

The influence of different native language systems on vowel discrimination and identification



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Vowel Perception

- **Vowel discrimination means hearing small difference between two sounds reliably.**
- **Vowel identification means categorizing a set of sounds reliably.**
- **Present cross-language study to examine perception of American English vowels by four language groups.**

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Relation Discrimination & ID

- **Our hypothesis for L2 listeners: If we cannot discriminate differences among L2 vowels, we cannot identify vowel sounds reliably.**
- **Stronger hypothesis by Perkell et al. (2004): Better discrimination associated with clearer production of vowels in own native language (L1).**

Perkell, Guenther, Lane, Matthies, Stockmann, Tiede and Zandipour (2004). The distinctness of speakers' productions of vowel contrasts is related to their discrimination of the contrasts, JASA 116, 2338-2344.

L1 influence on L2

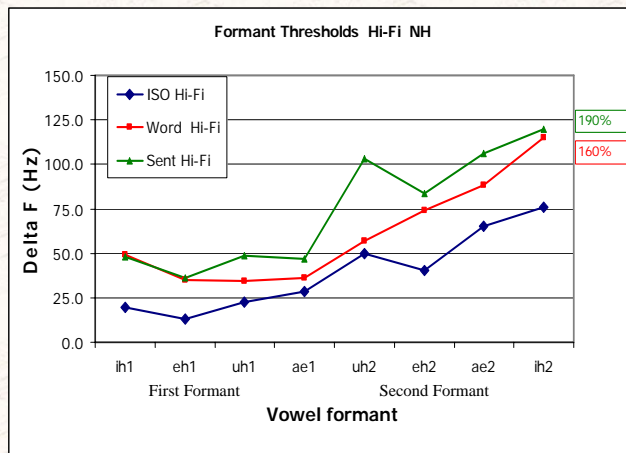
- Well known that L1 affects linguistic representations at central levels of processing in vowel identification.
- Question asked here: What is the lowest level of auditory processing influenced by L1?
- If low level peripheral processing compromised, then learning new L2 vowels will be challenging.

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Thresholds for Formant Frequency

- Using psychophysical methods, we have systematically examined vowel discrimination from low level peripheral processing to more central levels.
- Measure listeners' best ability to discriminate vowel formant differences: 'threshold' (DL, JND).
- Formant thresholds for L1 fall within one vowel category, even for sentences.

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Specific L2 Vowel study

1. Measure listeners' thresholds for discriminating vowel formants (peripheral level).
2. Measure listeners' identification accuracy for confusable vowels (linguistic level).
3. Correlate thresholds to linguistic categorization to determine influence of L1 on L2 perception.

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Languages

- Examine perception of American English (AE) vowels in words.
- Four groups of listeners, AE, Japanese (J), Danish (D), and Swedish (S).
- These languages have very different vowel systems.

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Monophthongal Vowels (Number)

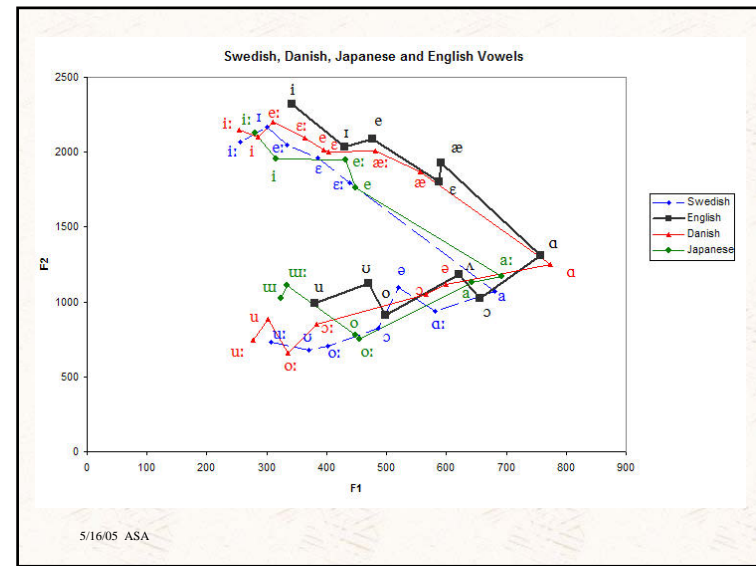
- Japanese
 - Fewer vowels (10)
 - Acoustic features: spectral, length
- English
 - More vowels (12)
 - Acoustic features: spectral primarily, /r/ color
- Swedish (19)
 - More vowels than English
 - Acoustic features: spectral, length, front rounded vowels, /r/ color
- Danish (22)
 - Most vowels
 - Acoustic features: spectral, length, front rounded vowels, /r/ color

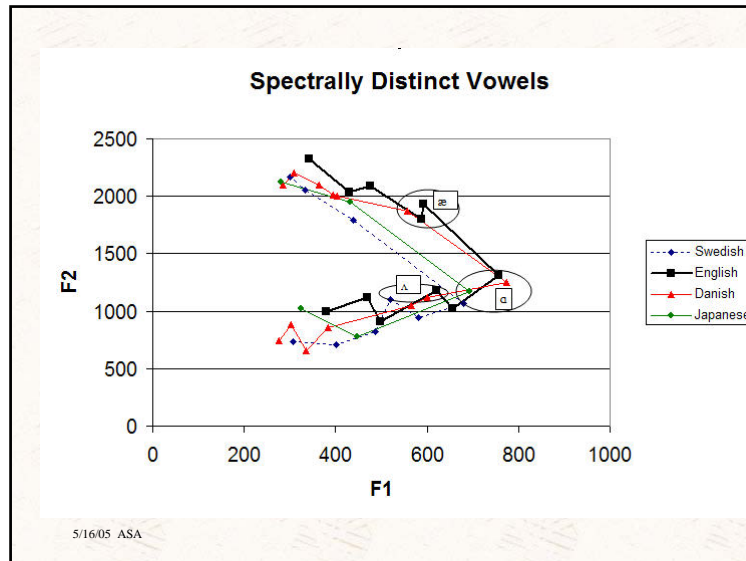
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Comparative Analysis of AE, J, D, S

- Find subset of vowels for study
- Two analyses
 - IPA description of vowels
 - Acoustic description of F1 X F2 vowel space
- Given our target language was AE, excluded front rounded, r-colored, and palatalized vowels, as well as diphthongs and Danish vowels with *stød* /ʔ/.

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Two Perception Tasks

1. **Formant frequency discrimination: F1 and F2 of /æ, ʌ, ɑ/ in /bVk/**
 - **Hi-fidelity stimuli resynthesized using STRAIGHT (Kawahara) to vary formant frequency and fix duration at 160ms.**
 - Ex. Standard /bæk/ æ-F1 (big step)
 - Used adaptive tracking procedure to estimate thresholds (Delta F in Hz)

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2. Vowel Identification Task

- several languages have /ɔ/ vowels close to /æ, ʌ, ɑ /
- Thus ID task 4 vowels: /æ, ʌ, ɑ, ɔ /
- Vowel length: natural & fixed (160 ms)
- ID Words in 10 CVC contexts,

Examples:

- CVC /æ/ /ʌ/ /ɑ/ /ɔ/
- /kVt/ cat cut cot caught
- /bVk/ back buck bock balk
- /nVt/ gnat nut not naught

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Listeners

- Six listeners, 3-M, 3-F, each language
- AE from North Midland dialect with /ɑ-ɔ/ contrast.
- D S J listeners had English in school, but less than 4 months exposure in English speaking environment.
- D S listeners were taught English (American or British) with oral methods, Japanese reading only.

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Procedures

- **Day 1: ID of /æ, ʌ, ɑ, ɔ /**
 - 80 tokens/vowel X 8 reps
 - Vowel keyword responses
- **Days 2: Recording of L1 vowels
Discrimination Training**
- **Days 3-4: Testing Discrimination**
 - F1, F2 in 'back' 'buck' 'bock'

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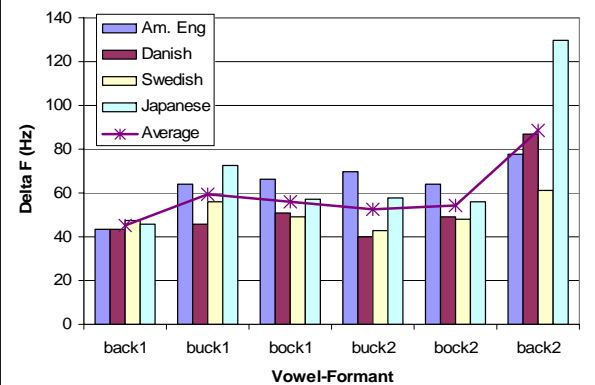
Discrimination Results

- **Thresholds in Delta F (Hz) calculated for 6 formants from 24 subjects**
- **Anova: Lang (4) X Formant (6) (log transform for outlier subjects)**

**No differences between languages.
Significant effect of formant, $p < 0.001$
No interaction**

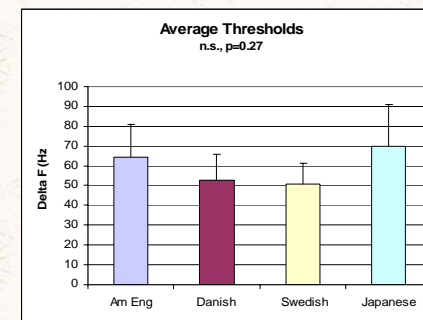
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Discrimination Thresholds



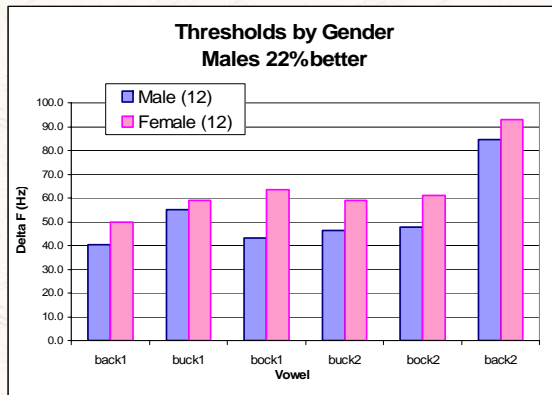
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Discrimination Summary



**At more peripheral level of processing,
discrimination of formants is similar even
though vowel systems are very different.**

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All four languages, average thresholds, male < female

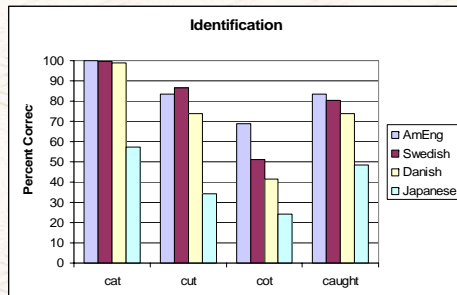
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Identification Results

- No difference for normal or fixed vowel duration.
 - Thus ID averaged over duration.
- Anova: Lang (4) X Vowel (4)
 - (rau transformed from percent correct)

All effects significant, $p < 0.001$.

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/a/ poorest, confused with /ɔ/ and /ʌ/.

AmEng=84% Swed=79% Dan=72% Japan=41%

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ID Summary

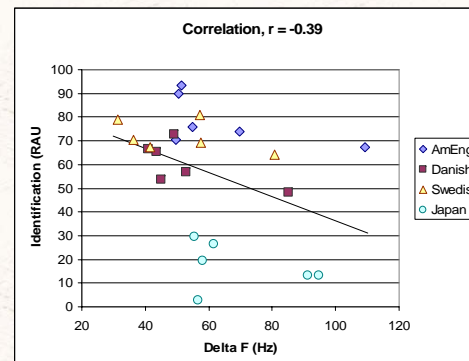
- As expected, L1 influences L2 linguistic categorization.
- The complexity of the vowel system in L1 appears to influence vowel categorization.
 - ID Japanese << ID Danish or Swedish (sparse) (complex)
- Results so far group data. Also examined individual differences in performance on two tasks.

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How does discrimination ability predict linguistic categorization?

- Remember our hypothesis for L2:
If we cannot discriminate differences in L2 vowels, we cannot identify vowel sounds in L2 reliably.
- Even though discrimination across languages was similar, individual thresholds differed as much as 300%.
- Examined correlation of thresholds (Hz) with ID (rau).

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Poor discrimination is moderately associated with poor ability to identify vowels.

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Summary

- Examined effects of 4 vowel systems on perception of real words with high-fidelity speech at two processing levels.
- ### Peripheral Level
1. Thresholds measured perception at low level peripheral auditory system
 2. Thresholds were similar across widely different vowel systems.
- Thus, vowel perception is not compromised in peripheral auditory system by L1- i.e. training is possible.**

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Linguistic Level

1. Few vowels in L1 (J sparse) associated with poor vowel categorization.
2. Complex vowel systems associated with similar performance, even when L2 vowels not in L1.

Thus, influence of L1 vowel systems on processing L2 vowels is primarily at a central, linguistic level.

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Relation Discrimination to Identification

- 1. While ability to discriminate formants similar across languages, individual thresholds differed by up to 300%.**
- 2. Thresholds moderately correlate with identification.**

Thus, persons in any L1 with poorer AE discrimination will exhibit reduced ability to identify AE vowels. However, mismatch between L1 and L2 vowel systems dominates L2 identification performance.

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End of Presentation

Any questions?

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