### Motivation: Ambiguous Patterning of Russian /v/

**Patterning of /v/ as an obstruent:**
1. Final Devoicing: Obstruents and /v/ are targets
   - a. [dæl-a] [dæl] ‘track (gen./nom.sg.)’
   - b. [sail] *sail*
   - c. [tra-vu] [tra-vu] ‘right (temp masc.)’
2. Voicing Assimilation: Obstruents and /v/ are targets
   - a. /v ruki/ [v ruki] ‘in one’s hand’
   - b. /v yspet/ [v yspet] ‘in the city’
   - c. /v supe/ [s up] ‘in the soup’

**Patterning of /v/ as a sonorant:**
1. Voicing Assimilation: Obstruents are triggers; Sonorants and /v/ are not triggers
   - a. [ot-pustit] [ot-pustit] ‘release’
   - b. [ot-brotit] [ot-brotit] ‘throw aside’
   - c. [ot-nisj] [ot-nisj] ‘carry away’
   - d. [ot-vist] [ot-vist] ‘lead away’

Ambiguous patterning of /v/ in other languages: Bulgarian (Scatton, 1984), Czech (Hall, 2003), Hebrew (Barkai and Horvath, 1978), Hungarian (Kiss and Bárkányi, 2006).

### Assessing Frication Degree with Spectral Centroid

#### Spectral Centroid:
- Weighted mean that assesses concentration of energy in frequency domain, but inappropriate for voiced sounds due to multiple peaks in the spectrum.
- Signal high-pass filtered at 1500 Hz to remove the effect of voicing and the first several harmonics.
- For each token, an average centroid was computed over three 20 ms Hann windows with 10 ms overlap from the middle of the segment.

#### Relative Spectral Centroid:
- Normalized measure to assess how similar the realization of /v/ tokens are to /f/ tokens with respect to high frequency energy.
- Within each environment, for each speaker, the mean centroid of /f/ subtracted from the centroid measure of every /v/ token.
- Same procedure applied to /v/ tokens, relativized to /f/, for comparison.

### Correlating Duration and Spectral Centroid

- Explore whether differences in spectral centroid arise from gestural undershoot (Lindblom, 1983).
- Relative duration calculated as a percentage of syllable duration for tokens of /v/ and /f/.
- Restrict analysis to WIS environment in order to control for syllable structure and stress; only words with open initial syllables were selected.
- Two-way ANOVA (segment x language) showed main effects of both segment (F = 187.676, p < 0.001) and an interaction of segment and language (F = 33.5, p = 3.27e-14), but not for language alone (F = 1.962, p = 0.142).
- Correlation statistically significant for /v/ tokens in all three languages, but correlation coefficients are small (r = 0.42).

### Discussion

According to Padgett (2002) the ambiguous patterning of Russian /v/ is due to an inherently intermediate phonetic realization of /v/ as a “narrow approximant”, transcribed as [v].

However, this study only supports such an analysis if the data are collapsed over all environments. Controlling for stress and word position reveals a more subtle relationship.

### Correlation of Duration and Spectral Centroid

<table>
<thead>
<tr>
<th>Segment</th>
<th>Relative duration of [v] and [f] in WIS position</th>
<th>Correlation between spectral centroid and relative duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>WIS</td>
<td><img src="image1.png" alt="Graph" /></td>
<td><img src="image2.png" alt="Graph" /></td>
</tr>
<tr>
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### Conclusions
- There exists a partial correlation between phonological status and phonetic realization; tokens of Greek /v/ are consistently produced with high frication and more similarly to tokens of /f/ with respect to frication degree than tokens of Serbian /v/.
- The difference in spectral centroid cannot be attributed to gestural undershoot (at most 16% of the variance is accounted for this way).
- There is no evidence that tokens of Russian /v/ are consistently produced with less frication than Greek, but more frication than Serbian. Instead, Russian typically patterns either with Greek (WIS) or with Serbian (WMU).
- The relationship between phonological status and phonetic realization is complex, and this study highlights the need for carefully controlled, cross-linguistic phonetic studies.

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### References

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### Methodology
- 7 native speakers of Greek, Russian, Serbian
- SD722 digital recorder, 44100 Hz, 16-bit
- Hand-segmented in Praat
- Resampled to 22050 Hz, analysed in Matlab
- Segments recorded: /v/, /f/,
- Flanking vowels: /s/, /u/.

### Correlation of Duration and Spectral Centroid

<table>
<thead>
<tr>
<th>Environment</th>
<th>Spectral centroid of [v] by language and environment</th>
<th>Relative centrdroid of /v/ and /f/</th>
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### Discussion

- Voicing contrast in both stops and sibilants
- /f/, /v/ or /w, V/ ambiguous patterning of /v/ in all four prevocalic environments under consideration.
- Russian, however, patterns with Greek (Barkai and Horvath, 1978), Hungarian (Kiss and Bárkányi, 2006).
- Presence of /v/ in the inventory; cannot attribute differences in patterning to dispersion

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### References