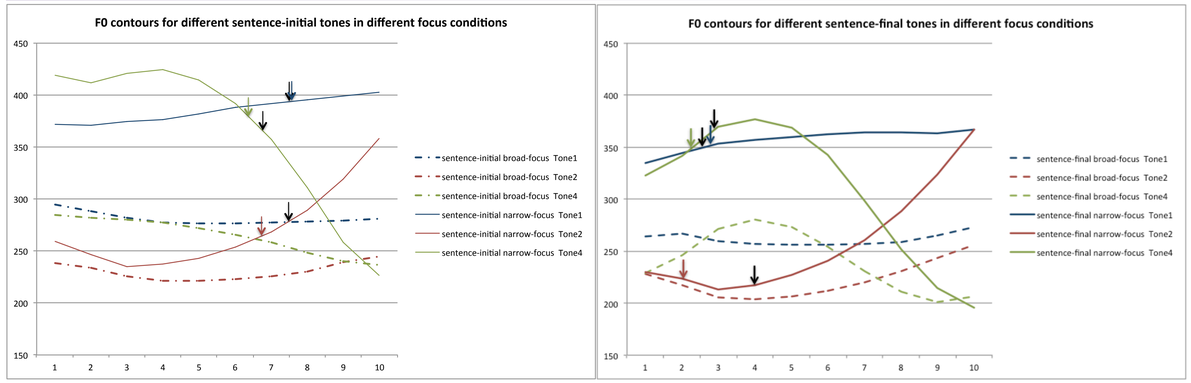


Figure 3. Arrows indicating the mean isolation points for tone or PA for each tone (1, 2, or 4) in either sentence-initial or sentence-final positions are depicted upon the mean F0 contours. For each specific condition, two arrows are displayed right upon its F0 contour: the arrow sharing the color with the F0 contour displays the position for correct tone isolation, and the other (black) displays the position for correct pitch accent isolation.

- Results confirmed our hypotheses that tone shape modulates the time course of tone vs. PA processing.
  - Sentence-initial:
    - No time advantage of tone vs. PA for Tone1 or Tone4 target words, but
    - a significant PA advantage for Tone2 words (F0 maxima is available in the very first pass, whereas more gates are needed for listeners to perceive a slope in the contour and thus establish the Tone2 identity, rendering a PA advantage)
  - Sentence-final:
    - No time advantage of tone vs. PA for Tone1 target words, but
    - a significant tone advantage for Tone2 and Tone4 words (F0 maxima information is realized later, and especially later for Tone2 words, rendering a tone advantage)
- Evidence for parallel processing of tone (lexical) and PA (semantic and pragmatic) information during online spoken language comprehension.

## References

Grosjean, F. (1980). Spoken Word Recognition Processes and the Gating Paradigm. *Perception & psychophysics, 28*(4), 267-283.

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