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Acoustic and Perceptual Variation Across Hindi, Spanish, American English, and German Vowels

Danielle Meyer

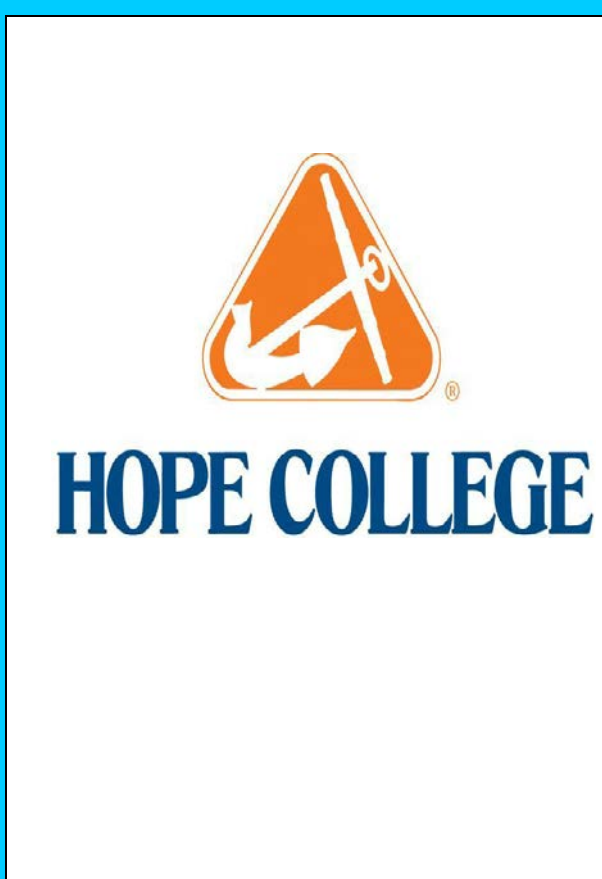
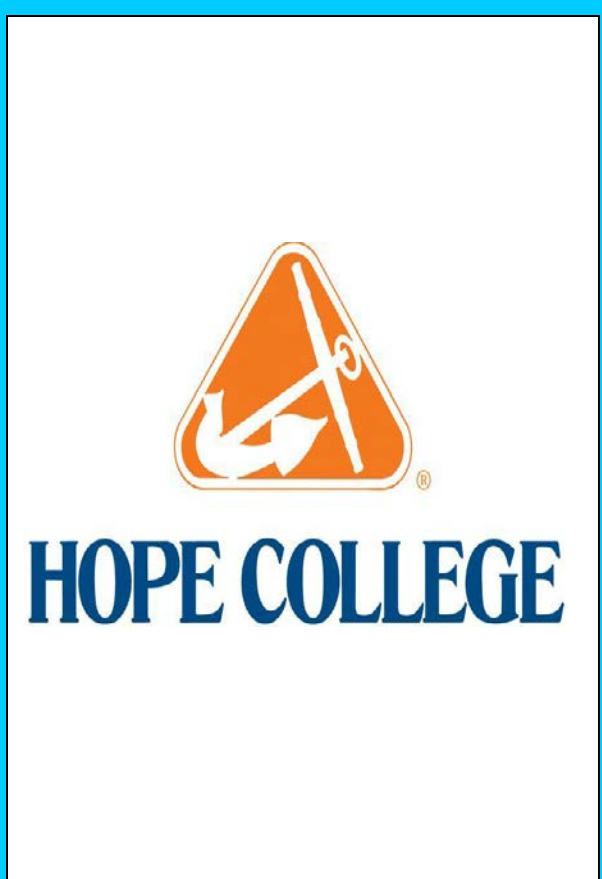
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Acoustic and Perceptual Variation Across Hindi, Spanish, American English, and German Vowels

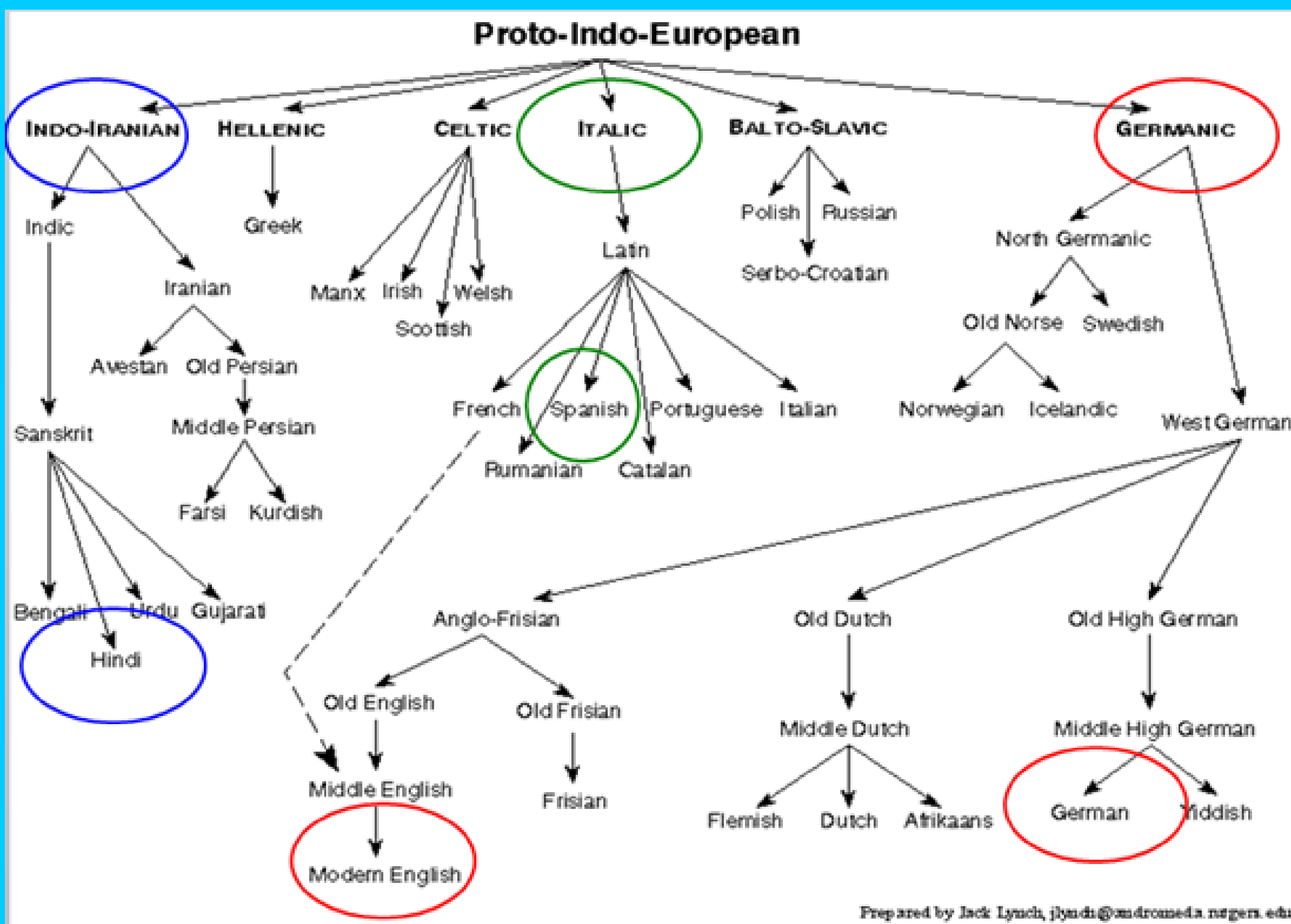
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[i] [ɪ] [e] [ɛ]

[a] [a:] [y] [ø:]

BACKGROUND

- Languages of interest: Hindi, Spanish, General American English, and German
- All four are in very discrete categories on the Proto-Indo-European family tree, grouped by shared lingual characteristics (Lynch, n.d.)
- The four languages have distinct vowel inventories, only overlapping by 5 vowels:
 - [i],[u],[e],[o],[a]
- Syllable-timed languages, such as Hindi and Spanish, have unreduced, or fuller, vowels, and therefore are less likely to undershoot vowel targets
- Stress-timed languages, such as German and English, have reduced, or weaker, vowels, and therefore are more likely to undershoot vowel targets (Dauer, 1983).



PERCEPTUAL HYPOTHESES

- Listeners with a language background (foreign language 2+ years/bilingual) are more accurate at identifying vowels than listeners who lack familiarity with foreign languages.
- Listeners with a language background will have the highest vowel identification accuracy in the language(s) they are most familiar.
- Listeners with multilingual experience will be more accurate in identifying vowels than monolingual individuals.
- Monolingual English speakers will be more accurate in identifying vowels in Spanish and Hindi.

MATERIALS AND METHODS

PARTICIPANTS

Speakers

- n = 4
- 1 per language
- All speakers recorded all reside in Michigan

Listeners

- n = 50
- 17-22 years of age, college undergraduates
- Both males and females participated
- Combination of participants with monolingual and bilingual experience

EXPERIMENTAL DESIGN, MATERIALS AND PROCEDURE

- Participants signed consent forms.
- Participants filled out a background language questionnaire
- Each participant listened to 37 unique acoustic recordings of vowels in the context of h-vowel-d words and answered two questions after the presentation of a vowel
 - recordings were a randomized assortment of vowels of the four languages of interest
 - Performed six times for a total of 222 total stimulus (37 x 6)
 - Reference sheet regarding IPA symbols was provided
 - Questions participants answered
 - Which perceptual category does the vowel in the word best represent?
 - Rate the vowel sound with respect to goodness of fit as an exemplar of that category.

MEASURES

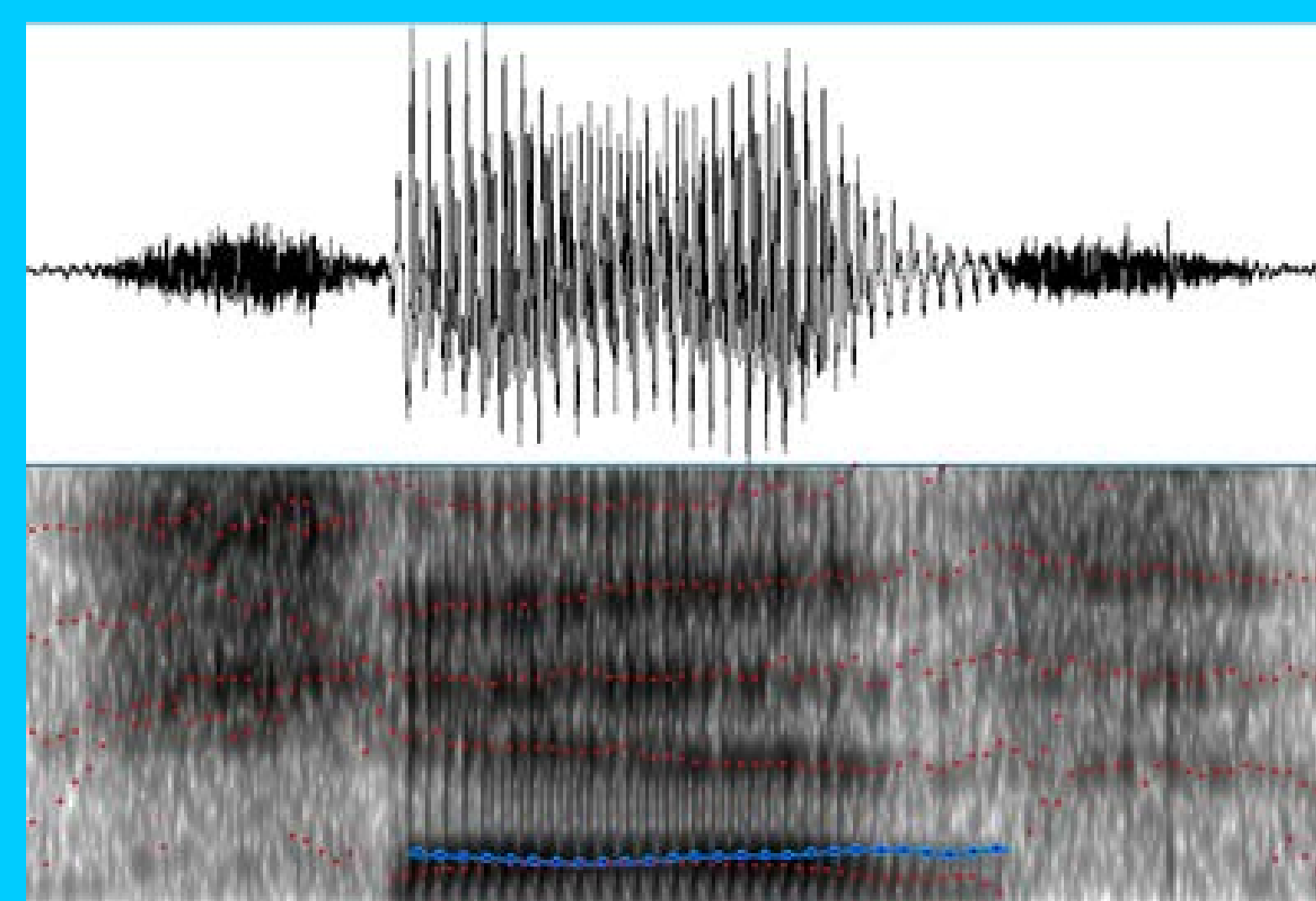
Perceptual Analysis

- E-prime stimulus presentation software by Psychology Software Tools, Inc. Solutions for Research, Assessment, and Education
- Self-paced, interactive computer program for stimulus presentation and data collection

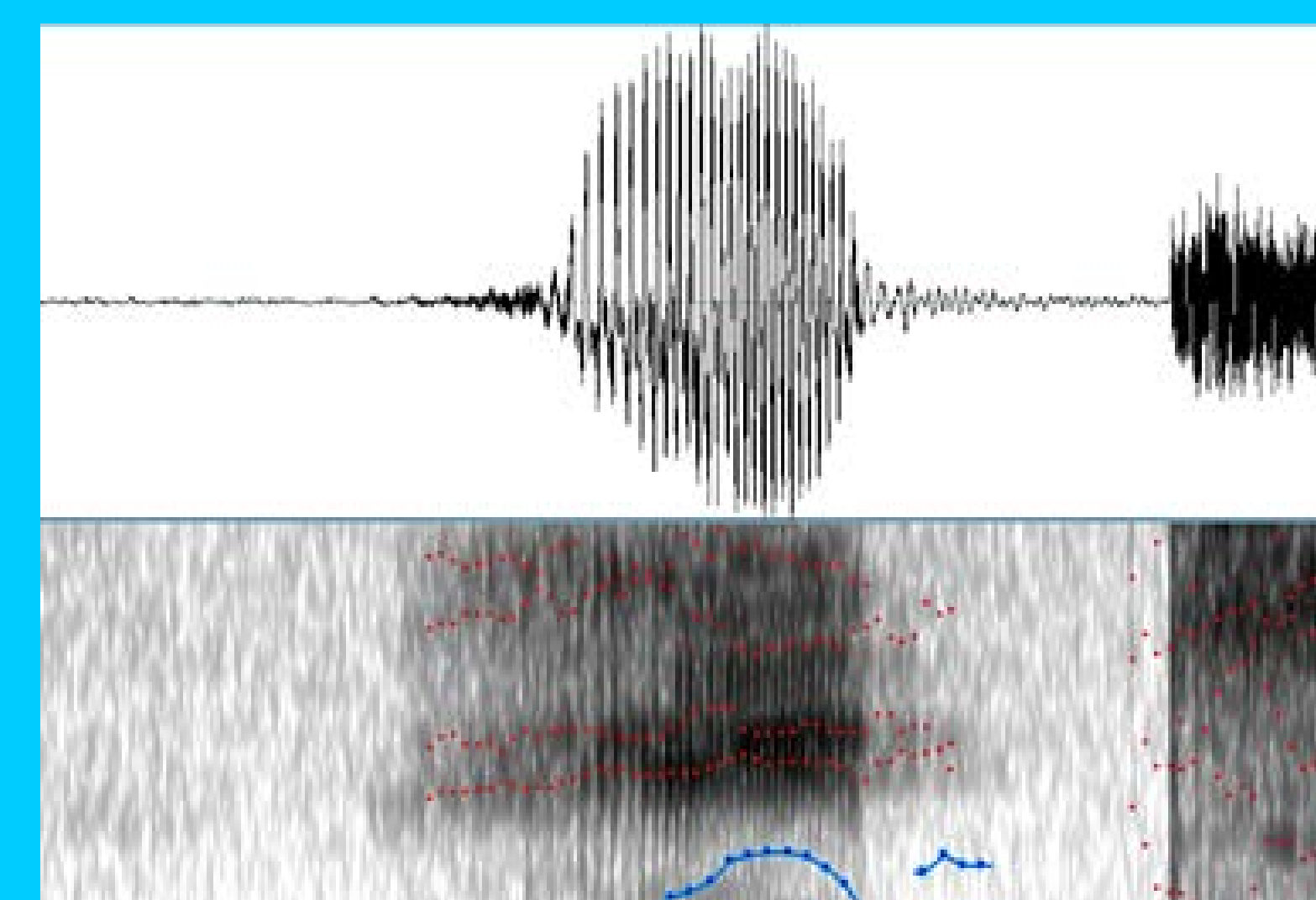
- Accuracy of vowel identification - percent correct
- Goodness of fit ratings - mean

Acoustic Analysis

- Formant frequencies - F1 and F2
- Vowel duration



Spanish [e]



German [e]

Reference Sheet			
/i/	/ɪ/	/e/	/æ/
heed	hid	head	had
/a/	/ʊ/	/ɛ/	/u/
hahd	hood	hayed	who'd
/o/	/ʌ/	/ɜ:/	/ɔ/
hoed	hud	heard	hawed

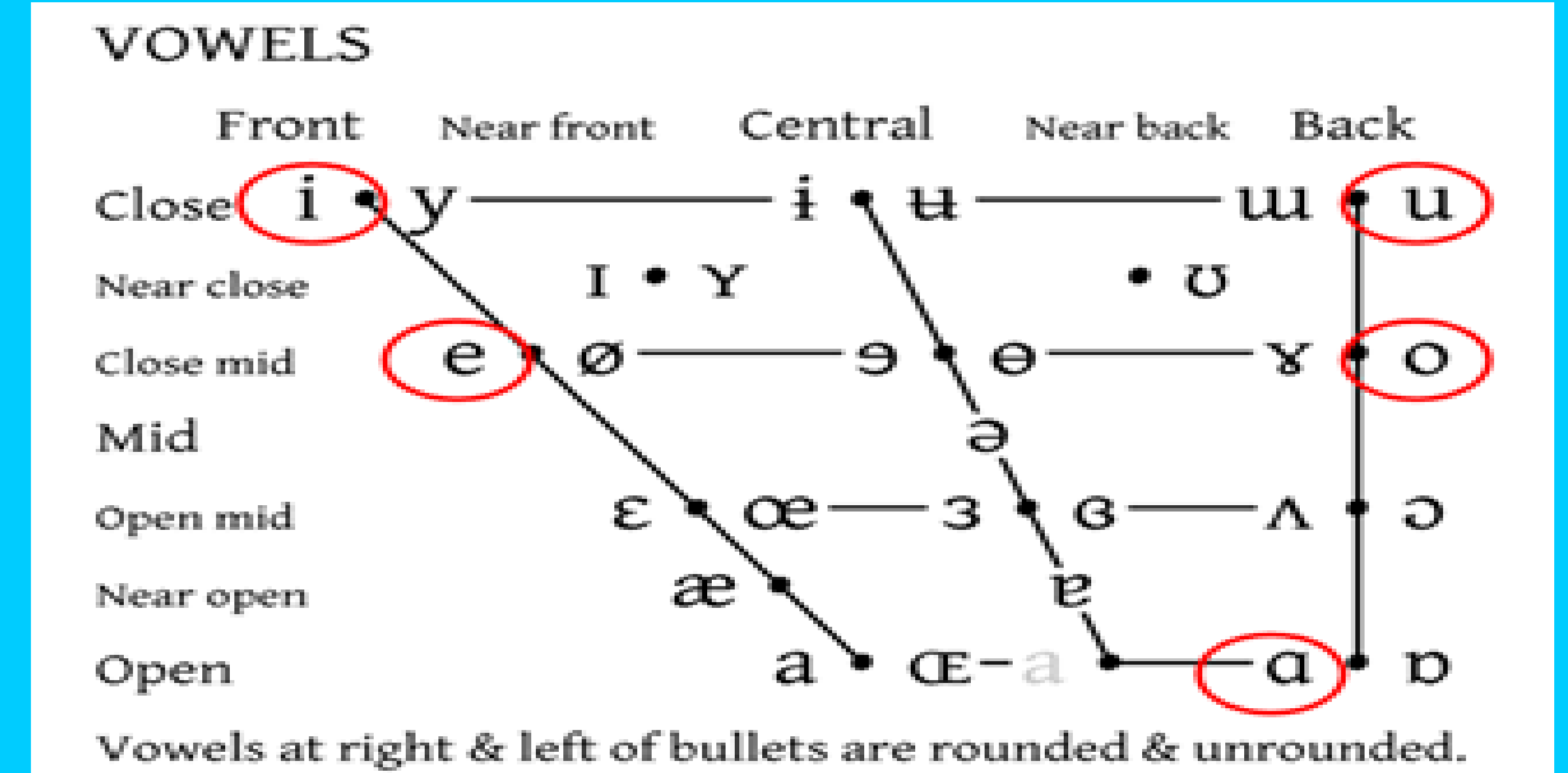
ACOUSTIC HYPOTHESES

- Hindi and Spanish will have less target vowel undershoot and longer vowel duration due to being syllable-timed languages.
- English and German will have a greater target vowel undershoot and shorter vowel duration due to being stress-timed languages.

ACOUSTIC RESULTS

	American English	German	Hindi	Spanish
Duration	214.14 ms	161.06 ms	303.00 ms	216.38 ms
F0	134.61 Hz	176.47 Hz	141.97 Hz	124.69 Hz
F1	392.62 Hz	295.03 Hz	421.30 Hz	460.372 Hz
F2	2150.00 Hz	2498.16 Hz	2047.41 Hz	1729.32 Hz
F3	2747.77 Hz	2920.91 Hz	2623.18 Hz	2624.97 Hz
F4	3602.41 Hz	3990.48 Hz	3465.84 Hz	3573.83 Hz

Table 1: Durations, fundamental frequencies, and formant frequencies of the [e] vowel produced by four different male speakers of American English, German, Hindi, and Spanish. Duration is measured in milliseconds (ms); fundamental frequencies and formants are measured in Hertz (Hz).



REFERENCES

Dauer, R. M. (1983). Stress-timing and syllable-timing reanalyzed. *Journal of Phonetics*.
Lynch, J. (n.d.). The Indo-European Language Family Tree. Retrieved from <http://andromeda.rutgers.edu/~lynch/language.html>