The Phonetic Properties of [v] in Russian, Greek and Serbian

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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, ʊ/ in the inventory; cannot attribute differences in patterning to dispersion

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 and R
- 5 randomised real word lists read in frame sentence
- Segments recorded: /f, v/
- Flanking vowels: /a, o/

Environments:
Prevocalic, controlling for stress and position in word (initial vs. medial)
1. Word-initial, stressed syllable (**WIS**)
2. Word-initial, unstressed syllable (**WIU**)
3. Word-medial stressed syllable (Gr, Ru only) (**WMS**)
4. Word-medial, unstressed syllable (**WMU**)

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? This study finds that Greek and Serbian /v/ tokens differ in the distribution and concentration of energy, the former patterning as an obstruent and the latter as a sonorant in all four prevocalic environments under consideration. Russian, however, patterns with Greek in some cases but with Serbian in others. Thus the claim that Russian has a phonetically intermediate "narrow approximant", as argued for by Padgett (2002), is not substantiated in these data.

References

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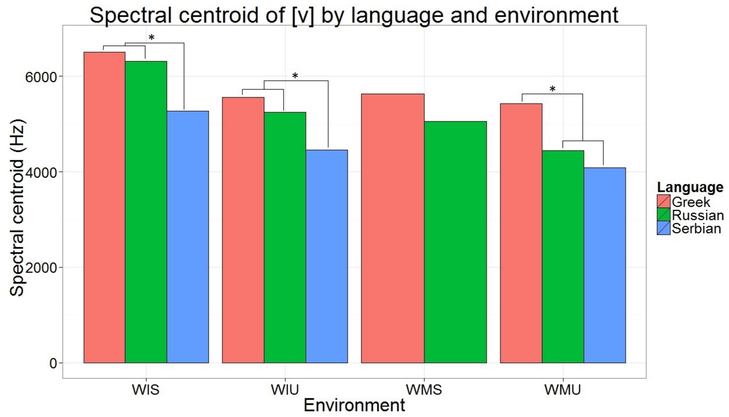
Assessing Frication Degree with Spectral Centroid

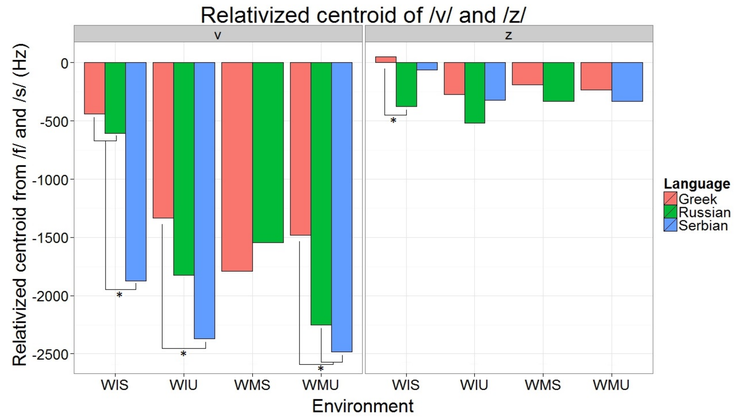
Spectral Centroid:
- Weighted mean that assesses concentration of energy in frequency domain, but inappropriate for voiced sounds due to multiple peaks in the spectrum.
- Signal high-pass filtered at 1500 Hz to remove the effect of voicing and the first several harmonics.
- For each token, an average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



One-way ANOVAs were performed on the centroid values calculated for /v/ for each environment separately; significant differences in mean centroid as shown by post-hoc Tukey tests are indicated with an asterisk.

	F	p
WIS	18.87	2.43e-08
WIU	6.441	2.32e-03
WMS	2.178	0.143
WMU	14.01	2.01e-06

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 /z/ tokens, relativized to /s/, for comparison.

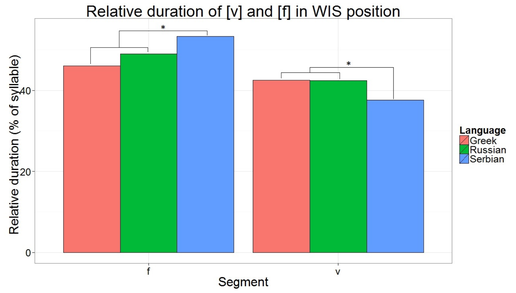


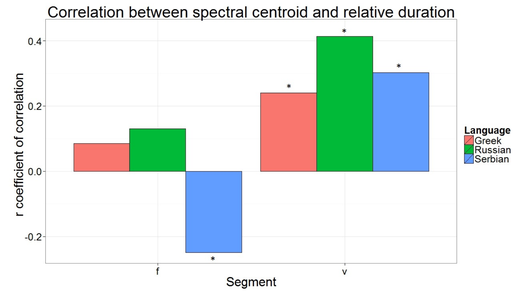
One-way ANOVAs were performed on the relativized centroid values calculated for /v/ and /z/ for each environment separately; significant differences in mean centroid as shown by post-hoc Tukey tests are indicated with an asterisk.

	/v/		/z/	
	F	p	F	p
WIS	37.48	6.72E-15	5.073	7.23E-03
WIU	5.919	3.75E-03	2.335	9.99E-02
WMS	0.391	5.33E-01	0.776	3.80E-01
WMU	7.501	7.20E-04	0.702	4.04E-01

Correlation of 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 /f/ and /v/.
- 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 × language) showed main effects of both segment [F = 187.676 p = 2e-16] 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 ($<$ 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 [ʋ].

	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]	[ʋ]	[ʊ]

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.

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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