Phonetic effects of onset complexity on the English syllable

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INTRODUCTION
Crosslinguistically, onset-sensitive categorical weight criteria are rare (Gordon 2005). However, onset characteristics still predict syllable behavior in languages where onsets do not participate in categorical weighting criteria, an effect which is argued to be phonetically motivated (Kelly 2004, Ryan 2014). This production study demonstrates the stress-independent acoustic properties of onsets that may be responsible for these effects in American English.

HYPOTHESES
Goedemans (1998) and Ryan (2014) find that the syllable’s perceptual center (p-center, Morton et al. 1979) advances earlier in the syllable when there are more onset segments. What are possible acoustic correlates of the p-center?
- Intensity maximum, F0 maximum, Δ-intensity maximum

Predictions:
More onset segments → earlier intensity maximum
Voiced onset segments → earlier F0 maximum
Δ-intensity maximum

MATERIALS & METHODS

<table>
<thead>
<tr>
<th>Vowel</th>
<th>Rhyme</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>/ap/</td>
<td>rap, trap, strap</td>
</tr>
<tr>
<td>i</td>
<td>/il/</td>
<td>ill, still, shrill</td>
</tr>
<tr>
<td>u</td>
<td>/ud/</td>
<td>rude, screwed</td>
</tr>
<tr>
<td>e</td>
<td>/em/</td>
<td>them, trim</td>
</tr>
<tr>
<td>æ</td>
<td>/æt/</td>
<td>aet, Kate</td>
</tr>
<tr>
<td>æ</td>
<td>/æ/</td>
<td>ache, rake</td>
</tr>
</tbody>
</table>

- 19 native speakers of American English
- 160 targets
  - Monosyllabic
  - Monomorphic
  - Varying in number of onset segments (0-3)
  - Each target matched at least one other target in all but one onset segment (see Examples)
- 40 disyllabic fillers
- Spoken in the carrier: “Please say ___ again.”

MEASURES

Measures Normalized...
- Relative to Word Duration:
  - Segment Duration
  - Total Onset Duration
  - Total Rime Duration
- Timing relative to Vowel Onset and Word Duration:
  - Intensity maximum
  - F0 maximum
  - Δ-intensity maximum

What is Δ-intensity? The instantaneous slope at each timepoint along the intensity contour, calculated using a smoothed finite difference approximation of the first order derivative.

CONCLUSIONS
Onset segments impact syllable realization through:
- A compensatory trade-off in duration with the rime
- Intensity contour: earlier timing of intensity peak and greater maximum rate of change.

As onset complexity increases, vowel duration disproportionately decreases (c.f. Ryan 2014).

SINGLE ONSET VOicing

Single Onsets: voiceless → later and steeper increase in intensity
- In languages with onset-sensitive weight criteria, voiceless onsets are heavier than voiced.
- Value of max(Δ-intensity) more consistently patterns with segment-level characteristics of syllable weight than its timing (see below ↓)