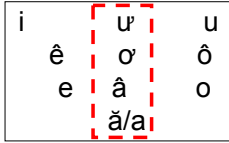


Introduction

The purpose of this study is to clarify the Vietnamese vowel system and to evaluate non-native speaker production of vowels predicted to be difficult. Specifically, the vowels in the middle of the chart will be explored in the most detail, with regard to vowel quality and duration features.



Vowels spoken by native speakers

QUESTIONS:

- Is *ɤ* a central or back vowel?
- Is *ɔ* a central or back vowel?
- Is *ă* a short version of *ɔ*, or are they distinct?
- Is *ă* a short version of *a*, or are they distinct?
- What effect does vowel length exhibit on syllable length?

Vowels spoken by non-native speakers of Vietnamese (American adult learners)

The vowels in the middle of the chart are predicted to be difficult for these adult learners because they have no clear counterpart in English.

QUESTIONS:

- Can they produce *ɤ* correctly (distinct from *u*)?
- Can they produce *ɔ* correctly (distinct from *ô*)?
- Can they distinguish long and short vowels?

Procedure

Participants produced 3-word sentences in response to individual target words that appeared on a computer screen in red, blue, black, or purple. For example, if the target word *bạng* appeared in blue, the speaker said *Từ bạng xanh* ("the word *bạng* is blue").

Measurement

Formants were extracted from vowel midpoints in words without nasal segments.

Formants extracted in Hz values were converted to Bark.

Normalization

Formants were normalized using maximum and minimum F1 and F2 vowels as individualized endpoints for each speaker's vowel space. That is, the highest formant had a value of 1.0 and the lowest formant had a value of 0.0.

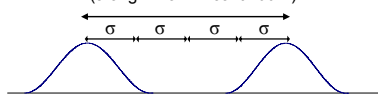
$$F1 \text{ (norm)} = \frac{(F_x - \text{Min}F1)}{(\text{Max}F1 - \text{Min}F1)}$$



Large and small vowel spaces were normalized using individual corner points as referents.

Separation of Vowels Using D'

Distance between distribution means (along F1 or F2 continuum)



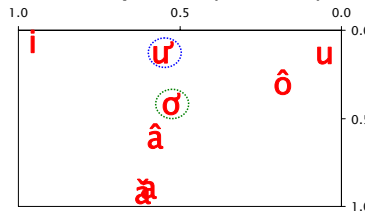
D' measures distance between means in terms of standard deviation units (σ).

F2 or F1 distributions for each vowel category are measured. Consistent vowel production and distinction between vowel categories result in a larger D' measure.

Right: D' values for three crucial vowel comparisons.

Results: Vowel Quality

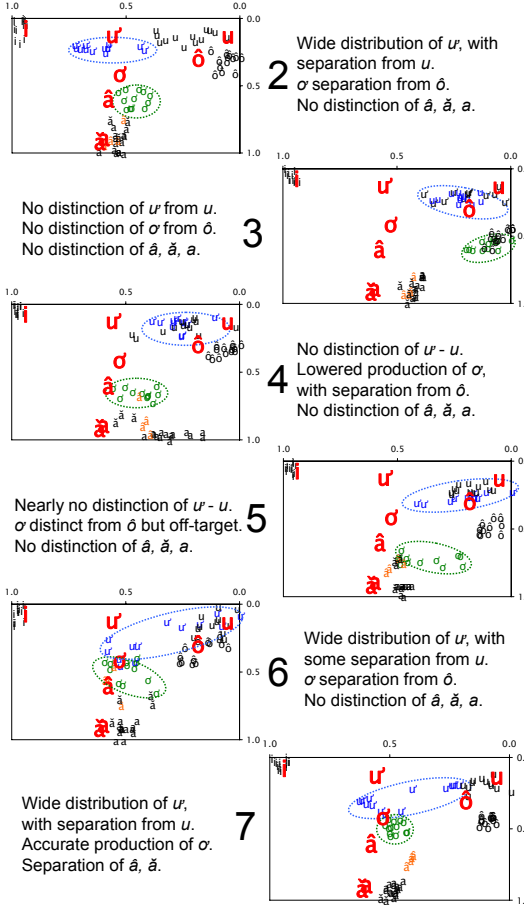
Native Speakers (1, 8, 9, 10)



Above: Vowel chart produced from average normalized values from all four native speakers

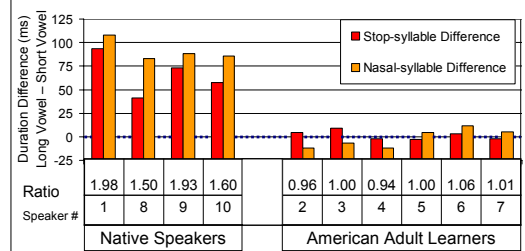
American Adult Learners (2, 3, 4, 5, 6, 7)

Below: Vowel utterances produced by each American adult learner (black, blue, green, orange) overlaid on the native vowel chart (red).



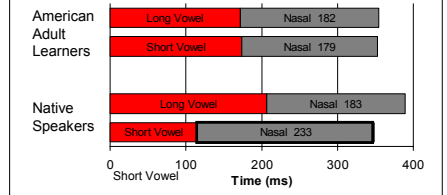
Results: Vowel Duration

Duration Difference Between Long and Short Vowels



Above: American adult learners demonstrate practically no distinction between long and short vowels. While some native speakers approach a 2:1 long:short ratio for vowel duration, the American adult learners' ratios are close to 1:1, suggesting that they lack the long/short distinction.

Segment Timeline in Nasal-Final Syllables



Above: Native speakers exhibit compensatory lengthening of nasal segments which follow short vowels. American adult learners demonstrate no durational difference between vowel types, and thus have no durational opposition to compensate for.

Conclusions

• Native Vietnamese Phonetics

- *ɤ* is a central vowel [i]
- *ɔ* is a mid central vowel [ə]
- *ă* is a mid-open central vowel [e]
- *ã* is an open central vowel [a]
- *ă* and *a* are in short-long opposition with equal vowel quality.
- *ă* and *ɔ* are in short-long opposition but do not have equal vowel quality.
- Extended duration of nasal segments compensates for short duration of preceding short vowels *ă* and *ã*.

• American Adults Learning Vietnamese

- These speakers produce much more overlap in their vowel categories for *ɤ*, *ɔ*, *ă*, *ã* and *a*, suggesting inconsistent production for these central vowels.
- *ɤ* is very prone to errors; it drifts towards *u*.
- *ɔ* is prone to errors (less than *ɤ*); it drifts towards *ô* and tends to be produced lower and more back, as in English /ʌ/.
- *ă* and *ã* are not consistently distinguished.
- Short vowels *ă* and *ã* are not distinguished from the other (long) vowels in terms of duration.
- *a* tends to be produced further back, as in English /a/.
- No compensatory lengthening is seen for nasal segments.

References

Pham, A. (2003) Vietnamese tone: A new analysis. Outstanding Dissertations in Linguistics. New York: Routledge.

Thompson, L.C. (1959). Saigon phonemics. *Language* 35, 454-476.

Disner, S.F. (1980). Evaluation of vowel normalization procedures. *J. Acoust. Soc. Am.* 67, 253-261.

Zwicker, E. Terhardt, E. (1980). Analytical expressions for critical-band rate and critical bandwidth as a function of frequency. *J. Acoust. Soc. Am.* 68, 1523-1525.

Lindblom, B.E.F. & Sundberg, J.E.F. (1971). Acoustical consequences of lip, tongue, jaw, and larynx movement. *J. Acoust. Soc. Am.* 50, 1166-1179.

Acknowledgements

We gratefully thank our speakers for participating and Bill Isardi for technical assistance.

Funding/Support

This material is based upon work supported, in whole or in part, with funding from the United States Government. Any opinions, findings and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the University of Maryland, College Park and/or any agency or entity of the United States Government.

Native Speakers

Vowel pair →	<i>ɤ</i> - <i>u</i>	<i>ɔ</i> - <i>ô</i>	<i>ă</i> - <i>ã</i>
Metric →	F2	F2	F1
D' →	12.21	12.46	8.72

American Adult Learners

2	D'	3.71	9.62	-0.28
3	D'	-0.39	1.13	0.23
4	D'	0.13	6.70	0.28
5	D'	0.18	3.70	0.26
6	D'	1.78	4.48	1.60
7	D'	3.05	14.58	10.48