Cross-language speech perception:  

Late versus early second-language bilinguals

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Main points from last week

- **Give ns:** are that native language (L1) experience …
  - shapes perception of speech segments/contrasts
  - guides acquisition and recognition of spoken words

- **Core Questions** re: these experience-based effects
  - **What do we learn from native speech experience?**
    - **Premise 1:** Language environment-specific relationships between surface *phonetic* patterns and more abstract *phonological* forms
  - **How do we learn those relationships?**
    - **Premise 2:** Naturally-occurring phonetic variation in spoken language input provides the material from which listeners discover native *phonetic-phonological relationships*
Perceiving dynamic invariance in speech: 

Phonological Constancy
Phonological Distinctiveness

- Role of phonetic variation in speech perception:
  - Perceiving dynamic invariance in phonemes and words
  - Acquiring phonological constancy and distinctiveness

- Perceptual assimilation of non-native contrasts
  - Categorical perception of non-native phonetic variation
  - Perceived phonological form of non-native syllable onsets

★ Multiple languages: Late L2 learners and early L2 bilinguals versus functional monolinguals

- Cross-accent assimilation in spoken word recognition
  - Adult word recognition across L1 vs. L2 regional accents
  - Early development of L1 word recognition across accents
Sequential bilinguals: Relationship between L1 and L2 speech

- L1 accent in *speaking* the L2:
  - *likelihood* increases the later the Age of Acquisition (AoA)
  - *strength* of accent increases with increasing AoA
  - affected by L1/L2 usage (dominance), L2 context, L2 model

- **Classic account**: Critical Period Hypothesis
  - specialized language module, *only* operates in early dev.

- **Current view**: Continuity, but ↑ L1 bias w/ ↑ AoA
  - Speech Learning Model (*SLM*): e.g., Flege, 1995
  - Perceptual Assimilation Model (*PAM*): e.g., Best, 1995
  - “L1 Accent” in perception causes accent in production
PAM: Monolinguals’ assimilation of nonnative speech contrasts to native phonetic categories

Assimilation of Nonnative Contrasts
NATIVE PHONOLOGICAL SPACE

Two-Category Assimilation

Single-Category Assimilation

Category Goodness Difference

Uncategorized-Categorized Assimilation

Uncategorized Assimilation

PAM: Monolinguals’ assimilation of nonnative speech contrasts to native phonetic categories
Adult acquisition of a second language …

PAM-L2 (Best & Tyler, 2007): Late bilinguals’ L2 speech perception
Late L2 learners: Learning a new vowel system

**PAM-L2** extension of PAM

*(Best & Tyler, 2007)*

- predicted differences in L2 learning for different assimilation types:
  - CG, UC/UU > SC or TC

★ predicted relation to L2 vocabulary growth

**Vocab Model** extension of PAM-L2

*(Bundgaard-Nielsen et al., 2011a, 2011b, 2012)*

- L2 vocabulary size affects L2 vowel learning
- must test whole-system L2-L1 vowel assimilation
Late (adult-onset) L2 learners: 
Process of L2 phonological learning

(Bundgaard-Nielsen et al., 2011a, 2011b, 2012)

• Japanese adult L2-English learners
  • 1 → 6 months immersion in Australia
  
  ★ 1st expt: whole-system L2-L1 vowel assimilations
  
  ★ 2nd expt: discrimination of SC, TC, UC and UU assimilated contrasts

• L2-English vocabulary at start:
  • High Vocabulary (HV: > 6000 L2 words)
  • Low Vocabulary (LV: < 6000 L2 words)
Late Japanese L2-English learners: Vocabulary size vs other L2-English factors

(Bundgaard-Nielsen et al., 2011a, 2011b)

Table 1. Vocabulary Group comparisons in mean Length of Stay (LOS) in Australia, Age of Immersion (AOI) in English, Age of Learning (AOL) onset, number of years of L2 study (Study), and L2 vocabulary size (Vocab).

<table>
<thead>
<tr>
<th>Comparison</th>
<th>df</th>
<th>df(error)</th>
<th>Mean Square</th>
<th>F</th>
<th>P value</th>
<th>(\eta^2)</th>
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<tbody>
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<td>LOS</td>
<td>1</td>
<td>29</td>
<td>10.856</td>
<td>1.139</td>
<td>.295</td>
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<tr>
<td>AOI</td>
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<td>8.562</td>
<td>.485</td>
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<tr>
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<td>2829524.618</td>
<td>64.310</td>
<td>.000</td>
<td>.689</td>
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</tbody>
</table>
Late Japanese L2-English learners: Exp. 1: Vowel Assimilation x Vocabulary size

(Bundgaard-Nielsen et al., 2011b)

Consistency of Identifications

Australian English vowel subset of interest
Late Japanese L2-English learners: 
Exp. 2: Vowel Discrimination x Vocabulary size 

(Bundgaard-Nielsen et al., 2011b)

LOW VOCAB group

TIME 1
TIME 2

HIGH VOCAB group

L2 $\rightarrow$ L1 Vowel Assimilations

L2 $\rightarrow$ L1 Vowel Assimilations
Category Overlap in L2 Learning
Tyler (2007 New Sounds), Tyler (in prep)

- lifetime L1 attunement → L2 phonological categories may overlap with uncategorized regions of the native phonetic space

- PAM-L2: New L2 phonological categories develop with increasing L2 vocabulary
  - can correspond to regions of phonetic space that are shared (overlap) with an existing L1 phonological category.
  - L2 attunement should be accompanied by reduction in phonetic overlap of L1 and L2 categories
Japanese acquisition of English /r/ and /l/

- L2-English /l/ & /r/ both assimilate to L1-Japanese “/r/” which is realized as [ɾ ~ l]
- thus, new L2 phonological categories must be established for English /r/ ([ɹ]) and /l/ ([ʃ])
- Poor initial discrimination of English /r/ and /l/ improves with immersion (e.g., MacKain et al., 1981) or HVI training (e.g., Bradlow et al., 1997, 1999)
- Is there L1-L2 phonetic overlap and does it reduce with immersion for adult L2 learners?
Novel task required:  
**Forced Category Goodness Rating**

- Standard perceptual assimilation task is not appropriate – it requires selection of one category.
- **Solution**: Provide a L2 rating category on each trial and participant provides a goodness rating only
- L2 Rating Categories: English R, L, W, Y
- Auditory Stimuli:
  - 10 step ROCK-LOCK continuum + endpoints WOCK and YOCK  
    *(MacKain et al., 1981; Best & Strange, 1992; Hallé et al., 1999)*
  - 5 repetitions of each token x each rating category (240 trials)
  - We report here the results for the endpoints only
Y as in YOCK

1=Highly Similar ------- 4=Somewhat Similar ------- 7=No Similarity
Participants

- All had learned English as a foreign language in Japan

- Less experienced (n = 15):
  - Length of residence in Sydney:
    - Mean = 5.5 weeks, Min = 1 week, Max = 10 weeks
  - Mean age = 26 years

- More experienced (n = 15):
  - Length of residence:
    - Mean = 10 yrs Min = 3 yrs, Max = 27 yrs
  - Mean age = 38 years
RESULTS
Rated as L or R

Mean Category Rating

< 10 weeks  > 3 years

Rating Category x Time in Australia

Stimulus endpoints:
/r/
/l/
/w/
/j/

L R L R
RESULTS
Rated as W or Y

Mean Category Rating
poor → excellent

< 10 weeks
> 3 years

Rating Category x Time in Australia
PAM-L2 (Best & Tyler, 2007): *Early* sequential bilinguals’ L2 speech perception

*Early fluent speakers of an L1 and L2 …*
L1-Serbian late versus early L2-English: Learning two nonnative L2 vowel contrasts
(Krebs-Lazendic & Best, 2013)

- English /i/-/ɪ/:
  - Both AoA groups categorized as a TC contrast of morphologically-conditioned syllable length diffs

- English /æ/-/ɛ/:
  - early bilinguals showed TC assimilation to Serbian /a/-/e/
  - late bilinguals showed SC assimilation to Serbian /a/ only
Focus: Early sequential bilinguals

- Evidence is that there is a persisting L1 bias in perception (and lexical decision) for C and V contrasts that exist in one language but not the other (Catalan-only contrasts as perceived by Spanish vs Catalan L1)

  (Sebastian-Galles, Bosch, Pallier et al, etc.: “Barcelona group” and beyond)

- But ... their environment was bilingual (~balanced): what about L2-dominant environments/bilinguals?

- Also, what about the uniquely bilingual skill of responding appropriately to language context, including bilingual-context code-switching?
Early Spanish-English bilinguals

L1-Spanish, L2-English by 6 years

Calderón, 1996; Calderón & Best, 1996

- Spanish /b/-/p/ → [b]-[p]
- English /b/-/p/ → [p/b]-[pʰ]
Assimilation patterns for nonnative Xhosa stop contrasts (laryngeal/glottic)

<table>
<thead>
<tr>
<th>Contrasts</th>
<th>Span-Eng Ss</th>
<th>Mono-Eng Ss</th>
</tr>
</thead>
<tbody>
<tr>
<td>ɓ - b</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ɓ - mb</td>
<td></td>
<td></td>
</tr>
<tr>
<td>pʰ - pʰ</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Calderón, 1996; Calderón & Best, 1996
Language Groups

% correct discrimination

![Bar chart showing discrimination across XHOSA CONTRASTS for Spanish-like and English-like language groups.](chart.png)
BILINGUALS: Language of Instruction

% correct discrimination

XHOSA CONTRASTS

b b (Spanish-like)  b mb (English-like)  p' p (English-like)
Early sequential bilinguals: Results of early L2-dominance


- Greek-L1 / English-L2 (by 6 years)
- L2-English dominant: Sydney Australia natives
- monolingual controls: Sydney vs Athens
- Language Mode effects in the bilinguals (re: the monolingual controls)
  - Greek (L1)
  - English (L2)
- production and perception
- stop VOT contrasts:
  - Greek & English /b-p/
  - Greek & English /d-t/
Early sequential bilinguals: *Production and Language Mode*  
(Antoniou, Best, Tyler & Kroos, 2010)

**Language Mode effect** on stop voicing production in both L1 and L2

→ Nativelike in both L1-Greek and L2-English
Early sequential bilinguals: Production and Language Mode
(Antoniou, Best, Tyler & Kroos, 2011)

Language Mode effect on target code-switched nonce word’s stop voicing production

→ … shifts to L1-Greek phonetic bias with code-switching!

[Graph showing voice onset time (ms) for different words and language modes]
Early sequential bilinguals: Perception of L1-L2 and Language Mode

(*Antoniou, Tyler & Best, 2012*)

**Language Mode effect** on stop voicing categorization and goodness ratings in both L1 and L2 ***

*** but strong **L2-dominance effect** on discrimination regardless of Language Mode

![Graph showing discrimination of English and Greek contrasts for monolinguals and bilinguals](image)

**Figure 7.1.** Monolinguals’ and bilinguals’ discrimination of English and Greek syllable-initial contrasts.
Early sequential bilinguals: *Nonnative* perception and Language Mode

*Antoniou, Best & Tyler, 2013*

- **Language Mode effect** on stop voicing categorization and goodness ratings in nonnative Ma’di voicing contrasts ***
- *** but *L1-L2 intermediate performance* on nonnative Ma’di contrast discrimination regardless of Language Mode
Conclusions

- **Late L2 learners (post-puberty):**
  - *L1 phonology* impacts L2 perception
  - but also *L1 within-category phonetic sensitivity*
  - *perceptual assimilation* to L1 makes some L2 contrasts easy, others difficult to learn
  - *L2 vocabulary size* correlated w/ L2 speech learning

- **Early sequential L2-dominant bilinguals (< 5 yr):**
  - *Language mode* systematically affects production of speech contrasts in L1 and L2
    - but *code-switch* during production reveals *L1 bias*
  - *Language mode* influences *perceptual categorization* of L1 and L2 contrasts
    - but *L2-dominance* biases L1 *discrimination* in early bilinguals
Our new research lines: Bilingual speech perception and production:

- Examining the “tightness” of the L1-L2 phonetics-phonology interface in early L2-dominant bilinguals’ perception and production
  ◦ Sayantan (Sam) Mandal PhD (w/ J Shaw, A Cutler)

- Examining morphological and prosodic influences on late L2 phonological learning
  ◦ Valeria Peretokina PhD (w/ J Shaw, M Tyler & B Di Biase)

- Examining resilience versus adaptation of L1 heritage Dialects in speech production and perception by Italian-Australian bilinguals
  ◦ w/ C Avesani, B Di Biase, V Galatà and M Vayra
Continuing on from here …

TWO further Labex talks

- **May 13 (16-18h):** Spoken word recognition across regional accent variation: I. Native and second language adults
- **May 20 (16-18h):** Spoken word recognition across regional accent variation: II. Development in young children