A longitudinal examination of individual variation in sibilant production and change

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Sound change

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

- ‘Short’ term with frequent observations (e.g. Sonderegger, 2012; Sonderegger et al., to appear; Yu et al., 2015)

- Long term with rare observations (e.g. Harrington et al., 2000; Sankoff, 2004)

- Long term with frequent observations
Research question

▶ What fluctuations in an individual’s sibilant production can be observed over an eleven year period?
  ▶ Can we identify factors that explain the variation?
  ▶ Are any of these fluctuations in line with ongoing sound changes?
English sibilants: [s] and [ʃ]
/s/-retraction

- in the context of /r/
  - ‘grocery’ is pronounced as [grʊʃəri]
  - ‘Sri Lanka’ is pronounced as [ʃəi ləŋkə]
- especially in /str/ clusters
  - ‘street’ is pronounced approaching [ʃtʃɪt]
- but less common is /spr/ and /skr/ clusters
  - ‘scream’ is not approaching [ʃkɹim]
  - ‘shopping spree’ is not approaching [ʃpɹi]
Oral arguments at the Supreme Court of the United States (SCOTUS) have been recorded since the installation of a recording system in October 1955.
Audio and transcript alignment on OYEZ.ORG

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.

Richard Pildes

Chief Justice John G. Roberts

So -- but they have to do that. They have to hit this sweet spot between those two extremes without taking race predominantly into consideration?
The SCorpus as a rich source of speech data

- Recordings from 1955 to the present (with varying audio quality).
- 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.
Methods & Analysis

- **Materials**
  - 40 cases for each term from 2003 to 2013 yielding 440 hours of audio analyzed
  - Time-averaged CoG was automatically extracted for each instance of /s/ or /ʃ/ using a Praat script modified from DiCanio (2013)
  - CoG measurements were calculated on the middle 80% of the sibilant (to exclude transitions) using six 15 ms windows with preemphasis at 80 Hz and an examined frequency range from 500 to 12000 Hz.
  - Word-initial and -medial instances of /s/ produced by the justices were analyzed if prevocalic or preceding /p t k(r)/, yielding 118,409 observations
  - We rely on the automatic alignment and measurements without human correction.
Methods & Analysis

▶ Analysis
  ▶ Smoothing Spline ANOVAs were run separately on each speaker with Target and Term
  ▶ Target is s, sp, st, sk, spr, str, skr, sh

\[
\text{CoG} \sim \text{Target} + \text{Term} + \text{Target:Term}
\]
Predicted CoG for all sibilant environments

Jacob B. Phillips & Alan C. L. Yu

Variation in sibilant production and change
Predicted CoG for prevocalic /s/ and /ʃ/
Comparison: Predicted CoG for Kennedy and Scalia

![Graph showing CoG (Hz) for Kennedy and Scalia over terms from 2004 to 2013. The graph compares the predicted CoG for sibilant sounds, with different colors representing different targets. The graph illustrates the variation in sibilant production and change across terms.](image-url)
The Court through the years


Rehnquist

Roberts

Alito

Breyer

Ginsburg

Kagan

Kennedy

O’Connor

Scalia

Sotomayor

Souter

Stevens

Thomas
The Court through the years


Rehnquist

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Souter

Stevens

Thomas

Variation in sibilant production and change
Focus: Predicted CoG for Kennedy
Focus: Predicted CoG for Scalia
Methods & Analysis

- Analysis
  - Mixed effects regressions were run on the four speakers who remain on the Court of the eleven-year period (Breyer, Ginsburg, Kennedy, and Scalia) with \textsc{Target} and \textsc{Term}
    - Separate models were run for three three-year periods (2005-2007, 2008-2010, 2011-2013)

\[
\text{CoG} \sim (\text{Target} + \text{Term})^2 + (1 \mid \text{Word})
\]
## Individual shifts during periods of change or stability

<table>
<thead>
<tr>
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<th>Change 1</th>
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<th>Change 2</th>
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<th>Stability</th>
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<td>60</td>
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Rehnquist–Roberts
O’Connor–Alito
Souter–Sotomayor
Breyer–Kagan

0 **** 0.001 ** 0.01 * 0.05
Individual shifts during periods of change or stability

- None of the four justices examined shows any significant shifts in sibilant trajectory during a period of bench stability.
  - May indicate a stronger effect of the Chief Justice, (in line with Danescu-Niculescu-Mizil et al., 2012)
Predicted CoG for prevocalic /s/ and /ʃ/
Individual shifts in /s/-/ʃ/ contrast during periods of change or stability

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0 **** 0.001 ** 0.01 * 0.05
Individual shifts in /s/-/ʃ/ contrast during periods of change or stability

- Fewer shifts in /ʃ/ relative to /s/ than in overall effect on all sibilants
- Despite the changes in sibilant production overtime, the relative contrast between /s/ and /ʃ/ remains stable.
Examining retraction in /str/ clusters

Variation in sibilant production and change
Examining retraction in /str/ clusters

Kennedy

Ginsburg

CoG (Hz)

Term

Target

S

STR

SH

Variation in sibilant production and change
Individual shifts in /s/-/str/ contrast during periods of change or stability

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Implications

▶ Over a period of eleven years, shifts in sibilant production can be observed across individuals.
▶ These shifts appear to be partially socially and phonologically mediated.
▶ No individuals exhibited significant shifts with respect to /s/-retraction, a sound change in progress.


