**OVERVIEW: A PERCEPTION STUDY**
- An ABX perception study on nasal distinction
  - Nasal vs. oral onsets in different vowel contexts
- A ‘better’ vowel context did not improve listeners’ perception of unattested nasal distinction in voiced onsets
- Attested nasal contrasts were not perceived equally well across manners of articulation

**BACKGROUND: NASALITY IN TAIWANESE**
- Nasal distinction is attested but restricted in Taiwanese
  - ꪌ pʰ ‘put on’ pʰ ‘take advantage of’
  - ꪌ ‘sad’ ꪌ ‘side’
  - ꪌ ‘flavor’ ꪌ ‘bí’
  - ꪌ ‘noodle’
- Previous account: especially before nasal vowels, this distinction would not be salient (Wang, 2017)
  - Full nasality in nasal vowels in Taiwanese (Chang et al., 2011)
  - Oral voiced stops lack strong burst release
  - [bʱaʰ]-[mã] and [mã] would sound really similar
- Different situation in French & Portuguese: where /bh/ and /mh/ are contrastive and there is an oral onset in [bʱã],[ã]. (Chang et al., 2011; Devalx et al., 2008; Parkinson, 1983)

- Prediction of this account: additional cues at the initial portion of the vowel should improve the perception of this contrast
  - [bʱã]-[mã] is a better distinction than [bʱã]-[mã]

**RESEARCH QUESTIONS & PREDICTIONS**
- Does an ‘better’ vowel context improve the perception of unattested oral-nasal distinction?
  - ‘Phonotactic’ hypothesis: No
    - [ba]-[mã] > [bʱã]-[mã] = [bʱã]-[mã]
  - ‘Phonetic’ hypothesis: Yes
    - [ba]-[mã] > [bʱã]-[mã] > [bʱã]-[mã]
- Are all attested oral-nasal contrasts perceived equally well?
  - ‘Phonotactic’ hypothesis: Yes
  - ‘Phonetic’ hypothesis: No
  - aspiration and voicing in addition to nasality will enhance the difference:
    - ꪌ [a]-[mã] > [a]-[mã] > [ba]-[mã]
    - ꪌ [a]-[mã] > [a]-[mã] > [ba]-[mã]
    - ꪌ [b]-[mã] > [b]-[n]

**METHOD**
- ABX perception on word tokens with varied first syllable
  - e.g. [baku]-[mãku]-[baku]
- Stimuli (196 in total, plus 32 fillers)
  - Nonce words concatenating a word and a nonce word
  - Independent variables, all on the oral item:
    - For testing the vowel context effect: Vowel nasality (ba-mã, bʱa-mã, bʱã-mã)
    - Onset of partially nasalized vowel (bʱã) had a 10% oral onset (30-40 ms.), created by mixing and splicing oral and nasal tokens (cf., Styler et al., 2011)
    - For testing the place/manner of articulation effect:
      - Onset voicing/aspiration (ba-mã, pa-mã, pʱa-mã) and Onset place of articulation (ba-mã, la-mã)
  - Participants:
    - 40 participants, 18-30 years old, split in gender, self-reported to be fluent Taiwanese speakers
    - 6 of them were filtered out for not performing significantly above chance for the ba-mã type stimuli
  - Main analysis: Mixed-effects logistic regression in R

**RESULTS: INDIVIDUAL PERFORMANCES**
- Difficult task with voiced oral stops (left column)
  - The attested [ba]-[mã] and [la]-[mã] contrasts were not performed well (bottom-left panel)

**RESULTS: MAIN ANALYSIS**
- Fully vs. partially nasalized vowels
  - Perception did not improve with partially nasalized vowels (e.g., [bʱã]-[mã])
  - Attested [ba]-[mã] was not performed better than unattested distinctions

**DISCUSSION**
- A very difficult task for voiced items: effect of the presence of easier items (i.e., aspirated stops)?
  - The vowel context effect was not found
    - Phonetic differences in nasal vowels did not overturn the phonotactic effect on perception
  - A phonetic effect was found along the aspiration/voicing dimension
    - An enhancing effect on perceiving contrasts/distinctions
    - In Taiwanese, this dimension is more widely contrastive than nasality (so, also phonotactic?)

**FUTURE RESEARCH**
- With similar hypothesis/design:
  - Eliminate fillers & easier items
  - Increase duration of oral onset to nasal vowels
  - Taking the property of the stop release into account (Informal observation: French /b/ has a stronger burst than Taiwanese /b/)
  - Another way to account for the Taiwanese data: protection of nasal contrast in vowels
    - /ma/ [mã] or /ba/, environmental shielding (Stanton, to appear)
  - Experiment: Taiwanese speakers’ sensitivity to vowels whose nasality differs to different extents