Production and Perception of Marginal Vowel Length Contrasts in Thai

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Length is contrastive for all monophthongs in the Thai vowel system.

<table>
<thead>
<tr>
<th></th>
<th>front</th>
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<th>mid</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>short</td>
<td>long</td>
<td>short</td>
<td>long</td>
<td>short</td>
<td>long</td>
</tr>
<tr>
<td>high</td>
<td>i</td>
<td>iː</td>
<td>ɯ</td>
<td>ɯː</td>
<td>u</td>
<td>uː</td>
</tr>
<tr>
<td>close-mid</td>
<td>e</td>
<td>eː</td>
<td>ɤ</td>
<td>ɤː</td>
<td>o</td>
<td>oː</td>
</tr>
<tr>
<td>open-mid/low</td>
<td>ɛ</td>
<td>ɛː</td>
<td>a</td>
<td>aː</td>
<td>ɔ</td>
<td>ɔː</td>
</tr>
<tr>
<td>diphthong</td>
<td>ɪɛ</td>
<td>ɛm</td>
<td>ɛn</td>
<td></td>
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</tr>
</tbody>
</table>

(Nacaskul 2008)
Not all vowels display an equal “degree of contrastiveness.”

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<td>u</td>
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</tr>
<tr>
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<td>e</td>
<td>ɤ</td>
<td>ɔ</td>
</tr>
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<td>ɛ</td>
<td>ə</td>
<td>ɛ</td>
</tr>
<tr>
<td>diphthong</td>
<td>iɛ</td>
<td>em</td>
<td>en</td>
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</table>

• /ɛ-ɛː/ and /ɔ-ɔː/ are not easy to classify as phonemic.
• They have very few minimal pairs.
• A handful of words show variations between short and long forms
These behaviors suggest that they are “marginally” contrastive.

- Marginal contrasts, by definition, are phonological relationships that are “intermediate” between contrast and allophony (Hall 2013).

- Cases of marginal contrasts have been reported in a large number of literature on many languages, e.g. Spanish, English, Korean, etc.
The length contrasts of /ɛ-ɛː/ and /ɔ-ɔː/ are less robust.

<table>
<thead>
<tr>
<th>Vowel pairs</th>
<th>Kullback-Liebler distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>a-aː</td>
<td>4.720554247</td>
</tr>
<tr>
<td>i-iː</td>
<td>4.254116054</td>
</tr>
<tr>
<td>u-uː</td>
<td>2.376471841</td>
</tr>
<tr>
<td>ɔ-ɔː</td>
<td>1.502070389</td>
</tr>
<tr>
<td>ɛ-ɛː</td>
<td>1.222368506</td>
</tr>
</tbody>
</table>

(Pittayaporn 2015)
The distribution of short and long vowels in Thai National Corpus also confirms the predictability.

The type frequency of /a-aː/
The distribution of short and long vowels in Thai National Corpus also confirms the predictability.

The type frequency of /ɛ-ɛː/ and /ɔ-ɔː/
The /ɛ-ɛː/ and /ɔ-ɔː/ have several characteristics similar to marginal contrasts in many languages.

1) Partial predictability
2) Frequency
3) Variability
4) Phonetic similarity?
This paper studies phonetic similarities of the marginal contrast in production and perception.

- The production and perception of “fully contrastive” vowels are compared with those of “marginally contrastive” vowels.

<table>
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<tr>
<th>Full contrast</th>
<th>Marginal contrast</th>
</tr>
</thead>
<tbody>
<tr>
<td>a-aː</td>
<td>ɔ-ɔː, ɛ-ɛː</td>
</tr>
<tr>
<td>(i-iː, u-uː)</td>
<td></td>
</tr>
</tbody>
</table>
Experiment 1: Production

• Expected distribution of vowel durations:

Full Contrast

Marginal Contrast
Methods

• 10 Thai native speakers in Bangkok, Thailand
• Task: Map task and Reading task
• Stimuli: monosyllabic words labeled as having short or long vowels based on three native speakers’ judgements
  • 52 words with /ɔ-ɔː/ and /ɛ-ɛː/ and 26 words with /a-aː/
• Durational proportion of vowel nuclei is analyzed
  • Durational proportion of a vowel = \( \frac{\text{vowel duration}}{\text{rime duration}} \)
Result: The distribution of /a-aː/ show two distinct categories with few overlapping items.
The distribution of /ɛ-ɛː/ and /ɔ-ɔː/ also show two distinct categories, but with significantly more overlapping items.
The distribution of /ɛ-ɛː/ and /ɔ-ɔː/ also show two distinct categories, but with significantly more overlapping items.
The boundaries between two categories of /ɛ-ɛː/ and /ɔ-ɔː/ are less clear.
The durational proportion of the short and long vowels for every vowel pair significantly distribute into two categories ($p < 0.001$).
The distance between /a-aː/ is significantly different from /ɛ-ɛː/ ($p < 0.05$), but not for /ɔ-ɔː/. 
The result supports the prediction.

• The bimodal distributions

  The short and long vowels are *two categories* regardless of the degree of contrast.
The result supports the prediction.

- The boundary in the distribution of durational proportion
  
  The boundary between short and long marginally contrastive vowels is *fuzzier*. 
The result supports the prediction.

• The shorter distance between the short and long marginally contrastive vowels

  The marginally contrastive vowels are \textit{closer} together than the fully contrastive ones.

  It is still puzzling at this point why only the \textit{/ɛ-ɛː/} behave as we expected.
Experiment 2: Perception

- Expected result:
  Native speakers are able to categorize the fully contrastive vowels with a sharp boundary, while the boundary is fuzzier for the marginally contrastive vowels.

![Diagram showing frequency of judging as category as a function of duration of stimuli for Full Contrast and Marginal Contrast.](image)
Experiment 2: Perception

- Expected result:
The reaction time also displays the fuzzy boundary by having more steps with relatively long reaction time, not only for the middle point.

**Diagram:**
- Full Contrast
- Marginal Contrast

![Graphs showing reaction time and duration of stimuli for Full Contrast and Marginal Contrast.](image)
Methods

- 15 Thai native speakers in Ithaca, New York
- Task: ABX discrimination task
- Stimuli: 10 nonce words in [fV(:)p] template
  - Full contrast: [fíːp], [fìːːp], [fùːp], [fùːːp], [fàːp], [fàːːp],
  - Marginal contrast: [fɛ̀ːp], [fɛːːp], [fɔːp], [fɔːːp]
- Initial recordings are manipulated in steps until their durations are similar to the duration of their long or short counterparts.
- Listeners’ responses and reaction time are studied
Result: Listeners were barely confused between the shortest and the longest stimuli.
The reaction time to the edged stimuli are not different regardless of vowel qualities ($p > 0.05$).
Short and long are two distinct categories.

• According to the responses, the listeners have short and long vowels as two categories.

• The reaction time also shows that the listeners do not have more difficulty to distinguish the stimuli with prototypical duration of short and long vowels, even though they are marginally contrastive vowels.
The identification functions of the fully and marginally contrastive vowels are very similar.
The listeners’ judgement rejects the prediction.

• The marginally contrastive vowels even have a slightly steeper transition slope in the identification functions.

• They do not display the fuzzy boundary of the marginal contrasts, unlike the production data.
The reaction time to almost every vowel stimuli are similar with one peak at the middle.
Interestingly, instead of having a sharp peak, /ɛ-ɛ:/ have two steps with relatively long reaction time.
But the reaction time for /i-iː/ also seems to have similar distribution.
However, the overall reaction time for fully and marginally contrastive vowels are not different ($p > 0.05$)
The reaction time does not display the fuzzy boundary

- The overall reaction time are not significantly different.

- The distribution that we expected to find only for marginally contrastive elements is also found in the responses to the fully contrastive elements.
The marginal vowel length contrasts in Thai show phonetic similarity in the production.

- All vowels distribute into two categories. ✔
- The durational distribution of the short and long marginally contrastive vowels are closer together. ✔
- The boundary between the marginally contrastive vowels is fuzzier. ✔
But not quite clear for the perception.

• Listeners judged the edged stimuli into *two* categories. ✔

• The identification functions do not reflect the fuzzy boundary of the marginal contrasts. ✗

• The reaction time also do not show differences between fully and marginally contrastive vowels. ✗
What factors may account for this discrepancy?

• There are methodological differences between the two experiments.

• In the perception test, the stimuli were nonce words.

• The previous studies have found that there are perceptual differences between words and nonce words (Pitt & Samuel 1993; Samuel 1986).
Furthermore, the phonetic similarity might be the result of having few minimal pairs.

- A number of studies reported that words with high phonological neighborhood density are hyperarticulated and phonetically enhanced compared to words with low neighborhood density.

- Evidences are increased vowel dispersion and longer VOT found in many studies.
Pierrehunbert (2002) explained this phenomenon based on exemplar model

“If a word has no similar competitor, then even a rather slurred example of it will be recognized as a token of the word. As a result, the exemplar distribution for successfully recognized instances of low density words will include more reduced tokens than for high density words.”
The exemplar clouds of low density words are more widely distributed.
Based on this model, the marginally contrastive vowels have almost no “similar competitor”

- In the production experiment, we found that the boundary of the marginally contrastive vowels is fuzzy.
- It is therefore because the reduced forms are also labeled as tokens of the words with those vowels, in contrary to the fully contrastive vowels.
The perception experiment forced the listeners to responses to “minimal pairs”

- The ABX task forced the listeners to store A and B as two words, a minimal pair.

- The listeners therefore responded to all stimuli sets similarly regardless of the degree of contrastiveness, as they would for words with high phonological density.
Based on this model, the phonetic similarity may come down to word-specific phonetic effects.

- The phonetic similarity in marginal contrast, at least for the case of Thai vowel length distinction, lies on the correlation of phonetic categories and word-specific phonetics.

- Not the non-robustness of the phonological categories themselves.
Selected references


Nacaskul, Karnchana. 2008. Thai sound system Bangkok: Publication of Academic Works of Faculty of Arts, Chulalongkorn University.

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