

Vowel Reduction in Russian: The Categorical and the Gradient

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I. Introduction

- Phonological vowel reduction hereafter VR : neutralization of vowel quality contrasts in unstressed syllables.
- Figures in recent theoretical literature e.g. Barnes , Beckman , Crosswhite , Flemming oo a and b, Steriade as an example of a pattern of Positional Neutralization with relatively clear phonetic underpinnings.
- Understanding the relationship between these phonetic underpinnings and the phonological grammar in patterns such as VR is a central task of current work on the phonetics phonology interface.

2. Russian Vowel Reduction

. . Facts

- Contemporary Standard Russian: traditionally claimed to display two distinct patterns or degrees of VR, one for the syllable immediately preceding the tonic here, first pretonic , and one for all other unstressed syllables.
- Five vowels contrast in stressed syllables .
- Mid vowels do not surface in unstressed syllables.

Stressed vowel inventory	□	1 pretonic □	□	pretonic, posttonic □
i		i		i
e				ə
o				
a		a		
u		u		u

- Focus of this talk: /a/ vs. /o/
- /a/ and /o/ contrast in stressed syllables, but this contrast is neutralized in unstressed syllables as follows:

- a. /a/, /o/ □ [a]/[ɐ] in first pretonic syllables, a.k.a. Degree reduction
- b. /a/, /o/ □ [ə] in other unstressed syllables, a.k.a. Degree reduction

¹ See Padgett 2001 and sources therein for arguments against a contrast between /i/ and the high central vowel /i/.

VR in Contemporary Standard Russian

	STRESSED		DEGREE	REDUCTION	DEGREE	REDUCTION
/o/	mólədəstʲ	youth	malódʲmʲkʲij	young (dim.)	məladóʲ	young
	bólʲ	pain	balʲétʲ	to hurt	bəlʲivóʲ	pain (adj.)
/a/	stárij	old (adj.)	starʲik	old man	stərʲmá	old times
	rázum	reason	razúmnə	wisely (adv.)	rəzumʲétʲ	to understand

- Several exceptions to the pattern described above are recognized:

No reduction to schwa in absolute word initial position

/odno'mu/	[adna'mu]	'one' dat.sg.	*[ədna'mu]
/obi'zajet/	[ab'i'zajit]	'insult, abuse' sg.	*[əb'i'zajit]

No reduction to schwa in hiatus before a

/odnoo'braznij/	> [adnaa'braznij]	'monotonous'	*[adnəa'braznij]
/sootno'senije/	> [saatna'senʲije]	'relationship'	*[səatna'senʲije]

No reduction to schwa in absolute phrase final syllables Matusевич : ,
Zlatoustova :

. . Previous approaches

- Two recent OT accounts:
 - a. Alderete : Faithfulness constraints parameterized to the head foot i.e. the stressed syllable and first pretonic rank higher than markedness constraints against a in unstressed syllables, which in turn outrank general Faithfulness constraints.
 - b. Crosswhite : vowels outside the head foot cannot bear moras, but a cannot be non-moraic, and so is realized as schwa.
- Both these approaches must present essentially diacritic solutions to the exceptional patterns described above.
- All previous accounts of VR in Russian treat both Degree and Degree reduction patterns as phonological, i.e. as changing phonological category membership through manipulation of distinctive feature specifications.

. . Phonetic underpinnings of phonological vowel reduction

- Phonological patterns such as elimination of mid vowels and raising of low vowels in unstressed syllables have been claimed to have their source in the reduction of phonetic vowel durations in unstressed syllables.

- Languages with phonological vowel reduction are almost invariably those languages with a stress accent strongly and reliably cued by a difference in vowel duration between stressed and unstressed syllables (Lehiste).
- Shortening of vowels in unstressed syllables leads to undershoot of more open target articulations of non high vowels. Raising of these creates a compressed vowel space in which contrasts are likely to be misperceived and to collapse over time (See Barnes & Flemming for discussion).
- This accounts for the typological generalization that in VR systems, vowel height contrasts are the first to go. When this happens, the vowels to go are almost invariably the mid and low vowels. High vowels stay put.

. One experiment, begetting another...

- Though phonological VR has clear phonetic roots diachronically in the shorter durations associated with unstressed syllables in VR languages, to what extent phonetic duration is active in triggering vowel reduction synchronically is still poorly understood.
- The following experiment was designed to investigate this question.

. . Methodology

- Experiment # was designed to determine what, if any, active role phonetic duration plays in the realization of vowel reduction in reduction.
- Test words: Russian trisyllables

stressed /a/	stressed /o/
pretonic /a/	pretonic /o/
pretonic /a/	pretonic /o/
- All target vowels were located in open syllables followed by unpalatalized voiced or voiceless stops and preceded by unpalatalized voiced stops, voiceless stops, or laterals.
- Tokens were embedded in frame sentences of the form *Mashka X skazala*, 'Mashka said X'. Each token appeared twice for a total of sentences.
- Sentences were randomized and arranged in blocks of .
- Subjects, one male from St. Petersburg, one female from Ufa, student age native speakers of Russian, were instructed to read through each block of sentences once slowly and then once again as quickly as possible to achieve maximum variation in vowel durations.
- Sessions were recorded directly to CD at a sampling rate of . KHz. Duration and LPC formant measurements were taken using Praat 4.1.11 speech analysis software (Copyright@1992-2003 by Paul Boersma and David Weenink).

. . Results

. . . Mean values for duration and F

Speaker		PRETONIC		PRETONIC
Duration		84 ms.		41 ms
F		553 Hz		462 Hz
Speaker 2		1 PRETONIC		2 PRETONIC
	STRESSED		/a, o/	/a, o/
	/a/	/o/		
Duration	86 ms.	73 ms	68 ms.	25 ms.
F1	722 Hz	466	726 Hz	492 Hz

- Neither speaker had any significant difference between unstressed /a/ and /o/ in any position. This contrast is completely neutralized.
- Speaker shows a mean F for pretonic /a, o/ dramatically lower than a typical value for stressed /a/. Reflects traditional transcription of the former as [a] e.g. Matusevič, Avanesov. Probably more like [ɐ], see Barnes, chapter, for details.
- For Speaker, no significant difference was found between F values for pretonic /a, o/ and stressed /a/.

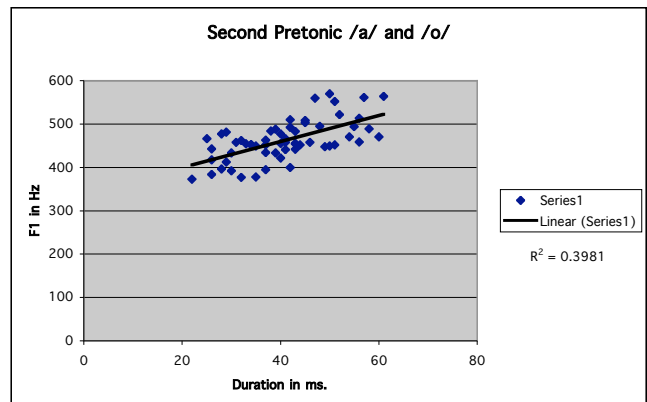
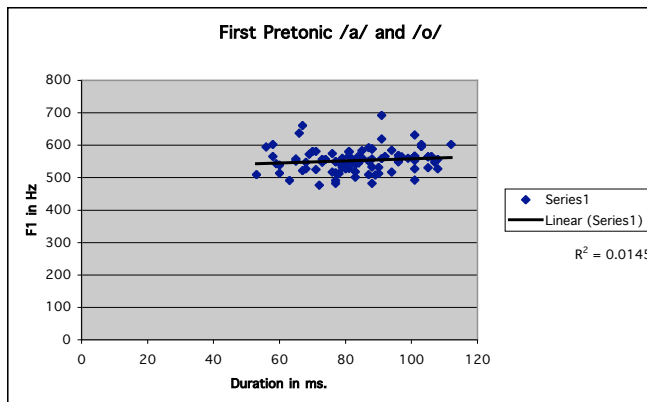
. . . Vowel height as a function of phonetic duration

- The following displays the results of linear regression analyses of the relationship between vowel duration and vowel height for Speakers and in Experiment.

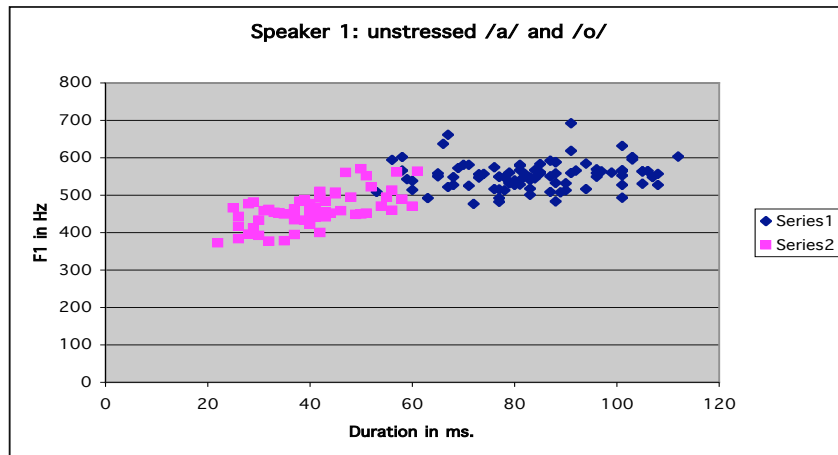
Speaker

a. $R(92) = .179, p > .05$

b. $R = . , p < .$



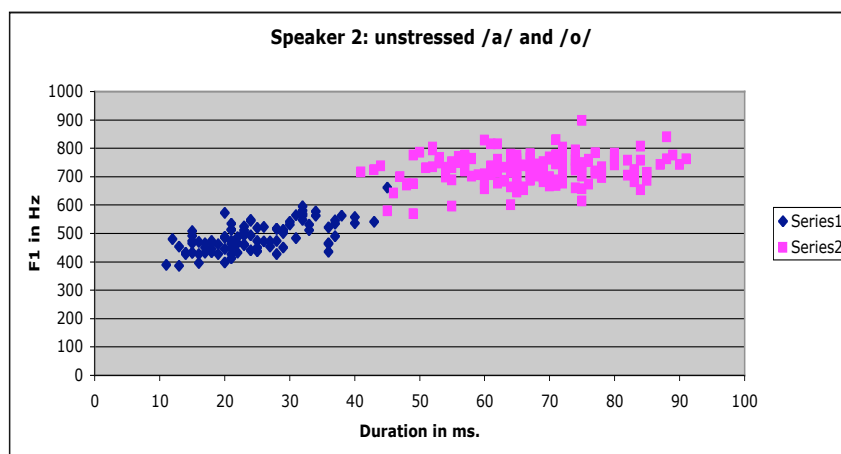
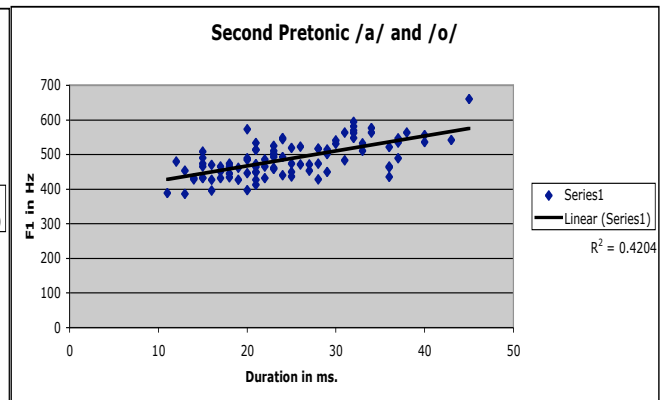
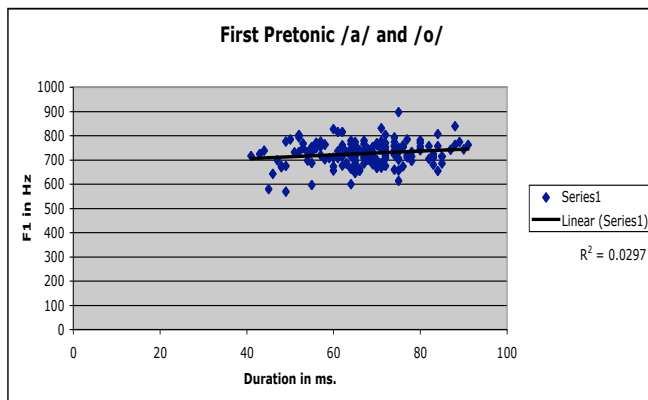
² Speaker 1 in fact read a somewhat earlier version of the same experiment containing fewer words and not testing vowels in stressed syllables.



Speaker

a. $R = .$, $p > .$

b. $R = .$, $p < .$



. Interim summary

- Neutralization of /a/ and /o/ in unstressed syllables is categorical. No significant difference between these underlying categories is preserved. This is true regardless of position relative to stress.
- Reduction to schwa in Degree reduction environments has a clear gradient character. Vowel height is strongly dependent on vowel duration. A cline of F values is recorded between more a like values on longer vowels and more schwa like values on shorter vowels.
- Categorical vs. gradient application is argued to be a defining distinction between symbolic phonological processes and quantitative phonetic processes see e.g. Keating c, Cohn , Zsiga , Myers , Barnes , *inter alia*
- Hypothesis: given the duration dependent cline of F values produced in Degree reduction contexts, there is no reason to think the phonology has any role in or access to reduction of unstressed /a, o/ to schwa. The merger of /a/ and /o/ in unstressed syllables, on the other hand, is clearly categorical and phonological.

. Experiment # : Hyperarticulation

- F values for Degree reduction in Experiment approach, but fail to clearly attain canonical a like qualities. Experiment seeks to draw out this result more clearly.

. . Methodology

- Test words were trisyllables of Russian, with /a/, and with /o/ in open second pretonic syllables. All target vowels were located in open syllables followed by unpalatalized voiced or voiceless stops and preceded by unpalatalized voiced stops, voiceless stops, or laterals.
- Target words were framed in sentences of the form *Po moemu on X skazal*, 'Seems to me he said X'.
- Speakers were four student age native speakers of Russian: three females raised in Ufa, Saint Petersburg, and Moscow respectively, and one male, from Moscow.
- Sentences were embedded in a longer list of similar sentences and randomized.
- Following an experimental paradigm used in, e.g. Johnson, Flemming and Wright , subjects read each sentence, and then were asked twice to repeat themselves by an experimenter simulating incomprehension speakers were informed this would occur before the experiment began :

Sample dialogue

Sp: *Po moemu on X skazal.* 'Seems to me he said X'
JB: *Ab? Ne ponjal.* 'Huh? I didn't get that.'
Sp: *X on skazal!* 'He said X!'
JB: *Što eto on skazal??!* 'He said what??!'
Sp: *X!*

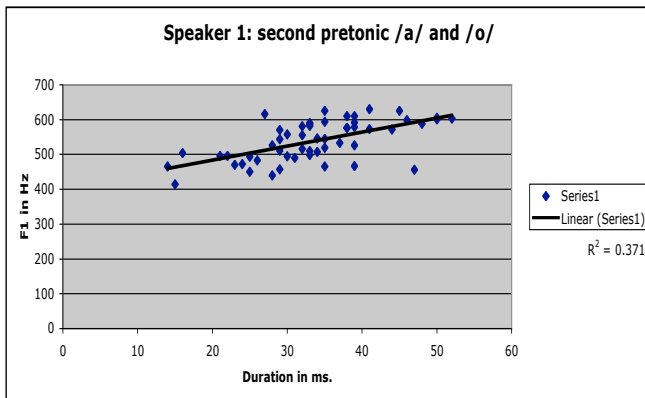
- Each word received three repetitions, the second and third with substantial hyperarticulation.
- All speakers reported finding this experimental methodology deeply exasperating.
- Sessions were recorded directly to CD at a sampling rate of . . . KHz. Duration and LPC formant measurements were taken using Praat 4.1.11 speech analysis software (Copyright@1992-2003 by Paul Boersma and David Weenink).

. . Results

Vowel height as a function of phonetic duration

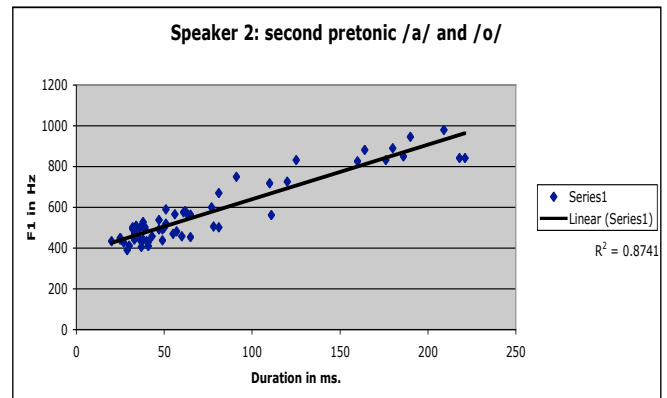
Speaker

R = . . . , p < .



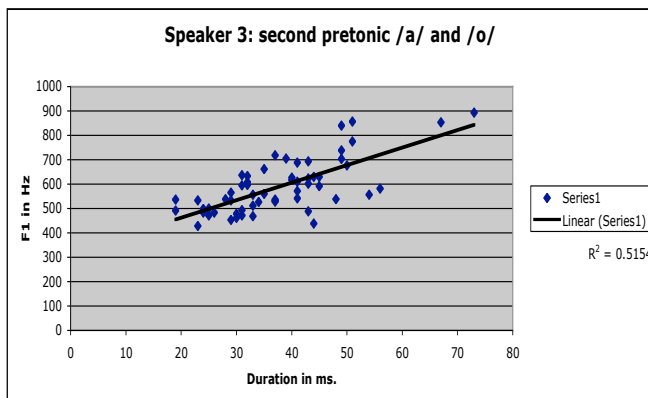
Speaker

R = . . . , p < .



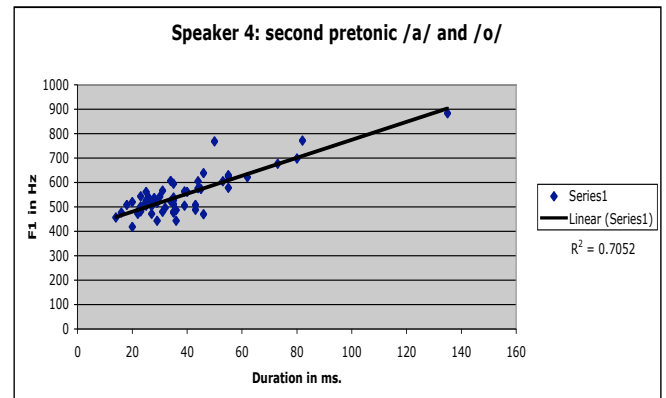
c. Speaker

R = . . . , p < .

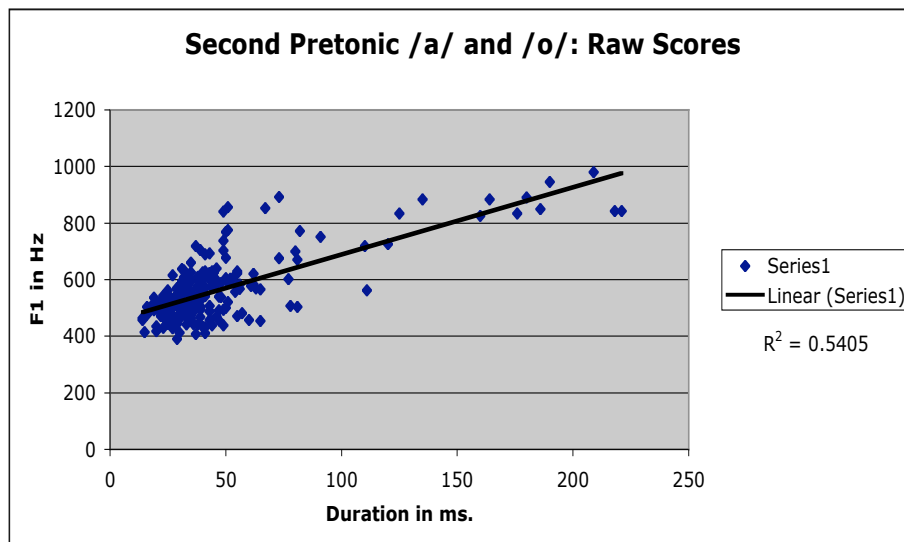


d. Speaker

R = . . . , p < .

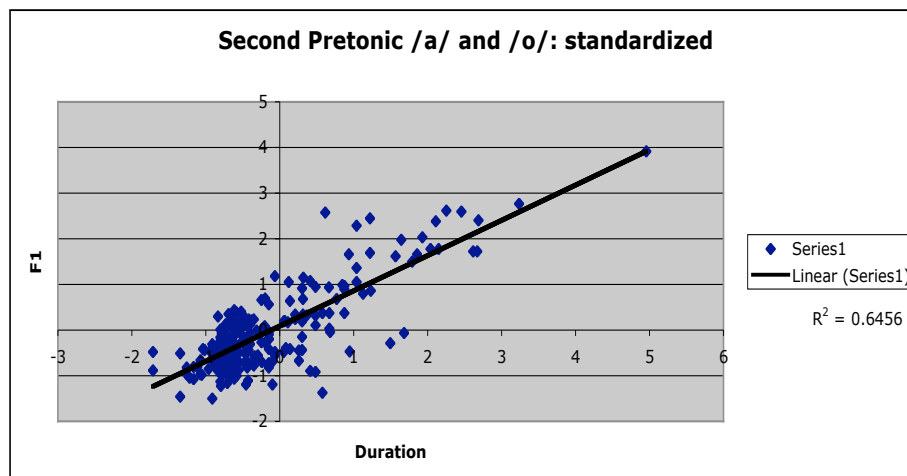


All speakers, raw scores: $r(228) = .737, p < .0001$



- To escape problems of interspeaker comparison of vowel formant values, raw duration and F₁ values for all speakers were converted to a standardized z score format, yielding the following results:

All speakers, z scores: $R = .737, p < .0001$



.. Discussion

- All speakers show a highly significant correlation between vowel duration and vowel height. Reduction of /a, o/ to ə applies gradually, with syllables afforded sufficient duration by hyperarticulation showing little or no vowel raising.

³ $z_x = (x - \bar{x}) / \sigma_x$, where \bar{x} is the mean for a given set of values, and σ_x the standard deviation.

- *Crucially*, no amount of lengthening is sufficient to restore an underlying /o/ in an unstressed syllable. The neutralization of /a/ and /o/ in unstressed syllables is categorical and phonological, displaying no sensitivity whatsoever to phonetic duration.
- Were the non application of reduction to schwa in clear speech in any sense a paralinguistic effect, e.g. a spelling pronunciation, we would expect restoration of /o/ in unstressed syllables as well. This never occurs.

. Conclusions

- There are indeed two types of vowel reduction in Russian.
- Only one is accomplished in the phonology. The other is a gradient process accomplished by the phonetics. /ə/ is not a phonological category in Russian.
- This conclusion simplifies Russian phonology greatly, while requiring nothing of the phonetics other than the capacity to implement fine grained durational patterns conditioned by prosodic structure, a capacity it must have under any circumstances.
- Additional payoff: the seemingly arbitrary exceptions to Degree reduction detailed in above now make perfect sense. Absolute word initial position, hiatus before another a , and absolute phrase final position are all environments in which additional phonetic duration is likely to be present. Duration dependent phonetic reduction to schwa does not then apply.
- Any model of the phonetics phonology interface must be equipped to handle not only the distinction between categorical and gradient processes, but also the complete lack of sensitivity of categorical processes to their phonetic environments.

REFERENCES

- Alderete, John. . Faithfulness to prosodic heads. Unpublished manuscript. Rutgers Optimality Archive #
- Avanesov, R. I. . *Russkoe Literaturnoe Proiznoshenie*. Moscow: Prosveshchenie.
- Barnes, Jonathan. . The role of duration in the positional neutralization of vowel contrasts. Paper presented at the Annual Meeting of the LSA, Washington, D.C.
- Barnes, Jonathan. . *Positional Neutralization: a phonologization approach to typological patterns*. Ph.D. dissertation, University of California, Berkeley.
- Beckman, Jill N. . *Positional Faithfulness*. Doctoral dissertation, University of Massachusetts, Amherst.
- Byrd, Dani. . A phase window framework for articulatory timing. *Phonology* :
- Cohn, Abigail. . *Phonetic and phonological rules of nasalization*, Ph.D. dissertation, UCLA.
- Crosswhite, Katherine. . *Vowel reduction in Optimality Theory*. New York & London: Routledge.
- de Jong, Kenneth. . The supraglottal articulation of prominence in English: linguistic stress as hyperarticulation. *Journal of the Acoustical Society of America* :
- Flemming, Edward S. . a. Vowel reduction and duration dependent undershoot. Paper presented at the Conference on the Phonetics Phonology Interface, ZAS, Berlin. October , .

- Flemming, Edward S. b. Scalar and categorical phenomena in a unified model of phonetics and phonology. *Phonology* :
- Flemming, Edward S. To appear. Contrast and perceptual distinctiveness. *The phonetic bases of markedness*, ed. by B. Hayes, R. Kirchner and D. Steriade. Cambridge: Cambridge University Press.
- Johnson, K., E. Flemming, and R. Wright The hyperspace effect: Phonetic targets are hyperarticulated, *Language* , .
- Keating, Patricia. a. Underspecification in phonetics. *Phonology* , : .
- Keating, Patricia. b. The phonology phonetics interface. *Linguistics: The Cambridge Survey, Volume I: Grammatical Theory*, ed. by F. Newmeyer, . Cambridge: Cambridge University Press.
- Keating, Patricia A. a. The window model of coarticulation: articulatory evidence. *Papers in laboratory phonology I: Between the grammar and physics of speech*, ed. by John Kingston and Mary E. Beckman, . Cambridge: Cambridge University Press.
- Keating, Patricia A. b. Phonetic representations in a generative grammar. *Journal of Phonetics* : .
- Keating, Patricia. . The phonology phonetics interface. *Interfaces in Phonology*, ed. by U. Kleinhenz, . *Studia grammatica* , Berlin: Akademie Verlag.
- Kiparsky, Valentin. . *Russian Historical Grammar*. Ann Arbor: Ardis.
- Kirchner, Robert. . *An effort based approach to consonant lenition*. Ph.D. Dissertation, University of California, Los Angeles.
- Lindblom, Björn. . Spectrographic study of vowel reduction. *Journal of the Acoustical Society of America* , : .
- Matusevič, M. I. . *Sovremennyj Russkij Jazyk: Fonetika*. Moscow: Prosveshchenie.
- Myers, Scott. . Boundary disputes: the distinction between phonetic and phonological sound patterns. *Phonological Knowledge: Conceptual and Empirical Issues*, ed. by Burton Roberts, Noel, Philip Carr and Gerard Docherty, . Oxford: Oxford University Press.
- Nord, L. . Vowel reduction Centralization or contextual assimilation? *Proceedings of the Speech Communication Seminar, Stockholm. Aug. , ,* . ed. by G. Fant, pp. , Stockholm: Almqvist & Wiksell.
- Nord, Lennart. . Acoustic studies of vowel reduction in Swedish. *Proceedings of the Eleventh International Congress of Phonetic Sciences, August , , Tallinn, Estonia, USSR. Volume , pp. . Tallinn: Academy of Sciences of the Estonian S.S.R.*
- Ohala, John J. . The listener as a source of sound change. *Papers from the parasession on language and behavior, Chicago Linguistic Society*, ed. by Carrie S. Masek, Roberta A. Hendrick and Mary Frances Miller, . Chicago: CLS.
- Padgett, Jaye. . Contrast dispersion and Russian palatalization. In Elizabeth Hume and Keith Johnson, eds., *The role of speech perception in phonology*, pp. , Academic Press: San Diego, CA.
- Padgett, Jaye and Marija Tabain. . Adaptive dispersion theory and phonological vowel reduction in Russian, Ms.
- Shcherba, L. V. . *Russkie glasnye v kachestvennom i kolichestvennom otnoshenii*. Sankt Peterburg.
- Shevelov, George Y. . *A prehistory of Slavic. The historical phonology of Common Slavic*. Heidelberg: Carl Winter Universitätsverlag.
- Steriade, Donca. . Positional neutralization and the expression of contrast. Ms., UCLA
- Zlatoustova, L. V. . *Foneticheskie Edinitsy Russkoj Rechi*. Moscow: Izdatel'stvo Moskovskogo Universiteta.
- Zlatoustova, L. V. . *Foneticheskaia Struktura Slova v Potoke Rechi*. Kazan': Izdatel'stvo Kazanskogo Universiteta.
- Zsiga, Elizabeth Cook. . *Features, gestures, and the temporal aspects of phonological organization*. Ph.D. dissertation, Yale University.