Typological and articulatory perspectives on context effects

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Overview

How do speech production and perception map onto the typology of synchronic sound patterns?

▶ Phonological patterns database: What frequent synchronic patterns call for an explanation via sound change?
▶ Questioning the role of social identity in the early stages of sound change.
▶ Articulatory studies of covert innovations that can actuate and advance without speaker awareness.
P-base (Mielke, 2008; Brohan and Mielke, 2014)

- Database of 4560 phonological patterns in 537 languages
- Phonological segments associated to feature vectors.
- Patterns labeled according to input, output, context, assimilatory/non-assimilatory change, etc.
- Web interface: http://phon.chass.ncsu.edu/pbase-app/
Other 30.5%
V epen 2.3%
glide epenthesis 2%
glottal epenthesis 1.6%
C epen 1.2%
V deletion 6.2%
C deletion 6.4%
glide deletion 2.3%
epenthesis 2%
glottal deletion 2.3%
gliding 2.5%
regressive nasal place assim 4.5%
Palatalization 3.2%
lenition 13.8%
other assimilation 18.5%
V nasalization 1.8%
final devoicing 1.1%
Context-sensitive phonological patterns

- Recurrent phonological patterns reflecting recurrent (context-sensitive) sound changes.
- What is missing?
- QUESTION: What do you think are the relative rates of occurrence of context-free and context-sensitive sound change?
Well-established bias factors (Garrett and Johnson, 2013)

<table>
<thead>
<tr>
<th>Bias factors</th>
<th>Representative sound changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production/perception bias</td>
<td>Consonant harmony; anticipatory displacement</td>
</tr>
<tr>
<td>Motor planning</td>
<td>Rhotacism, other fricative-to-glide shifts; final devoicing</td>
</tr>
<tr>
<td>Aerodynamic constraints</td>
<td>Palatalization; umlaut; VN &gt; V; vowel coalescence</td>
</tr>
<tr>
<td>Gestural mechanics</td>
<td>Interdental fricative labialization; back vowel rounding</td>
</tr>
</tbody>
</table>

Systemic bias

- Auditory enhancement
Sound change actuation and social factors...

- Janda and Joseph (2003): Sound change is initiated by phonetic factors, but spread primarily by social factors.
- But how?
- Garrett and Johnson (2013) model: “We will further suggest that social factors interact with bias variation in ways that lead to sound change.” (+ figures →)

Bivariate random selection

Social identity

Phonetic output

-2 0 2 4 6 8

-2 0 2 4 6 8
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Typical patterns for new sound changes (Labov, 2001)

- Age stratification
  (more advanced among younger people)
- The curvilinear pattern
  (more advanced among the middle social classes)
- Absence of style shifting
  (because the new variant has little social indexical value, and may not even be perceived).

Age stratification in Philadelphia /aw/ fronting (Labov, 2001)
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The curvilinear pattern in Philadelphia /aw/ fronting (Labov, 2001)
A sound change trajectory

- nominal variation
- exaggeration
- stratified feature
- indexical feature
- nominal variation
A sound change trajectory

▶ QUESTION: What proportion of potential sound changes maintain their trajectory at each stage?
Innovations that do not seem innovative

- Language users overwhelmingly use forms that are already in use.
- **CLAIM**: The typology of sound change is the typology of ways to do something you don’t realize you aren’t already doing.
- Predicts another form of underphonologization (Moreton, 2008)
- Innovative forms may have phonetic, structural, or contact-based sources...
Innovators and early adopters (Milroy and Milroy, 1985, 381-2)

“[B]y making a further distinction between INNOVATORS of a linguistic change and the EARLY ADOPTERS, we have suggested a principled reason for the difficulty experienced in observing the introduction of an innovation into a community. This may be seen as the earliest stage of a linguistic change – at least from the point of view of the community which is adopting it.”
Internal sources of innovation

- innovative variants overtly present in other people’s speech (spread of an innovative variant)
External sources of innovation

- output of a mechanical process
- covert reanalysis (e.g., Blevins’ CHANCE)
- an interpretation of aggregate data about the language
- an output present in another phonological contexts (analogy) or in another speech style
Articulatory differences: overview

- Persian /t/ deletion: deletion and gestural overlap
- English /s/ retraction: degree of motivation for coarticulation is covert
- French rhotic vowels: shift from front/rounded to bunched, covert shift to retroflex
- English /æ/ tensing: managing multiple context effects
Falahati (2013): /t/ deletion in Persian

\[ /χt#b/ \rightarrow [χb] \]

\[ /χt#j/ \rightarrow [χj] \]
Falahati (2013): /t/ by perception and production

Subject: S4, S5, S3, S1, S2, S7, S6

/t/ percept/gesture
- [t]/full
- ∅/full
- ∅/partial
- ∅/none

% of tokens

0.0 0.2 0.4 0.6 0.8 1.0
Falahati (2013): /t/ by perception and production

- Mixture of deleted and overlapped /t/s.
- Difficult to match actual rate of deletion without knowing the rate of overlapped /t/s.
- Frequency matching results in incrementation of deletion rate.
Baker et al. (2011): [s]-[u] articulatory difference

- Articulatory bias toward retraction is variable among non-retractors.
- Hidden parameter makes compensation for coarticulation more difficult.
- Acoustic target matching without compensation for individual bias could result in (forwards or backwards) incrementation.
Rhotic vowels in Canadian French

- Perceptually and acoustically similar to English [ɪ]
- Not obviously borrowed from English
Rhotic vowels in Canadian French

- Perceptually and acoustically similar to English [ʌ]
- Not obviously borrowed from English
Rhotic vowels in Canadian French

- Perceptually and acoustically similar to English [ɾ]
- Not obviously borrowed from English
Anecdotally, rhotic vs. nonrhotic is non-salient.

Francophones are less sensitive to rhoticity of /ø/ and of /œ/ compared to anglophones from North Carolina.

Rhoticity is more salient to francophones who do not produce rhotic vowels.

Rhotic /ø/ vs. English [əʊ] is more distinct than rhotic /ø/ vs. non-rhotic /ø/.
Rhotic vowels corpus study (Mielke, 2013)

- Based on two existing corpora (Poplack, 1989; Poplack and Bourdages, 2010): *Corpus du français parlé à Ottawa-Hull* (adults from Ottawa and Gatineau, recorded in 1982, and *Corpus du français de l’Outaouais au nouveau millénaire* (students and teachers recorded in the last decade)

- 21 hours from 75 speakers analyzed using a French forced aligner (Milne, 2013).
Mapping from phonetic biases to phonological patterns

Articulatory studies

Covert motivations

Vowel studies

F3 by birth year (speaker means)
F1, F2, and F3 by birth year
F1, F2, and F3 by birth year

- Backing/rounding shifted to rhoticity after 1960 without speaker awareness.
- The most rhotic speakers are least aware of the difference.
Two English [ə] variants (Delattre and Freeman, 1968)

- Bunched
- Retroflex

Type 4

Type 7
Ultrasound data collection methods (Ottawa)

Ultrasound imaging
- Terason T3000 + Ultraspeech (Hueber et al., 2007)
- Mid-sagittal ultrasound and face video captured at 30 fps.
- Palatron system for head movement correction (Mielke et al., 2005; Baker, 2005)

Participants
- 23 francophones from Quebec, Ontario, and New Brunswick
- 16 females, 7 males, aged 18-38 (born 1973-1993)

Stimuli
- 30-35 target words with /ø Œ œœ/ and 77-108 fillers
- 3 repetitions in carrier phrases:
  2 × “Je dis __.” 1 × “Je dis ___ encore.”
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Sample ultrasound images for /ø/ in pneu

Bunched

Retroflex

Non-rhotic

.avi ø œ œ

.mwv ø œ œ

.avi ø œ œ

.mwv ø œ œ

.avi ø œ œ

.mwv ø œ œ
Quantifying concavity: \textit{parfum}: bunched rhotic
Quantifying concavity: parfum: non-rhotic
Quantifying concavity: parfum: retroflex rhotic
Rhoticity by F3 and concavity: /ø/

Change #1 (rhoticity):
- Covert and gradual
- Linear concavity/rhoticity relationship.

Change #2 (retroflexion):
- Covert and abrupt
- No intermediate levels of retroflexion.
- Bunching and retroflexion are interchangeable for extreme rhoticity.
Rhoticity by F3 and tongue blade angle: /ø/

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Mielke Typological/articulatory/context
Rhôtic vowels summary

**Bunched**
- similar to a mid front vowel
- gradual exaggeration of low F3 or enhancement of low F2

**Retroflex**
- no gradual path from a mid front vowel
- diagnostic of new target?
Managing invariance across contexts

Guenther et al. (1999): articulatory variability reduces acoustic variability in English /ʌ/.

- /ʌ/’s low F3 can be achieved by increasing the palatal constriction length, by increasing the front cavity length, and by decreasing the constriction area.

- Speakers exploit trading relations between them.

- /ʌ/ tongue postures resemble those required for adjacent sounds, and speakers use remaining degrees of freedom to achieve /ʌ/’s acoustic target.
/æ/ tensing contexts

- Tensing before /m n/
  - Lingual articulations offset the acoustic effects of nasalization in English and enhance it in French, with idiosyncratic articulatory strategies (Carignan et al., 2011; Carignan, pear).
  - De Decker and Nycz (2012) found interspeaker differences in lingual articulations for pre-nasal /æ/ in New Jersey.

- Tensing before /g η/
  - Variable anticipation of formant transitions associated with velars

- Tensing before /f θ s/

- etc.
/æ/ in North American English (Labov et al., 2005)
Ultrasound data collection methods (Raleigh and Ottawa)

Ultrasound imaging
- Terason T3000 + Ultraspeech (Hueber et al., 2007)
- Mid-sagittal ultrasound video captured at 60 fps.
- Articulate Instruments ultrasound headset

Participants
- 20 English speakers from the U.S. and Canada + 1 from the U.K.

Stimuli
- 120 monosyllabic words, randomized and repeated 3 times without carrier phrase

Collaboration with Chris Carignan & Robin Dodsworth (NCSU).
Ultrasound PCA (Hueber et al., 2007; Carignan and Mielke, ms)

(figure from Gick et al. 2013)
Vowel space (diagonals)

normalized F1 frequency (Hz)

normalized F2 frequency (Hz)

nov20 normalized and selected F1 and F2

IY1
IY0 IH1IH1LEY1
EY1L
EH1
EH1L
AE1 AE1L
ER1ER0 ER1L
AA1
AA1R
AW1 AO1
AO1R
AO1L
OW1
OW1L
UW1 UW1L
/æ/ tensing before /n/

- pre-/m n/ tensing for 19 of 20 North Americans (Wilmington, NC example)
- smallest difference: Fargo, ND
- no peak: Newfoundland
- no difference: UK
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/æ/ tensing: /g/ > /d/

- /g/ > /d/ by end of vowel for all speakers (velar pinch)
- from 2nd half of vowel for mid-Atlantic, Buffalo, all but one Southern speaker (Harrisburg, NC example)
- from 1st half of vowel for all Northwest, Northern (−Buffalo & +Virginia) (Olympia, WA example)
- entire vowel for all Ontario speakers (Barrie example)
Mapping from phonetic biases to phonological patterns

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\[ /æ/ \text{ tensing: } /\eta/ \succ /g/ \]

- 16/20 North Americans: no pre-/\eta/ peak, but tenser than pre-/g/ (Harrisburg, NC example)
- pre-/\eta/ \succ pre-/n/ (Fargo, ND)
- pre-/\eta/ = pre-/g/ (Barrie, ON)
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/æ/ tensing: /ŋ/ > /g/

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pre-/ŋ/ > pre-/n/ (Fargo, ND)

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Mapping from phonetic biases to phonological patterns

Articulatory studies

Vowel studies

/æ/ tensing: /ŋ/ > /ɡ/ 

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▶ pre-/ŋ/ > pre-/n/ (Fargo, ND)

▶ pre-/ŋ/ = pre-/ɡ/ (Barrie, ON)
/æ/ tensing across contexts

- Managing invariance across contexts is challenging
- Tensing before /m n/ indicates distinct vowel target (like /f θ s/ in Philadelphia)
- Tensing before voiced velars appears to be different degrees of anticipation of velar constriction
From phonetic biases to phonological patterns...

- Typologically frequent types of phonological patterns match expected production/perception effects.
- Losses in the sound change $\rightarrow$ phonological pattern mapping:
  - **QUESTION**: What are the relative rates of occurrence of context-free and context-sensitive sound change?
  - **QUESTION**: What proportion of potential sound changes maintain their trajectory at each stage?
- Non-obvious innovations: Sound change is predicted to favor parameters that can change and progress without being noticed, e.g.:
  - ambiguity between intentional and non-intentional sources
  - inter-speaker differences in magnitude/nature of covert effects
  - multiple phonetic motivations for similar effects
Thanks

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- **P-base:** [http://phon.chass.ncsu.edu/pbase-app/](http://phon.chass.ncsu.edu/pbase-app/)


