The Acoustic Change Complex: tone perception in Mandarin and English speakers.

Alyssa Dyball[1,3], Nan Xu[2,3], Pragati Rao M. V. [2,3], Mridula Sharma[2,3] & Katherine Demuth[2,3]
Department of Psychology[1], Department of Linguistics[2], ARC Centre of Excellence in Cognition and its Disorders, Macquarie University, Sydney, Australia[3]

Background

- The Acoustic Change Complex (ACC) was recently proposed as the optimal measure for objective assessment of auditory discrimination.
- The ACC is an automatic brain response to change in an ongoing auditory stimulus. It consists of N1' and P2' peaks.
- BUT It is unclear if ACC is a response to **acoustic** or **phonemic change.**

Present study

- We used a cross-linguistic paradigm; Mandarin tones.
- In Mandarin (tone language), pitch is used to distinguish meaning between words.
  - E.g., ma + rising tone = hemp, ma + dipping tone = horse.
- Behavioural studies reveal that English speakers are poor at tone discrimination tasks compared to native Mandarin speakers.
- For Mandarin speakers acoustic changes in tone also indicates a phonemic contrast.
- For English speakers, acoustic changes in tone is linguistically irrelevant --- not perceived as a phonemic contrast.

Predictions

- IF ACC is a response to **acoustic change** ---- should be present in both groups. (Equal amplitude and latency).
- IF ACC is a response to **phonemic change** ---- should be present only in Mandarin speakers.

Stimuli

- Mandarin /a/ vowel produced with 2 differing tones, T2 (rising) and T3 (dipping) by a female native-speaker of Mandarin.
- The inflection point within T3 was expected to elicit an ACC response.

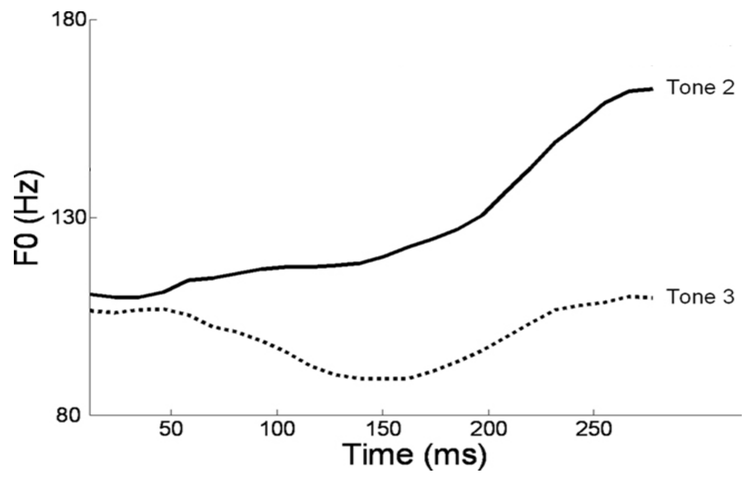

Figure 1: Pitch contours of T2 and T3.

Method

Participants: 9 Native Mandarin-speakers and 7 Australian-English speakers from the student pool at Macquarie University, Sydney. Nine of 16 participants were female aged between 18 and 30 (*M*= 22.4).

Task 1 (Control)

- 2 oddball sequences, T2 and T3 alternated as the standard (80%) and the deviant tone (20%).
- 150 trials per block, with 30 as the deviant.
- Participants were asked to press a button when they heard the deviant tone.
- 2 measures were recorded:
  - Response time (milliseconds)
  - Accuracy (d-prime).

Task 2

- Participants were fitted with sensors to record brain activity while passively listening to auditory stimuli.
- Each tone was presented in blocks of 100 repetitions.
- 2 measures were recorded:
  - Amplitude (microvolts): indicating the intensity of the response (larger amplitude, larger response)
  - Latency (milliseconds): indicating the time frame of the ACC response.

Results

Task 1

- No significant behavioural differences found between groups.

Task 2

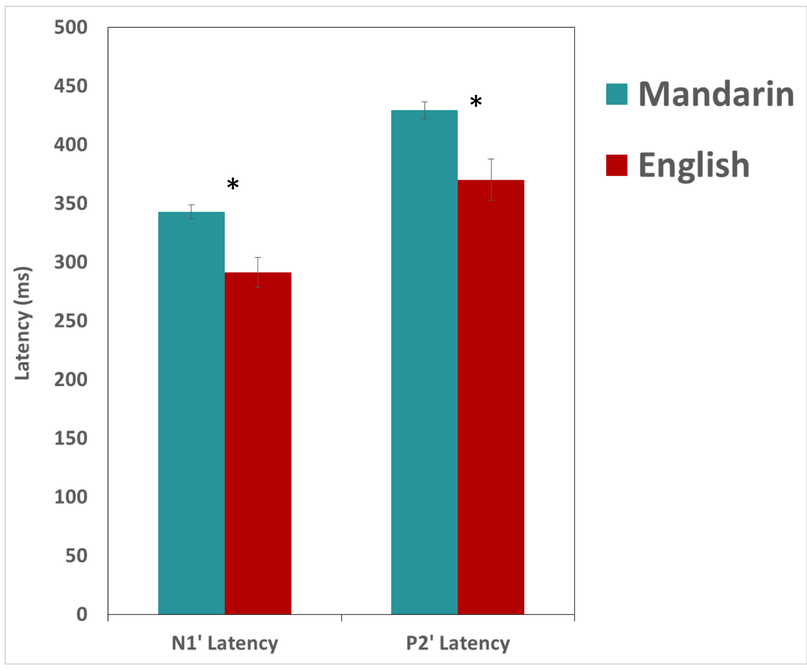

Figure 2: Mean latency response of N1 and P2 (ACC complex) for each group (*p < 0.05).

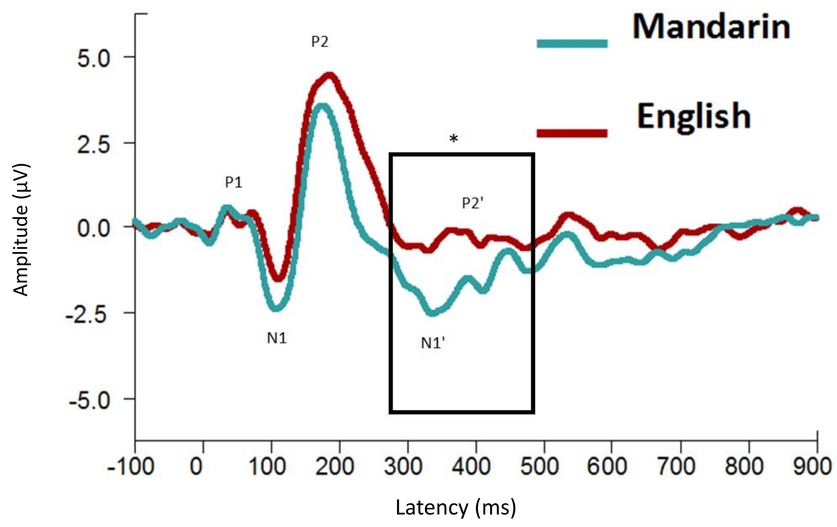

Figure 3: Time window for ACC response for both groups. Significant latency differences for peaks N1' and P2' (* p < 0.05).

- ACC was present only for dipping tone 3 in both groups.
- Only significant latency difference between groups found.

Conclusions

- Clear ACC response for both groups i.e. ACC is a response to acoustic change.
- Mandarin speakers show more consistent latency measures.
  - Language experience assists with better targeted responses to acoustic cues for tone discrimination.

Implications

- ACC is an appropriate measure for tone perception; may be appropriate for preverbal infants.
- Future research with other tone languages is necessary.

Selected references

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