# The Phonology and Phonetics of Ambiguity: A Case Study of /v/

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## Motivation: Ambiguous Patterning of Russian /v/

Patterning of /v/ as an obstruent:

(1) Final Devoicing: Obstruents and /v/ are targets

| | | | |
|---|---|---|---|
| a. | [sled-a] | [slet] | 'track (gen./nom.sg)' |
| b. | [mil] | *[mil] | 'dear' |
| c. | [prav-a] | [praf] | 'right (fem./masc.)' |

(2) Voicing Assimilation: Obstruents and /v/ are targets

| | | | |
|---|---|---|---|
| a. | /v ruke/ | [v ruke] | 'in one's hand' |
| b. | /v gorode/ | [v gorode] | 'in the city' |
| c. | /v supe/ | [f supe] | 'in the soup' |

Patterning of /v/ as a sonorant:

(3) Voicing Assimilation: Obstruents are triggers; Sonorants and /v/ are not triggers

| | | | |
|---|---|---|---|
| a. | /ot-pustit$^{j}$/ | [otpustit$^{j}$] | 'release' |
| b. | /ot-brosit$^{j}$/ | [odbrosit$^{j}$] | 'throw aside' |
| c. | /ot-nesti/ | [otnesti] | 'carry away' |
| d. | /ot-vesti/ | [otvesti] | '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).

## Situating Russian /v/ Cross-Linguistically

Control cases:
- Greek: /v/ patterns as an obstruent
- Serbian: /v/ patterns as a sonorant

Motivation: Like Russian, Greek and Serbian have
- Voicing contrast in both stops and sibilants
- Presence of /f/ in the inventory; /v, f/ a possible voicing pair
- Lack of /w, u/ in the inventory; cannot attribute differences in patterning to dispersion

## Padgett (2002): Ambiguous /v/ as "Narrow Approximant"

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 [ʋ̞].

| | Greek | Russian | Serbian |
|---|---|---|---|
| Undergoes regressive voicing assimilation? | yes | yes | no |
| Triggers regressive voicing assimilation? | yes | no | no |
| Undergoes final devoicing? | N/A | yes | N/A |
| | obstruent | ambiguous | sonorant |
| Predicted phonetic realization: | [v] | [ʋ̞] | [ʋ] |

## Summary

Cross-linguistically, /v/ patterns *ambivalently* (to use terminology from Mielke (2008)) with respect to the feature sonorant, patterning as an obstruent in some languages (Greek) and as a sonorant in others (Serbian). However /v/ may also pattern ambivalently with respect to [sonorant] within a single language as evidenced by Russian (Jakobson, 1978; Hayes, 1984; Padgett, 2002). Is this three-way patterning reflected in phonetic realization? It has been found that Greek and Serbian differ in the distribution and concentration of energy, the former patterning as an obstruent and the latter as a sonorant in both word-initial and word-medial position. Russian, however, patterns with Greek in word-initial position and with Serbian in word-medial position. Thus the claim that Russian has a phonetically intermediate "narrow approximant", as argued for by Padgett (2002), is not substantiated in these data.

## References

Barkai, Malachi, and Julia Horvath. 1978. Voicing assimilation and the sonority hierarchy: evidence from Russian, Hebrew and Hungarian. *Linguistics* 212:77–88.
Hall, Daniel Currie. 2003. A formal approach to /v/: Evidence from Czech and Slovak. In *Formal Approaches to Slavic Linguistics: The Ottawa Meeting.*
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Kiss, Zoltán, and Zsuzsanna Bárkányi. 2006. A phonetically-based approach to the phonology of [v] in Hungarian. *Acta Linguistica Hungarica* 53:175–226.
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## Phonetic Study: Does there exist a correlation between the phonological patterning of /v/ and its phonetic realization?

**Measures:** The degree of frication in /v/ was assessed by looking at the overall distribution of energy in the frequency domain (power spectra), and the concentration of energy above 1500 Hz (spectral centroid). The higher the degree of frication, the greater the distribution of energy in the high frequency range, and the higher the spectral centroid.

**Hypotheses**

| | Power Spectra | Centroid |
|---|---|---|
| Greek (fricative) | energy in high frequency range | high |
| Serbian (approximant) | energy in low frequency range | low |

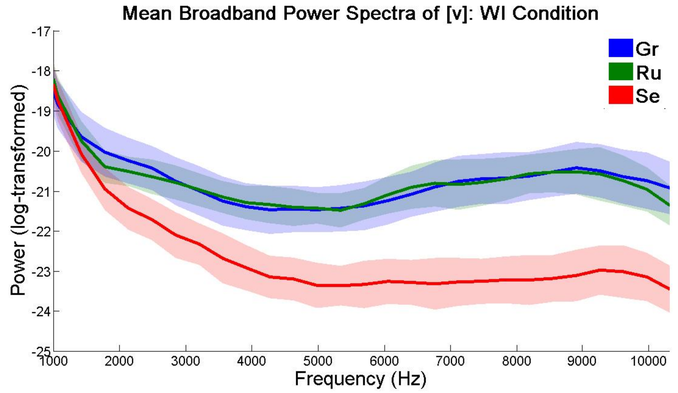
Russian /v/ will pattern *either* as in Greek *or* as in Serbian.

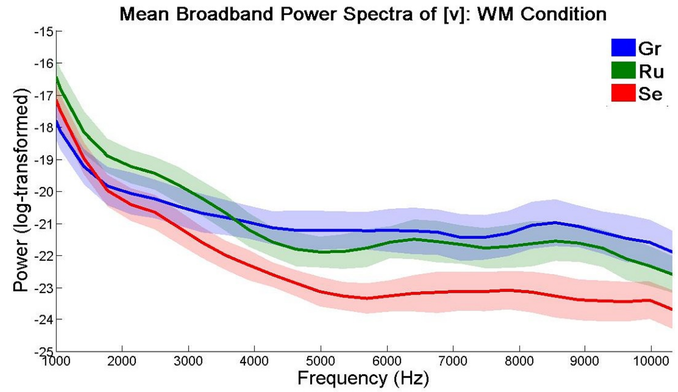
**Method**
- 7 native speakers of each language
- SD722 digital recorder; 44100 Hz, 16-bit
- Hand-segmented in Praat
- Resampled to 22050 Hz & analysed in Matlab
- 5 randomized word lists read in frame sentence

**Stimuli**
- Segments recorded: [f, v, s, z, m]
- Environments: ˈCV.CV(C) (real words)
  1. Word-initial, stressed syllable (WI)
  2. Word-medial, unstressed syllable (WM)
- Flanking vowels: /a, o/

## Power Spectra

**Computation of Power Spectra:** Broadband power spectra were computed using a 64-point FFT on a 2 ms Hann window in the middle of the segment. The log-transformed power spectra were then averaged over all repetitions, words and speakers, for each condition. The shaded area shows confidence intervals of two standard errors.

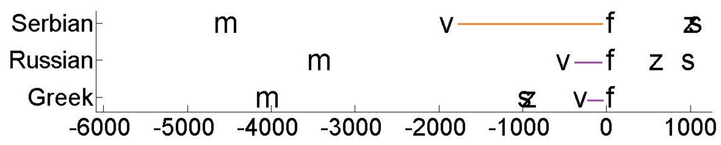


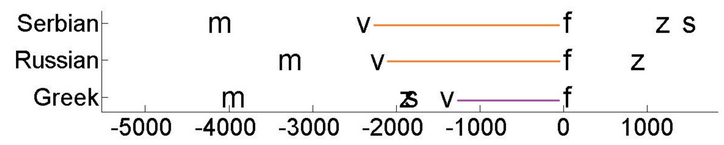




**Conclusion:** For all languages, there is less high frequency energy in the WM condition than the WI condition. In the WI condition, Greek and Russian /v/ display the same distribution of energy, and in fact have completely overlapping confidence intervals, thus patterning together to the exclusion of Serbian /v/. In the WM condition, Russian /v/ has the same distribution of energy as Serbian /v/, despite an overall greater power that results in non-overlapping confidence intervals; thus Serbian and Russian /v/ pattern together to the exclusion of Greek /v/.

## Relative Spectral Centroid

**Computation of Spectral Centroid:** 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.
**Compuation of Relative Spectral Centroid:** For each speaker, the mean centroid of /f/ tokens was computed and subtracted from each centroid measure taken for that speaker, then averaged over speakers within a language. This yields a normalized measure comparing how the concentration of high frequency energy between realizations of /f/ and /v/ differs across languages.




A two-way ANOVA (segment × language) on the (non-normalized) centroid values for [f, v, m, s, z] showed main effects of both segment [F = 382.9 p = 1.75394e-191] and language [F = 42.32, p = 2.78799e-018], as well as an interaction of segment and language [F = 33.84, p = 9.59282e-047].

A two-way ANOVA (segment × language) on the (non-normalized) centroid values for [f, v, m, z] showed main effects of both segment [F = 437.92, p = 0] and language [F = 7.34, p = 0.0007], as well as an interaction of segment and language [F = 46.94, p = 0].

**Conclusion:** Post-hoc Tukey tests show that in the WI condition, centroid values of /v/ tokens do not differ between Greek and Russian, but differ from those of Serbian; in the WM condition, centroid values of /v/ tokens do not differ between Serbian and Russian, but differ from those of Greek.

## Conclusion and Further Research

- The claim that Russian has a phonetically intermediate "narrow approximant" (Padgett, 2002) is not substantiated in these data.
- Russian /v/ is unique in that the degree of weakening it exhibits is much more drastic than that exhibited by Greek or Serbian /v/.
- Further research will include disentangling the contributions of stress and word-position in conditioning Russian /v/ weakening, as well as determining the effect of other prosodic positions on the realization of Russian /v/.

| | [v] | [ʋ̞] / [u] | [ʋ] |
|---|---|---|---|
| Greek | ✓ | ✓ | |
| Serbian | | ✓ | ✓ |
| Russian | ✓ | | ✓ |

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