Lexical tone in L2 Mandarin: The relation between categorical perception and real-time spoken word recognition

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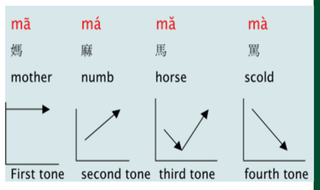
Research Questions

RQ1: *How do L2 learners process **tonal** cues along with **segmental** cues in Mandarin spoken word recognition?*

RQ2: *Does L2 learners' use of tonal cues in spoken word recognition relate to the ability to **perceive tone categorically**?*

Background

Tone is contrastive in Mandarin.



Native speakers of Mandarin (L1ers)

- perceive tone pair continua categorically (Hallé et al., 2004)
- use tonal and segmental cues concurrently in spoken word recognition (Malins & Joanisse, 2010)

Second language learners of Mandarin (L2ers)

- find tone challenging to master (Wang et al., 2006)
- perceive tone less categorically than L1ers (Shen & Froud, 2016, 2018); categorical perception (CP) is correlated with L2 proficiency (Ling et al., 2016)
- can identify tone in isolated syllables, but show difficulty in processing tone lexically (Pelzl et al., 2018)

→ *No study has investigated the relationship between CP and lexical processing of tone in L2 Mandarin*

→ *Contribute towards a better understanding of "the bridge between phonemes and words" in L2 processing (Wong & Perrachione, 2007)*

Participants

- L1ers: 30 native Mandarin speakers born and raised in China
- L2ers: 29 English-speaking learners of Mandarin; most recruited from intermediate to advanced Chinese classes in Hawai'i and China; age of onset: >12 years; self-rated proficiency: *M* = 2.90/5 (*SD*=.95); listening proficiency test score: *M* = 76.86% (*SD*=17.46%)

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Method & Procedure

Visual World (VWP) Eye-tracking Experiment:

3 AOIs: Target, Competitor, Distractor; all monosyllabic concrete nouns

- 3 conditions, differ in phonological overlap of competitor with the target:

  SC: Segmental competitor differs from target only by tone (*gou3 – gou1*)
  RC: Rhyme competitor shares rhyme with target (*gou3 – shou3*)
  VC: Vowel competitor shares vowel with target (*gou3 – dou4*)

- 36 critical trials = 12 sets (same target) * 3 conditions; 60 fillers

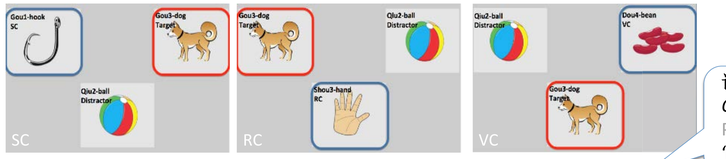
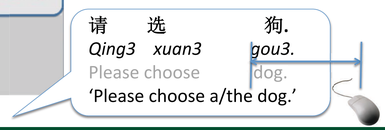


Fig1. Sample set of visual scenes.



1. Background questionnaire
2. Familiarization and naming
3. Visual World Eye-tracking Experiment
4. Tone Identification Task
5. Listening proficiency test

Tone Identification Task:

- For each of the 6 tone pairs, 9-step continua (with /pi/) and a 4-step continuum (with /kwo/) were created from naturally produced sounds using the PSOLA method (Moulines & Laroche, 1995)
- Participants hear a sound and categorize it as sound A or B (blocked by tone pair)

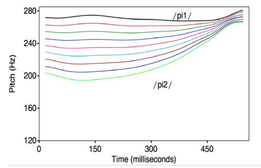


Fig2. Sample tone continuum (T1-T2)

Results

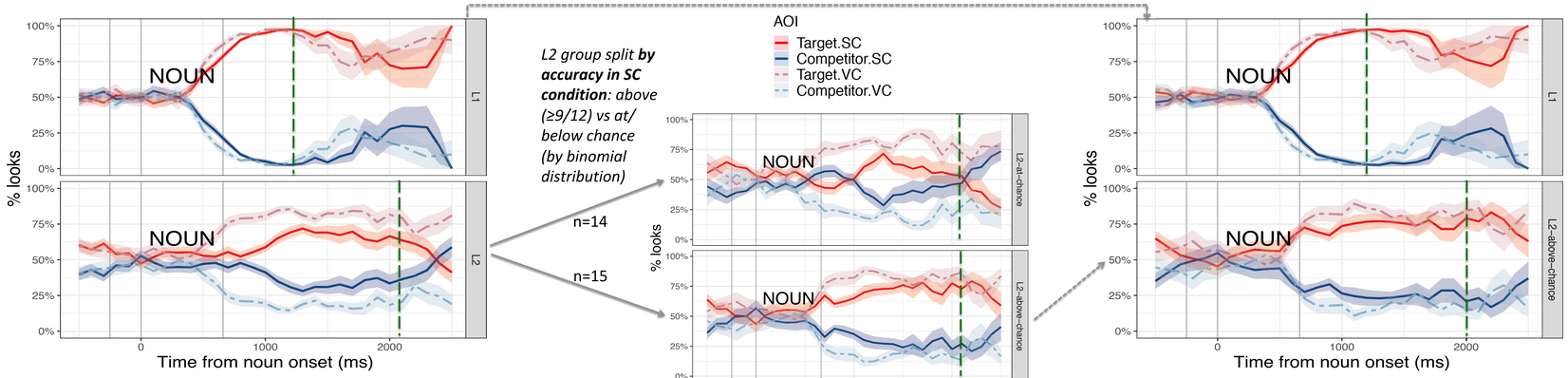


*Fig3. Proportion of looks to target and competitor in SC and VC conditions: **All trials**, L1 vs L2; dashed green line = mean time of mouse click*

*Fig4. Proportion of looks to target and competitor in SC and VC conditions: **All trials**, L2-at-chance vs L2-above-chance*

*Fig5. Proportion of looks to target and competitor in SC and VC conditions: **Trials with correct mouse click**, L1 vs L2-above-chance*

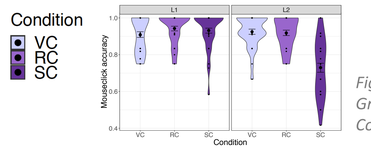


Fig6. Accuracy by Group (L1, L2) and Condition

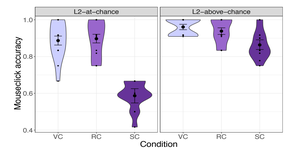


Fig7. Accuracy by Group (L2-at-chance, L2-above-chance) and Condition

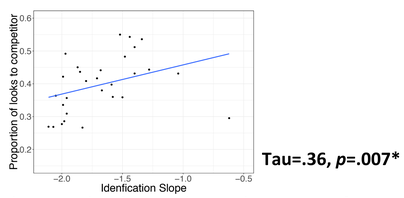


Fig8. Correlation between identification slope and proportion of looks to competitor in SC Condition; All trials, L2 group. (More negative identification slopes indicate more categorical perception.)

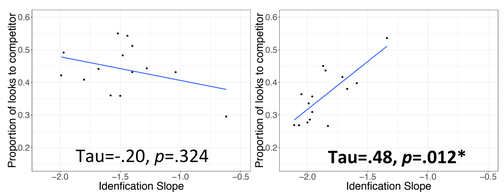


Fig9. Correlation between identification slope and proportion of looks to competitor in SC Condition; All trials, L2-at- (left) vs L2-above-chance (right).

Analysis: Linear mixed-effect regression (lmer)

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PropComp ~ Condition * Group + (1 | Participant)
PropComp ~ Condition * Group + (1 | Item)
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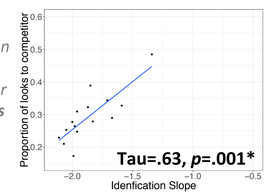
DV: proportion of looks to Competitor over total proportion of looks to Competitor and Target during window from 200ms after noun onset to **mouseclick in each trial;** Condition (simple-coded; baseline VC).

Effect of SC (vs VC):

- L1: b_1 = .02, p = .21; b_2 = .02, p = .48
- L2-above-chance: $\boldsymbol{b_1}$ **= .06,** $\boldsymbol{p}$ **= .04*;** b_2 = .21, p = .13

*Fig10. Correlation between identification slope and proportion of looks to competitor in SC Condition; **Trials with correct mouse click**, L2-above-chance.*



Summary & Conclusions

→ *RQ1: Compared to native speakers, L2 learners weigh tonal cues less than segmental cues. This is true even for learners with above-chance accuracy in recognizing words by tone alone on trials with correct mouse click.*

→ *RQ2: The more L2 learners perceive tone categorically, the more they rely on tonal cues during spoken word recognition.*

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