Modulation of the following segment effect on coronal stop deletion

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The following segment effect

...on deletion of word-final coronal stops in consonant clusters

- 13% of stops retained before a consonant
- 78% of stops retained before a vowel
The following segment effect

- Following Guy 1991a,b and Tanner et al. 2015: the following segment effect is malleable
- Different approaches to coronal stop deletion make different predictions about how other factors interact with the following segment effect
The following segment effect

- Assess three hypotheses that follow from different approaches to coronal stop deletion:
  - Following segment effect interacts with speech rate
  - Following segment effect interacts with lexical identity and frequency
  - Following segment effect interacts with syntactic structure
Interaction with speech rate

Predictions:
• Faster speech has more deletion
• Faster speech exaggerates the effect of a following consonant
Interaction with speech rate

Why?

- Fast speech compresses the time allotted to gestures, leading to overlap that is perceived as deletion

\[ /b/ \quad /d/ \quad /b/ \]

- **Tongue body**: wide pharyngeal
- **Tongue tip**: alveolar closure
- **Lips**: labial closure

Browman & Goldstein 1992
Interaction with speech rate

Why?

• Fast speech compresses the time available for gestures, leading to overlap that is perceived as deletion.

\[
\text{labial closure} \quad \text{labial closure}
\]

\[
\text{alveolar closure}
\]

\[
\text{wide pharyngeal}
\]

/b/  /d/  /b/

tongue body
tongue tip

Browman & Goldstein 1992
Interaction with speech rate

Why?
• Fast speech compresses the time available for gestures, leading to overlap that is perceived as deletion

/b/    /d/    /a/

<table>
<thead>
<tr>
<th>tongue body</th>
<th>wide pharyngeal</th>
<th>no overlapping gesture</th>
</tr>
</thead>
<tbody>
<tr>
<td>tongue tip</td>
<td>alveolar closure</td>
<td></td>
</tr>
<tr>
<td>lips</td>
<td>labial closure</td>
<td></td>
</tr>
</tbody>
</table>

Browman & Goldstein 1992
Interaction with lexical frequency

Predictions:
- Higher frequency words have more deletion
- Words that occur more before vowels have more retention
- Vowel-context bias is stronger in higher frequency words
Interaction with lexical frequency

Why?
- If a word has more pre-vowel than pre-consonant tokens in its exemplar cloud, and retention is higher before vowels, then overall the cloud will have more retention}

Pierrehumbert 2002
Interaction with lexical frequency

Why?
• In exemplar-theoretic models, allophonic biases accrue more rapidly in high-frequency words than low-frequency ones

V-biased: FACT  
pre-V exemplar  
pre-C exemplar  

C-biased: OLD

Pierrehumbert 2002
Interaction with syntactic structure

Predictions:
• Clause boundary reduces following segment effect
Interaction with syntactic structure

Why?
• New clause not always planned in time for the following segment to affect the variable outcome

Wagner 2012
Interaction with syntactic structure

Why?
• New clause not always planned in time for the following segment to affect the variable outcome

Wagner 2012
The deletion data

Sociolinguistic interviews with 106 white speakers (61 f, 45 m) from Philadelphia Neighborhood Corpus

Mean N=8.8 tokens

Labov & Rosenfelder 2011
The deletion data

938 auditorily-coded observations of 73 word types that:

- Contain a final homovoiced cluster (Wolfram 1969)
- Are monomorphemic (Guy 1991a,b)
- Are monosyllabic
- Are content words
- Have a following vowel or non-approximant consonant

Restricted to avoid many-way interaction terms
Regression modeling

First pass:

retention ~

speaker gender +
preceding segment +
following segment * normalized speech rate +
vowel-context bias * log word frequency +
following segment * clause boundary
Regression modeling

<table>
<thead>
<tr>
<th></th>
<th>Estimate</th>
<th>Std. error</th>
<th>z-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-1.34</td>
<td>1.77</td>
<td>-0.757</td>
<td>0.449</td>
</tr>
<tr>
<td>Male speaker</td>
<td>-0.11</td>
<td>0.16</td>
<td>-0.72</td>
<td>0.470</td>
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<tr>
<td>Following vowel</td>
<td>3.68</td>
<td>0.25</td>
<td>14.64</td>
<td>&lt; 2e-16</td>
</tr>
<tr>
<td>Clause-final</td>
<td>0.27</td>
<td>0.54</td>
<td>0.51</td>
<td>0.610</td>
</tr>
<tr>
<td>Preseg...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>n.s.</td>
</tr>
<tr>
<td>Norm. speech rate</td>
<td>-0.16</td>
<td>0.11</td>
<td>-1.42</td>
<td>0.155</td>
</tr>
<tr>
<td>V-context bias</td>
<td>1.45</td>
<td>2.23</td>
<td>0.65</td>
<td>0.515</td>
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<tr>
<td>Log word frequency</td>
<td>-0.08</td>
<td>0.20</td>
<td>-0.41</td>
<td>0.684</td>
</tr>
<tr>
<td>Fol.V : clause-final</td>
<td>-1.46</td>
<td>0.59</td>
<td>-2.49</td>
<td>0.013</td>
</tr>
<tr>
<td>Fol.V : speech rate</td>
<td>0.03</td>
<td>0.13</td>
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<tr>
<td>V-bias : word freq</td>
<td>-0.10</td>
<td>0.25</td>
<td>-0.41</td>
<td>0.679</td>
</tr>
</tbody>
</table>
Regression modeling

Take two:

$$\text{retention} \sim \text{speaker gender} + \text{preceding segment} + \text{normalized speech rate} + \text{vowel-context bias} + \text{log word frequency} + \text{following segment} \ast \text{clause boundary}$$
Regression modeling

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<tr>
<td><strong>Intercept</strong></td>
<td>-0.71</td>
<td>0.89</td>
<td>-0.79</td>
<td>0.428</td>
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<tr>
<td>Male speaker</td>
<td>-0.11</td>
<td>0.16</td>
<td>-0.69</td>
<td>0.489</td>
</tr>
<tr>
<td>Following vowel</td>
<td>3.68</td>
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<td>&lt; 2e16</td>
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</tr>
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<td>Preseg...</td>
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<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Norm. speech rate</td>
<td>-0.14</td>
<td>0.05</td>
<td>-2.66</td>
<td>0.008</td>
</tr>
<tr>
<td>V-context bias</td>
<td>0.56</td>
<td>0.45</td>
<td>1.22</td>
<td>0.221</td>
</tr>
<tr>
<td>Log word frequency</td>
<td>-0.16</td>
<td>-0.08</td>
<td>-2.07</td>
<td>0.039</td>
</tr>
<tr>
<td>Fol.V : clause-final</td>
<td>-1.42</td>
<td>0.57</td>
<td>-2.48</td>
<td>0.013</td>
</tr>
</tbody>
</table>
Clause boundary weakens following segment effect

Predicted retention probability

Following segment:
- Consonant
- Vowel
Clause boundary weakens following segment effect

Smaller following segment effect across clause boundary
Clause boundary weakens following segment effect

Less pre-vowel retention across clause boundary

Following segment
- consonant
- vowel
Clause boundary weakens following segment effect

• Why the asymmetry between pre-V and pre-C contexts?
• Suggests syllabification as the source of the following segment effect (Guy 1991a)
• Can’t be captured as clause boundaries blocking syllabification because other processes require syllabification across clause boundaries
• Consistent with predictions based on production-planning effects on phonological variation (Wagner 2012, MacKenzie 2012, Tanner et al. 2015)
Clause boundary weakens following segment effect

- Syllabification prevents deletion, giving rise to at least part of the following segment effect
- Unplanned clauses sometimes prevent syllabification, facilitating deletion by forcing the stop to remain in a coda position
Clause boundary weakens following segment effect

- Fun speculation: if the following segment effect is entirely a product of syllabification, then the difference between retention rates in pre-V and pre-C contexts across clause boundaries could represent an estimate of the rate at which the following clause is not yet planned...
Conclusions

• Production planning is neither a social constraint nor an internal linguistic one
• Rather, what Tamminga, McKenzie & Embick (forthcoming) call a “p-conditioning” factor: psychological and physiological effects
• Understanding why the following segment effect is sensitive to syntactic boundaries requires making reference to psycholinguistic processes
Thank you!

And thanks to Bill Labov and Dave Embick for their comments on this analysis.

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References


Wagner, M. 2012. Locality in phonology and production planning.