Stability and change in Scottish stops: a real-time study of three acoustic cues in Glasgwegian vernacular

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Stability and change in Germanic

• **phonological** stop voicing contrast: stable over time (Iverson & Salmons 2003)*

• **phonetic** realization: shifted over time
  – voicing-based → aspiration-based
    (e.g. Geiger & Salmons 2006)

* Exception: South Germanic (Peter Auer pc)
Stop voicing contrast in English

• **Phonology**: thought to be stable over time (e.g. Lass 1997)

• **Phonetics**: most commonly-measured cue, Voice Onset Time (VOT), varies massively (e.g. Lisker and Abramson 1964, 1967; Docherty 1992; Yao 2009; Sonderegger, 2012; Stuart-Smith et al., 2015)

• phonological stability – phonetic variability
Stops in Scottish English

• Scottish English: long noted to show voiceless stops with shorter aspiration than Southern English

‘...the emission of breath is barely perceptible. It never strikes the ear in the same way as in Southern English or Irish.’

Grant (1912: 80); cf. Wells (1982); Masuya (1997)
Stops in Scottish English

• Scottish English: long noted to show voiceless stops with shorter aspiration than Southern English

less aspirated  more aspirated
vernacular (? →)  standard

(cf Scobbie 2006)
Stops in Scottish English

• change in phonetic realization?
  – **voiceless stops**: greater aspiration (positive VOT) over time
    (Masuya 1997; Docherty et al. 2011; Stuart-Smith et al. 2015)
  – **voiced stops**: less frequent occurrence of phonetic voicing (negative VOT) (Scobbie 2006)

• evidence?
  – read speech (e.g. word lists)
  – single cue (VOT)

We don’t know:
  multiple cues
  individual speakers
  spontaneous speech
Research questions

• Specific context: Glaswegian vernacular

• How is the stop voicing contrast realized
  1. across multiple cues?
  2. within individual speakers?
  3. over time?

• Refine techniques for large(r)-scale robust acoustic phonetic analysis
Fine phonetic variation and sound change: A real-time study of Glaswegian

http://soundsofthecity.arts.gla.ac.uk/
(target) corpus for a real-time study of Glaswegian Vernacular

<table>
<thead>
<tr>
<th>Decade of Recording</th>
<th>Old 67-90 (Decade of Birth)</th>
<th>Middle-aged 40-55 (Decade of Birth)</th>
<th>Young 10-15 (Decade of Birth)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1970s</td>
<td>6 f, 6 m (1890s)</td>
<td>6 f, 6 m (1920s)</td>
<td>6 f, 6 m (1960s)</td>
</tr>
<tr>
<td>1980s</td>
<td>6 f, 6 m (1900s)</td>
<td>6 f, 6 m (1930s)</td>
<td>6 f, 6 m (1970s)</td>
</tr>
<tr>
<td>1990s</td>
<td>6 f, 6 m (1910s)</td>
<td>6 f, 6 m (1940s)</td>
<td>6 f, 6 m (1980s)</td>
</tr>
<tr>
<td>2000s</td>
<td>6 f, 6 m (1920s)</td>
<td>6 f, 6 m (1950s)</td>
<td>6 f, 6 m (1990s)</td>
</tr>
</tbody>
</table>

- Private, force-aligned, spontaneous speech
- Available for academic researchers
- 100 years of Glaswegian in apparent- and real-time
- Stored in LABB-CAT (Fromont and Hay 2012)
## Sample for this paper

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<tr>
<td>1970s</td>
<td>3f (1890s)</td>
<td>4f (1920s-b)</td>
<td>4f (1960s)</td>
</tr>
<tr>
<td>1980s</td>
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23 female speakers
I went up em, to Ruchill yesterday, to find what was on, you know? Eh, to practise, ‘cause you forget, eh, you know, if you’re not daeing anything all summer, ‘cause you’re only daeing it an hour a week. So I went up, and eh, they let me practise, eh, it’s desktop publishing, I missed it the last time, I only done a wee bit o’ it. So I want to repea-, you know, repeat it and dae it, the whole thing, you know, it’s quite interesting. Oh I like it, ‘cause I always wanted to learn to type.

Middle-aged woman recorded in conversation with her friend in 2000s
Methodology

• Sample
  – voiceless /p t k/ ; voiced /b d g/ plosives
  – stressed syllable-initial (no clusters)

• Three cues to voicing contrast
  1. VOT
  2. % voicing during closure (VDC)
  3. Closure duration (CD)
Burst

Onset of voicing

(positive) VOT

- **Automatic measurement**
  (Sonderegger and Keshet 2012; Keshet et al 2014)

- **+ (fast) manual correction**

- **“semi-automatic”**

- 7335 usable tokens

https://github.com/mlml/autovot

Stuart-Smith et al (2015)
Voicing During Closure (VDC)

1. **Automatic**
   (in Praat: Thea Knowles)

2. **Manual correction**

- 3194 usable tokens
- Only pre-fricative, vowel
Closure Duration (CD)

• semi-automatic (same as VDC)

• 1748 usable tokens

• Only: pre-fricative, vowel clear boundaries
Methodology

• Factors considered:
  – speech rate (syllables/second within phrase)
  – phrase position (initial, medial)
  – following vowel height
  – place of articulation (lab, alv, vel)
  – preceding segment (fricative, vowel, others)
  – annotator
Statistical analysis: Step 1

• One mixed-effects regression per cue
  – VOT, CD: Linear
  – VDC: Logistic (1 = any voicing)

• Fixed effects:
  – Voicing
  – Major factors (last slide)
  – + relevant interactions

• Random effects: as maximal as possible
  – By-Speaker, by-word
    • Intercept + slopes as possible (incl. Voicing)
Voicing contrast: all speakers

Voicing During Closure

VOT

Closure Duration

voiced

voiceless
VOT – all speakers over time

Old, Middle-Age speakers: VOT ≈ increases (real time)

Young speakers: VOT decreases

(Stuart-Smith et al. 2015)
Voicing during closure: all speakers over time

M: same as O?

Both: n.s.

Voiced

Voiceless

Old speakers: contrast decreases

$p < 0.0001$
Closure Duration: all speakers over time

Old speakers: decreases (voiced + voiceless)  
$p = 0.0001$

Young speakers: voiceless decreases  
$p = 0.05$
All speakers over time: summary

• VOT:
  – O, M: increase
  – Y: Decrease

• Voicing during closure:
  – O, M: contrast decreases
  – Y: Opposite?

• Closure duration
  – decreases

• Modest evidence for real-time change
  – most evident in older speakers
Statistical analysis – step 2

• For each cue (VOT, VDC, CD), for each speaker, statistical model → predicted
  1. cue value for voiceless stops
  2. cue value for voiced stops
  3. slope (voiceless/voiced difference)
     (from random effects)

• “essence” of each cue for each speaker’s realization of the voicing contrast
Voicing contrast: within cue within individuals

- Individual speakers
- Maintain contrast for each cue
- Lie along a continuum

(Scobie 2006)
Voicing contrast: across cues within speakers over time

VOT ~ Voicing During Closure

BirthYear

1895
Voicing contrast: across cues within speakers over time

VOT ~ Voicing During Closure
Voicing contrast: across cues within speakers over time

VDC slope (Voiced/voiceless) vs VOT intercept (ms)

Birth Year:
- 1895
- 1925a
- 1925b

VOT ~ Voicing During Closure
Voicing contrast: across cues within speakers over time

VOT ~ Voicing During Closure

BirthYear
1895
1925a
1925b
1955
Voicing contrast: across cues within speakers over time

VOT ~ Voicing During Closure

VDC slope (Voiced/voiceless)

BirthYear
- 1895
- 1925a
- 1925b
- 1955
- 1965
Voicing contrast: across cues within speakers over time

VOT ~ Voicing During Closure
Voicing contrast: across cues within speakers over time

VOT ~ Closure Duration

Closure duration slope (Voiceless / Voiced)

VOT (ms): intercept

Birth Year: 1895
Voicing contrast: across cues within speakers over time

VOT ~
Closure Duration

Closure duration slope (Voiceless / Voiced)
Voicing contrast: across cues within speakers over time

VOT ~ Closure Duration

Closure duration slope (Voiceless / Voiced)

VOT (ms): intercept

BirthYear
- 1895
- 1925a
- 1925b
Voicing contrast: across cues within speakers over time

VOT \sim
Closure Duration

Closure duration slope (Voiceless / Voiced)

BirthYear
- 1895
- 1925a
- 1925b
- 1955

VOT (ms): intercept
Voicing contrast: across cues within speakers over time

Closure duration slope (Voiceless / Voiced)

VOT ~
Closure
Duration

BirthYear
- 1895
- 1925a
- 1925b
- 1955
- 1965
Voicing contrast: across cues within speakers over time

VOT ~ Closure Duration

Closure duration slope (Voiceless / Voiced)
Summary: correlations among cues

• Speakers lie along continuum
  – VOT ↑
  – VDC use ↓
  – closure duration use ↑

• What (real-time) change there is is ≈ along continuum
Summary - method

• “Big Data”
• semi-automated: fast, high-quality phonetic measures
• Large $N$
• from spontaneous real-time speech

• we can start to discern patterns for multiple cues, individual speakers
  (cf lab studies: Dmitrieva et al. 2015; Schultz et al. 2012, Llanos et al. 2013; Schertz et al. 2015)
Summary – change and the contrast

• voicing contrast: maintains long-term phonological stability in Germanic (Iverson and Salmons 2003)

• individual speakers lie along a continuum of phonetic realizations
  — ~ ‘voicing-based’ ↔ ‘aspiration-based’ (cf Scobbie 2006)

• subtle phonetic change along this continuum towards ‘aspiration-based’ (Masuya 1997)
What about the anomaly?

• Youngest speakers (BYear 1990s):
  – Show apparent reversal (VOT, maybe VDC)
  – Pattern with oldest speakers
    (`boomerang’ effect: pc J. Salmons)

• Why?
  – Stuart-Smith et al. 2007 (e.g.):
    • Glaswegian adolescents in 1990s: more vernacular variants than those in 1970s
    • polarization between working-class and middle-class adolescents
    • vernacular styling…
No, it'll be pure good this holiday but. This is my plan right, we get to the holiday right, just the early hours of the morning, right? We go to our bed, right? We get up about two [in the afternoon], we go and explore the place, right? We come back, have our dinner and go oot to the dancing, then we come in about five o'clock, six o'clock in the morning, have something to eat, what breakfast, go to our bed, get up at eleven o'clock 'cause the hottest hour of the day is twelve o'clock, go out sunbathe 'til about two, come back up, go to our bed then go back out get something to eat and just keep going like that, and get pure steamin' out our heids!
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Questions