Asymmetrical mismatch negativity effects in Mandarin tone perception

Stephen Politzer-Ahles, Kevin Schluter, Kefei Wu, & Diogo Almeida
New York University Abu Dhabi, Abu Dhabi, United Arab Emirates

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Correspondence: spa268@nyu.edu

NEW YORK UNIVERSITY ABU DHABI

Introduction: Asymmetries in mismatch negativity

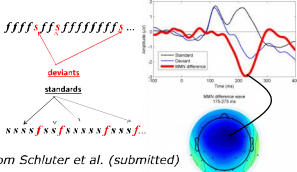- The mismatch negativity (MMN) paradigm:

Figure adapted from Schluter et al. (submitted)

- **Asymmetrical MMNs**: often MMN is bigger when the standard is featurally underspecified than when it's fully specified (e.g. Eulitz & Lahiri, 2004, *J Cog Nsci*)

- Asymmetrical MMN effects in **Mandarin tones** have not been directly tested for (see Law et al., 2013, for Cantonese)
- **Third Tone (T3)** may be underspecified (Qu, 2013):
  - Undergoes alternation (*T3 sandhi*): **/T3.T3/ → [T2.T3]**
  - Low tone, typologically less marked than High tones (Kuo, Yip, & Xu, 2007)
  - Acquired earlier (Qu, 2013)

- **The present study:** Test whether there are asymmetrical MMN effects when contrasting T3 against other tones

Predictions:

Underspecification of T3: asymmetrical MMN across the board when T3 is involved
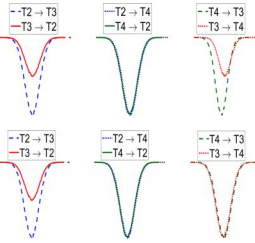
T3 sandhi: asymmetrical effect for T3 with T2 (which is phonologically related to T3), but not with T4 (unrelated to T3)


Methods

- Natural monosyllables manipulated to differ only in pitch
- Passive oddball paradigm with 6 block types: T2→T3, T3→T2, T2→T4, T4→T2, T3→T4, T4→T3
- 18 blocks (3 per condition) with 36 deviants and 224 standards, pseudorandomized such that each block began with ≥20 standards, and each deviant was preceded by 2-10 standards; 500 ms ISI
- Standards of a token subtracted from deviants of the same token in opposite block to yield MMNs
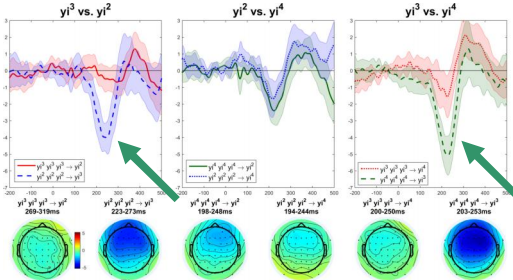
Experiment 1: Full 3rd Tone

Native speakers (N=16), channel Fz
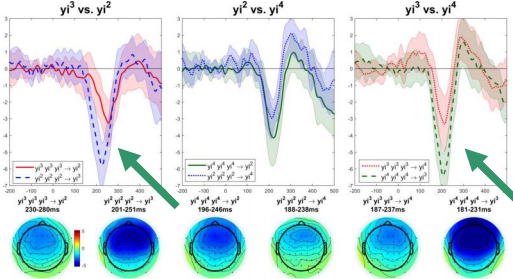
The predicted asymmetry is observed between T3 and other tones, but not between the non-T3 pair

Non-Chinese-speaking controls (N=16), channel Fz

Same asymmetry found in controls—could it be due to the acoustic complexity of T3, rather than to phonological knowledge?
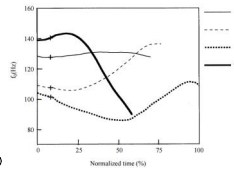(see Nordby et al, 1994, *Psychophys*; Czigler et al., 2013, *Cogn Affect Behav Nsci*)

Figure reprinted from Xu (1997, JPhon)
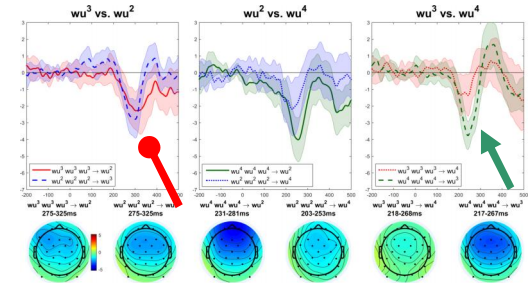
Experiment 2: Half 3rd Tone

Used another contextual variant of T3: half-T3 (occurs in non-final position), which is similar in acoustic complexity to the other tones

Now asymmetry is reliably observed in native speakers and not controls

Native speakers (N=16), channel Fz
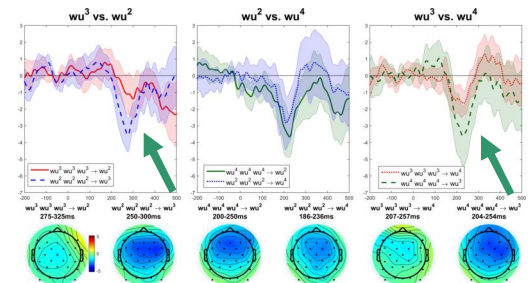
Non-Chinese-speaking controls (N=16), channel Fz

Discussion

- Observed asymmetrical MMNs for Mandarin tone contrasts:
  - Smaller MMN when standard is T3
  - Occurs in both T3~T2 (phonologically related) and T3~T4 (phonologically unrelated) contrasts

- Acoustic complexity plays a role (Full T3 experiment), but MMN is asymmetrical even when this is controlled (Half T3 experiment)
- The results provide neurophysiological evidence that T3 may be underspecified

- Pilot data suggest that this also holds for the T3~T1 contrast, and for contrasts using a variety of tokens (requiring more phonological abstraction)
- Future research: other Mandarin dialects, where T3 still alternates but is not Low?