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The neural basis of lexical tone in bilingual language processing

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Introduction

- Mandarin-English bilinguals use pitch to disambiguate lexical meanings in one language but not the other.
- Previous studies show that lexical tones, as a linguistic dimension, are left-lateralized (Fournier et al., 2010; Wong et al., 2004).
- Lexical tone processing in the bilingual context appears to be critical in creating cross-language activation/competition (i.e., language co-activation), esp. with *Interlingual homophones* (IHs), words that share phonology across languages but differ in meaning (Wang et al., 2020).

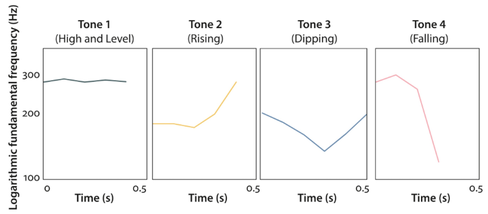

Fig. 1. The pitch contours of the four Mandarin tones

Research Aim

- We attempted to replicate the cross-language effects in Wang et al. (2020) and investigated the neural basis of lexical tone processing in Mandarin-English bilinguals when they perform a task in English-only.

Method (Auditory Oddball Paradigm)

- **Participants:** 26 Mandarin-English bilinguals (M_{age} = 25); 16 English native listeners (M_{age} = 22).
- **Stimuli:**

		IHs contrast (N=8)		
Standard	shoe/*ʃuː/*	buy/*bai/*	two/*tuː/*	lay/*lei/*
Deviant	shoe1/*ʃuː/1*	buy2/*bai/2*	two3/*tuː/3*	lay4/*lei/4*
		Non-IHs contrast (N=8)		
Standard	boy/*bɒɪ/*	hair/*heə/*	cue/*kjuː/*	bore/*bɔː(r)/*
Deviant	boy1/*bɒɪ/1*	hair2/*heə/2*	cue3/*kjuː/3*	bore4/*bɔː(r)/4*

Note: The numbers indicate the tones of corresponding Mandarin words, superimposed on English syllables (Wang, et al., in revision)

- **Procedure:**
  - A sequence includes a novel target (English CVC words) for participants to detect by button pressing.

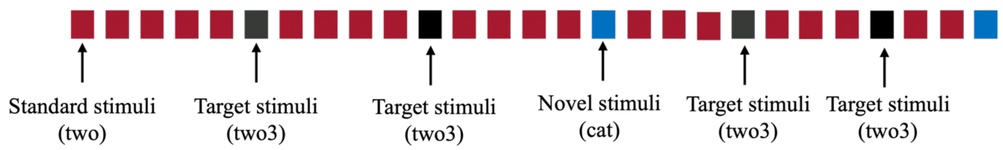

Fig. 2. An example of the auditory word sequence. Red: Standard stimuli (80%). Black: Target stimuli (16%). Blue: Novel stimuli (4%). Between each two deviant targets, there were 3 to 5 standard stimuli.

Current Results

- **Mandarin-English Bilinguals**

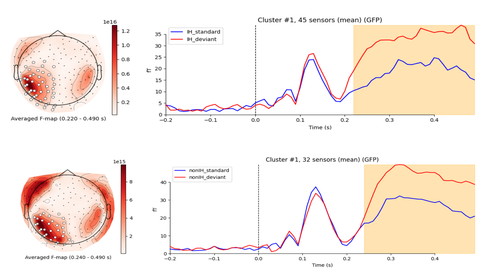

Fig. 3. MMF results of IH and non-IH

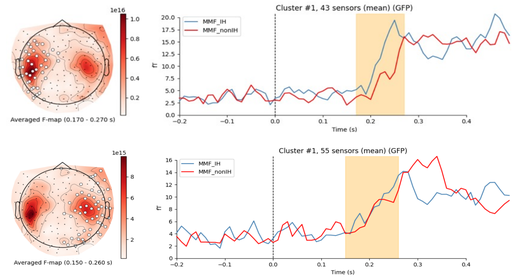

Fig. 4. MMF Deviant-Standard differences between IH and non-IH

- Cluster-based permutation tests revealed a significantly larger deviant-to-standard amplitude (i.e., mismatch negativity, MMF) in both conditions (IH condition: 220 - 490ms time window, $p = 0.023$; non-IH condition: 240 - 490ms time window, $p = 0.02$) (see **Fig. 3**).
- The comparison of MMF between the IH and non-IH conditions shows that the IHs elicited a significant larger MMF than the non-IHs in the left clusters ($p=0.042$, 170-270ms time window) and right clusters ($p=0.054$, 150-260ms time window, see **Fig. 4**).

- **English native listeners**

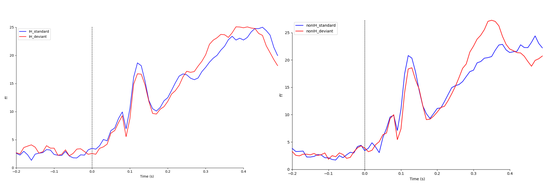

Fig. 5. MMF results of IH and non-IH

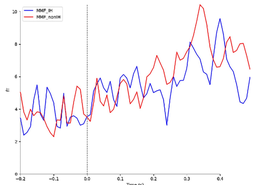

Fig. 6. MMF differences between IH and non-IH

- No significance of MMF or the MMF differences between conditions.

Current Conclusions

- As predicted, Mandarin-English bilinguals showed increased brain activities when processing the deviant interlingual homophones (IHs) compared to the non-IHs. This is due to the superimposed tonal information on the IH.
- No significant difference was observed between the IHs and non-IHs in English native listeners.
- These results consolidated the previous behavioral effects.

References **[1] Fournier, R., Gussenhoven, C., Jensen, O., & Hagoort, P.** (2010). Lateralization of tonal and intonational pitch processing: An MEG study. Brain Research, 1328, 79-88. **[2] Wang, X., Hui, B., & Chen, S.** (2020). Language selective or non-selective in bilingual lexical access? It depends on lexical tones! PLOS ONE, 15(3), e0230412. **[3] Wong, P. C. M., Parsons, L. M., Martinez, M., & Diehl, R. L.** (2004). The Role of the Insular Cortex in Pitch Pattern Perception: The Effect of Linguistic Contexts. The Journal of Neuroscience, 24(41), 9153–9160. **[4] Wang, X., Jheng, J., & McMurray, B.** (in revision). Tone Superimposition Technique in Speech Sciences: A Tutorial. https://doi.org/10.31219/osf.io/kwh7n.

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