The Acquisition of Mandarin Tones by Japanese Learners

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- Perceptual cues for Tone 2 and Tone 3: Turning point and $\Delta F_0$
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● **Introduction**

- Previous studies
  Mainly observation and comparison of the two languages

- Importance of turning point and Δ F0 on the distinction between Tone 2 and Tone 3 (Moore & Jongman 1997)

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What is difficult for Japanese native speakers in discriminating between Tone 2 and Tone 3?
Perceptual cues for Tone 2 and Tone 3: Turning point and $\Delta F_0$

Turning point and $\Delta F_0$ properties schematized for a contour tone (Moore and Jongman, 1997)
“There is an interdependency between $\Delta F_0$ and the timing of the turning point which contributes to perception of Mandarin tones 2 and 3”

Moore & Jongman (1997)
● **Experiment**

- **Subjects:** 27 native speakers of Chinese
  27 native speakers of Japanese

- **Vowels for synthesis:**
  `/a/, /o/, /e/, /i/, /u/, /ü/`

  `/uγ/
  (Chao 1968)`

  `/iγ/
  (Zhu 2010)`
Experiment

- Subjects: 27 native speakers of Chinese
27 native speakers of Japanese

- Vowels for synthesis:
  /a/, /o/, /e/, /i/, /u/, /ü/

/uv/ (Chao 1968)
/iy/ (Zhu 2010)
Stimuli:

based on the methods of Moore & Jongman (1997):

**Turning point**
- 20~220 ms in 40ms steps, 6 stimuli for each vowel

**Δ F₀**
- 10~70 Hz in steps of 15 Hz, 5 stimuli for each vowel
<table>
<thead>
<tr>
<th>ΔF₀ (Hz)</th>
<th>70</th>
<th>55</th>
<th>40</th>
<th>25</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
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<tr>
<td>60</td>
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<td>100</td>
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<td>140</td>
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<td>180</td>
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<tr>
<td>220</td>
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</tbody>
</table>

- **Higher ΔF₀**
- **Later turning point**
- **lower ΔF₀**
- **Earlier turning point**

**Combinations of turning point and ΔF₀ manipulations for synthesized stimuli**

6 turning point variations × 5 ΔF₀ variations × 4 vowels × 2 repetitions of each = **240 tokens**
Procedure

Experiment MFC program

"ooTextFile"
"ExperimentMFC 5"
stimuliAreSounds? <yes>
stimulusFileNameHead = "sounds0/"
stimulusFileNameTail = ".wav"
stimulusCarrierBefore = ""
stimulusCarrierAfter = ""
stimulusInitialSilenceDuration = 0.5 seconds
stimulusMedialSilenceDuration = 0.5
numberOfDifferentStimuli = 120
"11_i" |第二声|第三声"
"12_i" |第二声|第三声"
"13_i" |第二声|第三声"
"14_i" |第二声|第三声"
"15_i" |第二声|第三声"
........................................

numberOfReplicationsPerStimulus = 2
breakAfterEvery = 40
randomize =
<PermuteBalancedNoDoublets>
startText = "クリックして始めてください"
runText = "聞こえた声調を選んでください"
pauseText = "よろしければ休憩してください。クリックして再開してください。"
endText = "終了です。お疲れさまでした。"
maximumNumberOfReplays = 0
replayButton = 0 0 0 0 "" ""
okButton = 0 0 0 0 "" ""
oopsButton = 0 0 0 0 "" ""
responsesAreSounds? <no> "" "" "" 0 0
numberOfDifferentResponses = 2
 0.2 0.4 0.3 0.5 "" 40 "" ""left"
 0.6 0.8 0.3 0.5 "" 40 "" ""right"
numberOfGoodnessCategories = 0
The presentation screen of the experiment

Click it to start

Please choose the Tone which you heard

You can have a rest if you want and then click it to continue

The end. Thank you very much!
● Results

blue region: a significantly large (p<.05) number of Tone 2 responses
gray region: a significantly large (p<.05) number of Tone 3 responses

The results of Native Speakers for each vowel
The results of Japanese learners for each vowel
Data analysis

Independence test

Chinese speaker: An Interdependency between Turning point and $\Delta F_0$

Moore & Jongman (1997)

Japanese learner: No interdependency between Turning point and $\Delta F_0$
Japanese learner:

- Influence of both turning point and $\Delta F_0$
- Turning point is a more important determining factor
Discussion and Conclusion

- **Japanese learners:**
  1. Distinguishing between Tone 2 and Tone 3 is affected by the factors of turning point and $\Delta F_0$.
  2. Turning point seems to be the primary cause of confusion in learning Mandarin tones.

- **Chinese native speakers:**
  - An interdependency between $\Delta F_0$ and the turning point that contributes to perception of tones 2 and 3.
The order of perception ambiguity: /i/>/ü/>/a/>/u/
Shi (2008)

F2 values of the four vowels:

\[
/ i /> / ü /> / a /> / u / 
\]
Future investigation

- The smaller the F2 value, the better the ability of Japanese learners to perceive tones.

Does the F2 value influence tone perception of Japanese learners?
Thank you for your attention!
<table>
<thead>
<tr>
<th>$\Delta F_0$ (Hz)</th>
<th>15a</th>
<th>25a</th>
<th>35a</th>
<th>45a</th>
<th>55a</th>
<th>65a</th>
</tr>
</thead>
<tbody>
<tr>
<td>70</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>55</td>
<td>14a</td>
<td>24a</td>
<td>34a</td>
<td>44a</td>
<td>54a</td>
<td>64a</td>
</tr>
<tr>
<td>40</td>
<td>13a</td>
<td>23a</td>
<td>33a</td>
<td>43a</td>
<td>53a</td>
<td>63a</td>
</tr>
<tr>
<td>25</td>
<td>12a</td>
<td>22a</td>
<td>32a</td>
<td>42a</td>
<td>52a</td>
<td>62a</td>
</tr>
<tr>
<td>10</td>
<td>11a</td>
<td>21a</td>
<td>31a</td>
<td>41a</td>
<td>51a</td>
<td>61a</td>
</tr>
</tbody>
</table>

| 20 | 60 | 100 | 140 | 180 | 220 |

転換点 (ms) /a/
11 -a (TP: 20ms, $\Delta F_0$: 25Hz)
12-a (TP: 20ms, $\Delta F_0$: 25Hz)
13-a (TP: 20ms, $\Delta F_0$: 40Hz)
14-a \( (T_P: 20\text{ms}, \ \Delta F_0: 55\text{Hz}) \)
15-a (TP: 20ms, $\Delta F_0$: 70Hz)