Asymmetries in the perception of Mandarin tones: Evidence from mismatch negativity

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

169th Acoustical Society of America Annual Meeting (2015)

Correspondence: spa268@nyu.edu

Introduction: Asymmetries in mismatch negativity

- The mismatch negativity (MMN) paradigm:

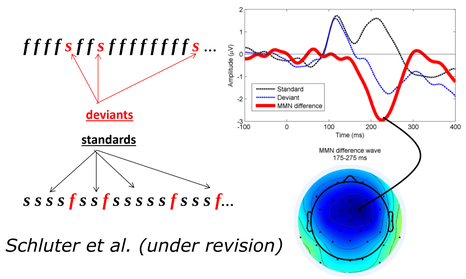


Figure adapted from Schluter et al. (under revision)

- ***Asymmetrical MMNs***: factors that increase MMN amplitude:
  - More prototypical standards (*Ikeda et al., 2002,* Nsci Let)
  - More acoustically peripheral deviants (*Polka & Bohn, 2011,* JPhon)
  - More featurally complex deviants (*Nordby et al, 1994,* Psychophys*; Timm et al., 2011,* Front Psychol)
  - Phonologically *underspecified* standards (*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*)

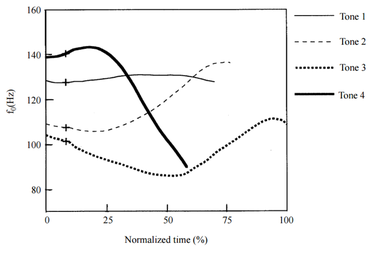


Figure reprinted from Xu (1997, JPhon*)*

- **The present study:**
  - Test whether there are asymmetrical MMN effects when contrasting T3 against other tones
  - Compare against non-Chinese-speaking controls to rule out non-phonological explanations such as those above

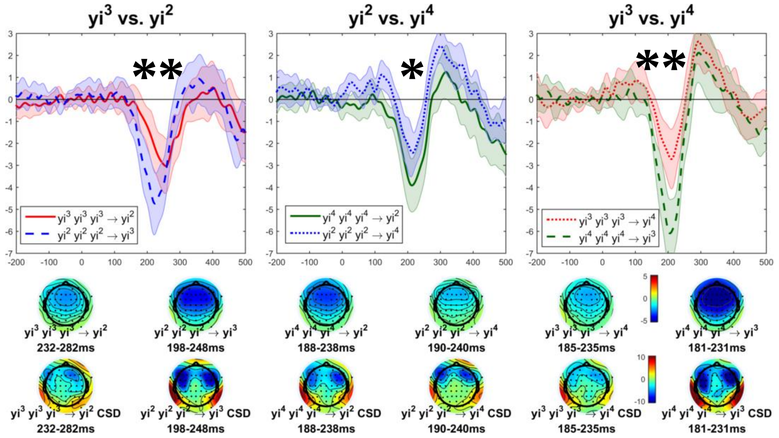
Methods

- 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
- Data cleaned with ICA; standards of a token subtracted from deviants of the same token in opposite block to yield MMNs

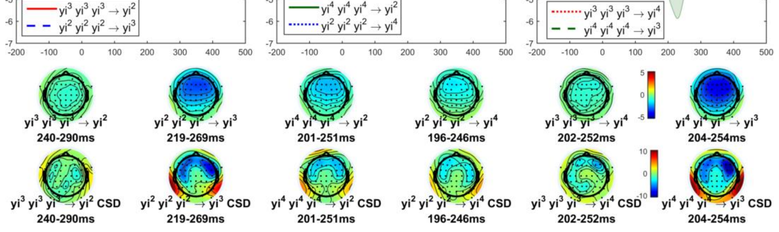
This research was supported by grant G1001 from the NYUAD Institute.

Experiment 1: Full 3rd Tone

Native speakers (N=16), channel Fz



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

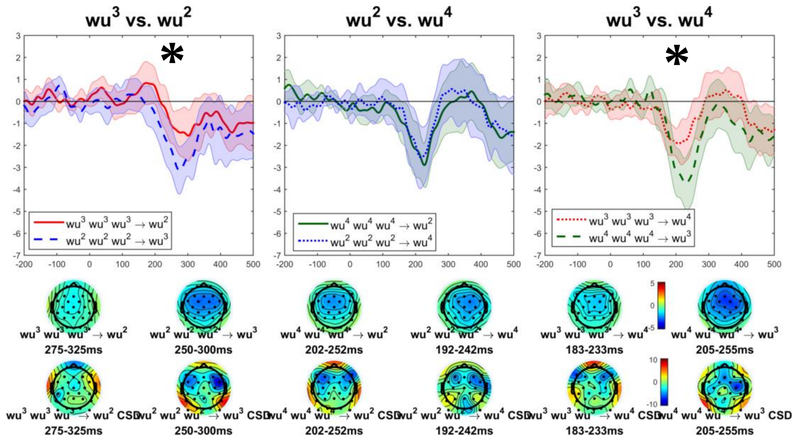


- ***Asymmetry between T3 and other tones***
- ***But non-Chinese-speaking controls also show this asymmetry!***
- ***Unexpected T2-T4 asymmetry***

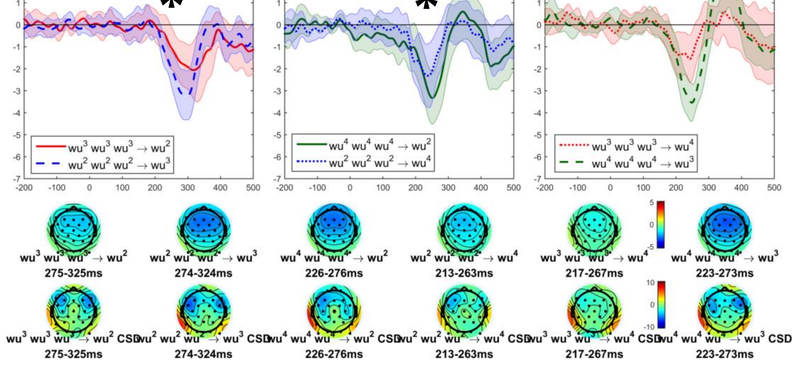
Experiment 2: Half 3rd Tone

Because the clear turning point of full T3 may have been a salient acoustic feature, we used another contextual variant of T3: half-T3 (occurs in non-final position), which has no salient turning point

Native speakers (N=16), channel Fz



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



- ***T3 asymmetry still present in both groups***

Discussion

- Observed asymmetrical MMNs for Mandarin tone contrasts:
  - Reliably smaller MMN when standard is T3
  - Occurs in both T3~T2 (phonologically related) and T3~T4 (phonologically unrelated) contrasts
  - Occurs in both native and control groups
- Results only consistent with T3 underspecification if we assume that Low tones are universally underspecified (even for speakers of non-tone languages)
- The results highlight the importance of testing acoustic controls before making conclusions about the role of underspecification in MMN studies
- Insufficient evidence yet to adjudicate between underspecification and acoustic accounts for the asymmetry
- If the results are driven by acoustic complexity, what aspects of the tone contour drive the percept of more or less complexity?
- Unexpected asymmetry between T2 and T4
  - While it was not significant in most experiments, MMNs were almost always numerically larger for T2 deviants.
  - Not predicted based on underspecification