Individual fluctuations in sibilant coarticulation in a longitudinal corpus

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4 January 2018
Variation &change

- What fluctuations do individuals exhibit in their speech over time?
- Can a sound change be observed over time within the speech of a single individual?
Longitudinal research on sound change

- **Short term with continuous observations**
  - m. 1 → m. 60

- ‘Medium’ term with frequent observations
  - d. 1 → d. 90

- **Long term with rare observations**
  - y. 1 → y. 50
Short term with continuous observations

- Phonetic accommodation/convergence/imitation
- Robustly observed and studied. (Goldinger, 1998; Pardo, 2006; Babel, 2010, 2012; Nielsen, 2011; Pinget, 2015; Zellou et al., 2016, i.a.)
- Example: Zellou et al. (2016)
  - Following exposure to a model talker with increased vowel nasalization, speakers produced a greater degree of vowel nasalization
‘Medium’ term with frequent observations

- Fluctuations/Trends (e.g. Sonderegger, 2012; Sonderegger et al., 2017; Yu et al., 2015)
  
  Example: Sonderegger et al. (2017)
  - Participants on the TV show Big Brother exhibit variation in VOT:
    - Short-term fluctuations are the norm
    - ‘Medium’-term trends are the exception
Long term with rare observations

- Changes (e.g. Harrington et al., 2000; Sankoff, 2004)
  
  ![Graph showing changes over time from year 1 to year 50]

- Example: Harrington et al. (2000)
  - Queen Elizabeth II has shifted her F1 and F2 toward, but not attaining, standard Southern British values during her annual Christmas broadcast
Longitudinal research on sound change

- Short term with continuous observations
  m. 1 → m. 60

- ‘Medium’ term with frequent observations
  d. 1 → d. 90

- Long term with rare observations
  y. 1 → y. 50

- Long term with frequent observations
  y. 1 → y. 20

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Individual fluctuations in sibilant coarticulation
Research question

- What fluctuations in an individual’s sibilant production can be observed over an eight year period?
  - Do all individuals exhibit similar fluctuations or variation?
  - Are these fluctuations mediated by coarticulatory triggers?
  - Are any of these fluctuations in line with ongoing sound changes?
Variation and coarticulation of /s/

- **Prevocalic:**
  - /s/ has a lower centroid frequency preceding rounded vowels (Mann & Repp, 1980)

- **Preconsonantal:**
  - /s/ has a lower centroid frequency preceding /r/ (Shapiro, 1995; Baker et al., 2011)
/s/-retraction

- in the context of /r/
  - ‘grocery’ is pronounced as [grouʃi]
  - ‘Sri Lanka’ is pronounced as [ʃiʃ ləŋkə]
- especially in /str/ clusters
  - ‘street’ is pronounced approaching [ʃtəit]
- but less common is /spr/ and /skr/ clusters
  - ‘scream’ is not approaching [ʃkəim]
  - ‘shopping spree’ is not approaching [ʃpəi]
The SCorpus

- Oral arguments before the SCOTUS recorded since 1955
  - Switched to digital recording in 2005
- Transcripts are provided by the Oyez Project

Alabama Legislative Black Caucus v. Alabama

**ORAL ARGUMENT OF RICHARD PILDES ON BEHALF OF THE APPELLANTS**

They can be a way of giving minorities faced with racially polarized voting a fair opportunity to elect, but they can also be a way of unnecessarily packing voters by race in ways that further polarize and isolate us by race.

**Chief Justice John G. Roberts**

So you want, on the one hand -- they obviously had to move new voters into the majority-minority districts because they were all underpopulated, and they need to move enough so that the minorities have an opportunity to elect candidates of their choice, but they can't move too many because that would be packing, correct?

Your Honor, we understand that States are in a bind in this situation as has been true under Title VII and under the Voting Rights Act under Section 2.
The SCorpus as a rich source of speech data

- The justices are active participants, interrupting the lawyers, with questions, hypotheticals, disagreements or even jokes
- Each term begins in October and ends in late June/early July
- The Court hears roughly eighty cases during each term
- Each case is generally an hour long
Materials

- 40 cases for each term from 2006 to 2013
  - $\approx 40$ hours of audio per term
  - $\approx 320$ hours of audio total
- Transcripts manually edited prior to, but not following, force alignment with P2FA (Yuan & Liberman, 2008)
Methods

- CoG was automatically extracted for each instance of /s/ or /ʃ/ using a Praat script modified from DiCanio (2013)
  - Time-averaged over six 15 ms windows
  - Middle 80% of the sibilant examined
  - Preemphasis at 80 Hz
  - Frequency range 500 to 12,000 Hz

- Values were z-scored: \[
\frac{CoG_{observed} - CoG_{mean}}{CoG_{sd}}
\]

- Word-initial and medial instances of /s/ produced by the justices were analyzed if prevocalic or preceding /{t k}(r)/
Analyses were conducted separately for the prevocalic and preconsonantal data.

Each analysis consisted of a static and a dynamic model:

- **Static**: linear mixed effects regressions with by-subject random slopes and intercepts
  - modeling z-scored CoG
- **Dynamic**: generalized additive mixed models with day and year smooths
  - modeling residualized CoG
Static preconsonantal analysis with coarticulatory triggers
Static preconsonantal analysis with coarticulatory triggers

Fitted CoG by Duration (x-axis), Stress (column) and Presence of /r/ (color)
Static prevocalic analysis with coarticulatory triggers

![Box plot comparing CoG (z-scored) between ROUND and UNROUND vowel rounding]
Static prevocalic analysis with coarticulatory triggers

Fitted CoG by Duration (x-axis), Stress (column) and Rounding (color)
Dynamic preconsonantal analysis, residualized for coarticulation

**Day** and **Year** smooths for model fitted on all justices.
Dynamic prevocalic analysis, residualized for coarticulation

Day and Year smooths for model fitted on all justices.
What if the coarticulatory triggers (PLACE, RPRESENCE, and ROUNDED) are included in the dynamic model instead of the static model?
Dynamic coarticulatory analysis – no /r/

Day smooths with no subsequent /r/ (left) and subsequent /r/ (right) for model fitted on all justices.
Dynamic coarticulatory analysis – subsequent /r/

YEAR smooths with no subsequent /r/ (left) and subsequent /r/ (right) for model fitted on all justices.
Dynamic coarticulatory analysis – unrounded

Day smooths with unrounded (left) and rounded right) for model fitted on all justices.
Dynamic coarticulatory analysis – rounded

\texttt{YEAR} smooths with unrounded (left) and rounded right) for model fitted on all justices.
Dynamic coarticulatory analysis: Kennedy

**Day** and **Year** smooths for model fitted on Justice Kennedy for no /r/.
Dynamic coarticulatory analysis: Kennedy

DAY and YEAR smooths for model fitted on Justice Kennedy for /r/.
Summary & implications

- There is a robust degree of variation within and between speakers in time trends of sibilant production and coarticulation
  - Day-to-day fluctuations are the norm
  - Long-term trends are the exception
  - Linear long-term trends are not observed
- Expands upon work on longitudinal variation:
  - Long-term with frequent observations
  - Focus on a sound change in progress


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Thank you to Carissa Abrego-Collier, Daniel Chen, Kathryn Franich, Betsy Pillion and other members of the SCOTUS Project at the University of Chicago. Additional thanks to Susan Lin and audiences at Midwest Speech and Language Days for their feedback!