Question: How are loanwords borrowed from English, a language without lexical tone, assigned tones in Mandarin Chinese, a language with lexical tone?

Approach: A corpus study of English loanwords in Mandarin

Principal Findings:
• Voicing in English is the most reliable predictor of tone in Mandarin
• English stress plays a secondary role, if any, in tonal adaptation

1. Background
• A common thread in English-to-Chinese tonal adaptation: the relationship between stress in English and lexical tone in Chinese languages

1.1 English Stress
• English stressed syllables have longer duration, higher F0, and greater amplitude than unstressed syllables (Cutler 2008)
• These properties can also distinguish Chinese tones → stress-to-tone?

1.2 Tonal Adaptation in Cantonese (Hao 2009)
• Overall, follows stress-to-tone principles:

<table>
<thead>
<tr>
<th>English Stress</th>
<th>Cantonese Tone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stressed (primary or secondary)</td>
<td>High</td>
</tr>
<tr>
<td>Pre-tonic unstressed</td>
<td>Mid</td>
</tr>
<tr>
<td>Post-tonic unstressed</td>
<td>Low</td>
</tr>
</tbody>
</table>

1.3 Tones of Mandarin

<table>
<thead>
<tr>
<th>Tone</th>
<th>Chao Digits</th>
<th>Pinyin</th>
<th>Relative Duration in Citation Form (Whalen &amp; Xu 1992)</th>
</tr>
</thead>
<tbody>
<tr>
<td>First (high)</td>
<td>55</td>
<td>mā</td>
<td>shortest</td>
</tr>
<tr>
<td>Second (rising)</td>
<td>35</td>
<td>má</td>
<td>longer</td>
</tr>
<tr>
<td>Third (falling-rising)</td>
<td>214</td>
<td>mā</td>
<td>longest</td>
</tr>
<tr>
<td>Fourth (falling)</td>
<td>51</td>
<td>mā</td>
<td>shortest</td>
</tr>
</tbody>
</table>
• Mandarin has tonotactic gaps (e.g. no dán)
  ▪ Syllables with unaspirated onsets tend not to appear with rising tone (Wu 2006)
  ▪ With rare exceptions, Mandarin doesn’t fill tonotactic gaps in loanword adaptation

1.4 Previous Work on Tonal Adaptation in Mandarin
• Corpus study by Wu (2006) of 100+ established loanwords still used in present-day Taiwan

Table 1: Tonal Assignment of English Loanword Syllables in Mandarin
(Based on Wu 2006)

<table>
<thead>
<tr>
<th>Syllable Type</th>
<th>Tone</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sonorant Onset</td>
<td>Rising</td>
<td>Stressed in English, but sonorant onsets lower F0 (Hombert, Ohala, &amp; Ewan 1979)</td>
</tr>
<tr>
<td>Aspirated Stop/Affricate Onset</td>
<td>Rising</td>
<td>Stressed in English, but Mandarin aspiration lowers F0</td>
</tr>
<tr>
<td>Unaspirated Stop/Affricate Onset</td>
<td>High</td>
<td>Stressed in English</td>
</tr>
</tbody>
</table>

- Generalizations confined to initial syllables of disyllabic adaptations of English trochees
- Onsets refer to onsets of Mandarin adapted syllables, not of English syllables
- Caveat: Wu’s discussion of tonal assignment and aspiration is based on 35 syllables, only 7 of which have aspirated onsets
• Experiment by Chang & Bradley (2012)
  ▪ Native Mandarin speakers asked to adapt disyllabic English nonce words (trochees and iambs) into Mandarin
  ▪ English nonce words have expected Mandarin segmental adaptations: syllable structure (CV, CVN), onset sonority, and onset aspiration all match
  ▪ Only stressed syllables analyzed
  ▪ Falling tone most common overall
  ▪ CVs with sonorant onsets less likely to get high tone than CVs with obstruent onsets
  ▪ CVs with aspirated stops more likely to get rising tone than CVs with unaspirated stops
Table 2: Tonal Assignment of English Loanword Syllables in Mandarin

<table>
<thead>
<tr>
<th>Syllable Type</th>
<th>Wu 2006</th>
<th>Tone</th>
<th>Chang &amp; Bradley 2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sonorant Onset</td>
<td>Rising</td>
<td><strong>High less likely</strong> relative to obstruent onsets</td>
<td></td>
</tr>
<tr>
<td>Aspirated Stop/Affricate Onset</td>
<td>Rising</td>
<td><strong>Rising</strong> second most likely (after falling)</td>
<td></td>
</tr>
<tr>
<td>Unaspirated Stop/Affricate Onset</td>
<td>High</td>
<td><strong>High</strong> second most likely (after falling)</td>
<td></td>
</tr>
</tbody>
</table>

2. The Present Study’s Corpus

- 3,660 syllables from 1,372 English loanwords in Mandarin
- Sources:
  - A corpus from a dissertation on segmental adaptation (Dong 2012): 1,194 English borrowings including 292 place names and 577 first names (85% of the syllables in my corpus)
  - Corpus from Wu (2006) (contributed 58 syllables to my corpus)
  - Online Chinese dictionary MDBG: search for “loanword” (13% of the syllables in my corpus)
- Corpus originally included 1,551 loanwords, but I excluded 179 for a variety of reasons:
  - Semantic influence (e.g. 蹦极 bèng jí ‘bungee jumping’: 蹦 means ‘jump’, 极 means ‘extreme’)
  - Loanwords from languages other than English or borrowed from English into Mandarin through another Chinese dialect
- Also excluded 60 syllables subject to third tone sandhi (ˇˇ → ˊ), e.g. first syllable in 法老 fà lǎo ‘pharaoh’
- 10 syllables in corpus can only bear one tone (ā, fó, hēi, lè, miù, rì, sè, sēn, tè, and téng) → most analyses based on a reduced corpus of 3,456 syllables without these syllables

3. Testing Past Claims

3.1 Wu (2006), Chang & Bradley (2012): English stressed syllables whose Mandarin adaptations begin with sonorants less likely to get high tone, more likely to get rising tone than those whose Mandarin adaptations begin with obstruents
- My corpus reveals the same pattern across all syllables (considering sonority of English segment to which Mandarin onset corresponds)

![Fig. 1: Tones of Loanword Syllables by Mandarin Onset's Sonority in English](image)

- Loanword syllables (including epenthetic syllables) whose Mandarin onsets correspond to English obstruents most often get high tone; loanword syllables whose onsets correspond to English sonorants most often get rising tone, rarely get high tone

3.2 Wu (2006), Chang & Bradley (2012): English stressed syllables more likely to get rising tone if their onset in Mandarin is aspirated than if it is unaspirated
- I was unable to replicate this finding
- Loanword syllables with aspirated onsets get rising tone less often than loanword syllables with unaspirated onsets

![Fig. 2: Tones of Loanword Syllables by Onset’s Aspiration in Mandarin](image)
4. Voicing

- Underexplored in previous literature
- Turns out to play a role in tonal adaptation
- Examining the effect of voicing in non-epenthetic loanword syllables whose onsets come from English obstruents:

**Fig. 3: Tones of Non-Epenthetic Loanword Syllables with Onsets from English Obstruents by English Voicing**

- Large differences in tone distributions are significant: $\chi^2 = 179.8687, p < 0.001$
- English voiced obstruent → rising tone
- English voiceless obstruent → high tone, then falling tone (both start high)
- Pattern consistent with lowering effect of voiced obstruents on F0 (Hombert, Ohala, & Ewan 1979)
- Why the relatively high rate of high tone assignment in syllables from voiced English obstruents?
  - Voiced English stops and affricates tend to be adapted with Mandarin unaspirated sounds, and syllables with unaspirated onsets tend to have gaps in rising tone
  - That rising tone is still preferred for these syllables testifies to strength of lowering effect
- We saw a preference for high tone in loanword syllables with onsets from English obstruents (Fig. 1), but 61.2% of those obstruents were voiceless → association actually between *voiceless* obstruents and high tone
Comparing Wu’s and my findings:

<table>
<thead>
<tr>
<th>Wu 2006</th>
<th>Present Study</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Onset Type</strong></td>
<td><strong>Tone</strong></td>
</tr>
<tr>
<td>(in Mandarin)</td>
<td>(in Mandarin)</td>
</tr>
<tr>
<td>Sonorant</td>
<td>Rising</td>
</tr>
<tr>
<td>Aspirated Stop/Affricate</td>
<td>Rising</td>
</tr>
<tr>
<td>Unaspirated Stop/Affricate</td>
<td>High</td>
</tr>
</tbody>
</table>

5. Stress-to-Tone Adaptation

5.1 Are the different English stress levels associated with particular tones?

Fig. 4: Tones of Non-Epenthetic Loanword Syllables by English Stress

- Overall significant differences: $\chi^2 = 24.0637$, $p < 0.001$
- Primary vs. secondary—no significant difference: $\chi^2 = 4.0221$, $p = 0.2591$
- Primary vs. unstressed—significant difference: $\chi^2 = 16.6695$, $p < 0.001$
- Secondary vs. unstressed—significant difference: $\chi^2 = 12.9904$, $p < 0.005$
- Primary- and secondary-stressed syllables pattern together, unstressed syllables pattern differently
- Stressed syllables prefer high tone—matching high pitch?
• Unstressed syllables get high tone less, get rising tone more—also matching pitch?

5.2 A different approach: Do segmentally identical syllables get different tones depending on their English stress level?

<table>
<thead>
<tr>
<th>Mandarin Syllable</th>
<th>Stress</th>
<th>High</th>
<th>Rising</th>
<th>Falling-Rising</th>
<th>Falling</th>
</tr>
</thead>
<tbody>
<tr>
<td>li</td>
<td>Primary (N = 37)</td>
<td>0</td>
<td>0</td>
<td>15</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>Secondary (N = 1)</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Unstressed (N = 124)</td>
<td>0</td>
<td>0</td>
<td>50</td>
<td>74</td>
</tr>
<tr>
<td>la</td>
<td>Primary (N = 17)</td>
<td>17</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Secondary (N = 1)</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Unstressed (N = 41)</td>
<td>41</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>luo</td>
<td>Primary (N = 40)</td>
<td>1</td>
<td>28</td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>Secondary (N = 3)</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Unstressed (N = 16)</td>
<td>0</td>
<td>11</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>xi</td>
<td>Primary (N = 22)</td>
<td>22</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Secondary (N = 1)</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Unstressed (N = 32)</td>
<td>32</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>ni</td>
<td>Primary (N = 9)</td>
<td>0</td>
<td>9</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Unstressed (N = 45)</td>
<td>0</td>
<td>45</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>ai</td>
<td>Primary (N = 46)</td>
<td>26</td>
<td>0</td>
<td>0</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Secondary (N = 1)</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Unstressed (N = 3)</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>wei</td>
<td>Primary (N = 28)</td>
<td>14</td>
<td>10</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Secondary (N = 4)</td>
<td>1</td>
<td>0</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Unstressed (N = 18)</td>
<td>4</td>
<td>14</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>di</td>
<td>Primary (N = 13)</td>
<td>1</td>
<td>4</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Unstressed (N = 32)</td>
<td>0</td>
<td>21</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>ya</td>
<td>Primary (N = 5)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Secondary (N = 4)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Unstressed (N = 36)</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>34</td>
</tr>
</tbody>
</table>

• Little evidence for stress affecting tone in individual syllables
• Case of li: proportions of lis that receive falling-rising and falling tone about the same whether li adapts an English stressed syllable or an unstressed one
• Two syllables show evidence of sensitivity to stress:
• **Wei**: tone distributions of *weis* from primary-stressed, secondary-stressed, and unstressed syllables differ significantly (Fisher’s Exact Test: $p < 0.001$), primary stress $\rightarrow$ high tone, unstressed $\rightarrow$ rising tone

• **Di**: tone distributions of *dis* from primary-stressed and unstressed syllables differ just significantly (Fisher’s Exact Test: $p < 0.05$), primary stress $\rightarrow$ falling tone, unstressed $\rightarrow$ rising tone

• Results of two approaches to investigating effect of stress conflict: unclear how much English stress influences tonal assignment

### 6. Exploring the Determinants of Tonal Assignment With A Decision Tree

• Another way of uncovering which factors significantly affect Mandarin tonal adaptation

• `ctree()` function from the R package *party* (Hothorn, Hornik, & Zeileis 2006) generates binary-branching decision trees through recursive partitioning

• Potential uses:
  ▪ Provide confirmation for my findings
  ▪ Reveal other determinants of tone
  ▪ Show that certain determinants only have an effect in a subset of the corpus

• Tree split in two parts because too large to show all at once

• First split by EngSegOnsetVoice (voicing of English segment to which adapted syllable’s onset corresponds; values: Voiced, Voiceless, null)

**Figure 5: Decision Tree for All Non-Epenthetic Loanword Syllables—EngSegOnsetVoice:Voiced Branch**
• Recall: both sonorants and voiced obstruents in English associated with rising tone—all terminal nodes but one show rising tone preference, as expected
• Syllables whose onsets come from sonorants split off: rising tone preferred
• Syllables whose onsets come from voiced obstruents split by stress
  ▪ Oddly, secondary-stressed syllables split off
  ▪ Then primary-stressed and unstressed split: both prefer rising tone, but primary-stressed get falling tone more → interaction of voicing and stress

Figure 6: Decision Tree for All Non-Epenthetic Loanword Syllables — EngSegOnsetVoice: null/Voiceless Branch

• First split by EngSegOnsetAsp divides syllables with onsets from voiceless stops and affricates from syllables with onsets from voiceless fricatives and syllables from onsetless English syllables
• Syllables with onsets from voiceless stops and affricates split by aspiration: both rarely get rising tone
• Node 2 and below exhibit a series of puzzling splits
  ▪ Terminal nodes show little rising tone, preference for high and/or falling tone
  ▪ High tone preference probably driven by onsets from voiceless fricatives
  ▪ Falling tone preference probably driven by loanword syllables from onsetless English syllables (many aös from /əʊ/ and yäs from /ə/)
Major contributions of decision tree:
- Confirmation of findings about effects of English voicing and sonority
- First split by English voicing → strengthens claim that voicing is single best predictor of tonal assignment
- Suggests stress may only matter for loanword syllables with onsets from English voiced obstruents

7. Conclusion

Voicing of English obstruents is best predictor of tonal assignment:
- Voiceless obstruents associated with high tone, voiced obstruents with rising tone (even though Mandarin syllables with unaspirated onsets tend to have rising tone gaps)
- Low-level phonetic details of English syllables affect their tonal adaptation and may override native tone-onset type associations
- While stress is almost the sole determinant of tonal assignment in English loanwords in Cantonese, its effect is weaker in Mandarin
- Some overall significant differences in tones assigned by stress level and trends that make phonetic sense, but don’t seem to hold for individual syllables
- Decision tree suggests stress may only affect the tones of loanword syllables with onsets from English voiced obstruents

Future directions:
- Further exploration of relationship between tonal assignment in loanwords and tonal patterns in the native lexicon
- Corroborating corpus findings with experimental evidence

Many thanks to Kie Zuraw for her advice on this project and to the UCLA Phonology Seminar audience for helpful feedback.

References


