Initial-Syllable Prominence:
What is it and where does it come from?

Jonathan Barnes
Boston University

1. Background

1.1.   Positional Neutralization (Steriade 1994)

- Certain positions, often termed '*strong*' or 'prominent', license the realization of more contrasts than remaining positions, termed '*weak*'.

EXAMPLE: Laryngeal feature contrasts involving e.g. voice, aspiration, and glottalization, are realized in syllable onsets, but neutralized in codas (Steriade 1997)

- Positional Neutralization (PN) is a central proving ground for theories of the phonetics-phonology interface.

1.2.   PN in the Grammar: Three Approaches

(1)   **Positional Faithfulness and Positional Markedness** (Alderete 1995, Beckman 1996, 1998, Crosswhite 2001, Zoll 1997, *inter alia*)

- Phonological strength results from Faithfulness or Markedness constraints parametrized to refer to specific positions.

a	Ident[hi]/σ@	>>	*MidV	>>	Ident[hi]
b	*MidV/unstressed σ	>>	Ident[hi]	>>	*Mid

- BLIND FAITH: In principle, any feature or marked structure may be paired with any strong or weak position to derive attested patterns.

(2)   **Licensing-by-Cue and Direct Phonetics** (Steriade 1997 *et seq.,* Flemming 1995, 1997, 2001, to appear, Kirchner 1998, Zhang 2001)

- Phonetic cues, not arbitrarily listed positions, license the realization of contrasts

EXAMPLE: Vowel contrasts are licensed in stressed syllables not by stressedness per se, but by the additional duration accorded vowels realized there. Durational pressures in unstressed syllables force neutralization.

PAYOFF: The utterly overwhelming majority of systems of Unstressed Vowel Reduction target only contrasts of vowel height, precisely those most susceptible to pressure from decreased duration (see Barnes 2002 for details).

- Predicts necessary co-presence of PN patterns and phonetic patterns giving rise to them.

- Must assign "unnatural" or synchronically arbitrary patterns a radically separate grammatical implementation.

(3)   **Neo-Grounded Phonology** (Smith 2002)

- Schema/Filter model of CON: position-specific markedness and faithfulness constraints freely constructed from constraint schemas (IDENT, ALIGN, C/*str*) and arguments. Results submitted to "substantive filters" which remove phonetically- or psycholinguistically-problematic constraints from consideration:

- 'Including constraint filters in the model allows domains external to the formal phonology, such as articulation, perception, and processing, to impose substantive considerations that have a fundamental impact on the contents of the universal constraint set CON, while the constraints themselves remain formal objects, formally constructed' (Smith 2002: 13).

2. Agenda

- This study focuses exclusively on PN patterns involving word-initial syllables.

- While the propensity for initial syllables to function as strong licensers of contrast is widely acknowledged, the reasons for this positional prominence are less than clear. Most recent treatments appeal to the importance of initial material in lexical retrieval and processing.

- Re-examination of the typology of initial-syllable PN patterns in order to determine a.) the source of those patterns and b.) what the typology lets us conclude concerning synchronic treatments of PN in the grammar.

3. Initial Position

- Initial in what? Often ambiguous. Beckman 1998 uses the root-initial syllable. Smith 2002 chooses the morphological word.

3.1. In What Sense are Initial Syllables "Prominent"?

- Beckman 1998 divides the list of "strong positions" into the phonetically prominent and the psycholinguistically prominent. Initial syllables deemed psycholinguistically prominent.

- Smith 2002 follows Beckman on initial syllables, with two important predictions:

  1. Psycholinguistically strong positions favor realization of all contrasts to assist lexical access. All contrasts equally relevant. Phonetics plays no role in determining potential constraint inventories.

  2. Segmental Contrast Condition: Positional Augmentation constraints (neutralizing certain contrasts to increase perceptual salience, e.g. mandating heavy nuclei in stressed syllables) only occur if they facilitate segmentation of the speech stream (e.g provide cues for word boundaries).

- Faithful realization of marked structures in word-initial syllables. Certain neutralizations targeting word-edge material (e.g. increasing sonority rise from word-initial C to V) may occur.

3.2. The Phonetics of Initial Position

- **Initial Strengthening**: Prosodic domain initial consonants in a wide variety of languages undergo a process of strengthening relative to their non-initial counterparts (Cho and Jun 2000, Byrd 2000, Cho and Keating 1999, Keating, Cho, Fougeron and Hsu 1999, Dilley, Shattuck-Hufnagel and Ostendorf 1996, Fougeron and Keating 1996, inter alia Byrd 2000, Dilley, Shattuck-Hufnagel and Ostendorf 1996, Fougeron and Keating 1996, Oller 1973).

- Both magnitude and duration of gestures increased initially. Both laryngeal and supralaryngeal gestures are targeted.

- Strengthening is cumulative, affecting segments initial in higher prosodic domains (Utterance, Intonational or Phonological phrase) more dramatically than initial segments in lower domains (Phonological Word).

- Byrd 2000 and Fougeron and Keating 1996: strengthening of domain-initial consonants *and* vowels in English. No effect on σ–1 vowels following onset consonants. Similar findings for French and English by Fougeron 1999 and Turk and Shattuck-Hufnagel 2000.

- Cho and Jun 2000 identify two potentially co-present patterns of initial strengthening:

  > *Syntagmatic contrast* is enhanced by processes increasing the "consonantality" (by e.g . decreasing the sonority)of initial consonants, sharpening the contrast between them and following vowels.

  > *Paradigmatic contrast* is enhanced by processes essentially hyperarticulating characteristic features of initial consonants or vowels (eg. increased glottal airflow and VOT on Korean lenis and aspirated stops, decreased glottal airflow and VOT for fortis stops).

4. Typology of Initial Syllable PN

4.1. Absolute Initial Segments

4.1.1. Word-Initial Consonants

(1)   Word-initial consonants often realize more contrasts than do consonants elsewhere in the word.

EXAMPLES: Doyayo, Shilluk, and !Xóō (cited in Beckman 1998). Kukuya (Hyman 1989, Paulian 1974)

- Predicted?

Ψ: √   Positional Faithfulness expresses psycholinguistic imperative to realize contrasts in σ–1.

Φ: √   Phonetic initial strengthening of paradigmatic contrast.

(2)   Word-initial consonants often undergo sonority-reducing neutralization processes.

EXAMPLES: Smith 2002 cites Mongolian, Mbabaram, and Campidanian Sardinian as requiring low sonority onsets, and Arapaho and Guhang Ifugao as banning word-initial onsetless syllables. Cross-linguistically common initial glottal stop epenthesis fits here.

PREDICTED?

Ψ: √   Segmental Contrast Condition releases initial C from Positional Faithfulness to facilitate segmentation of speech stream.

Φ: √   Phonetic initial strengthening of syntagmatic contrast.

4.1.2. Word-Initial Vowels

(3)   Absolute word-initial vowels express contrasts neutralized elsewhere, often resisting reduction processes.

EXAMPLES:

*   Casali 1997 cites evidence of preferential preservation of word-initial vowels (over word-final vowels) in hiatus contexts in a variety of languages.

*   Nawuri (Casali 1995, Kirchner 1998) initial vowels resist rounding harmony.

*   Russian absolute initial [a] resists duration-dependent reduction to [ə] which otherwise should apply.

*   'Rough breathing' available only on word-initial vowels in Greek (Steriade 1995).

PREDICTED?

Ψ: √   Positional Faithfulness expresses psycholinguistic imperative to realize contrasts in σ−1.

Φ: √   Phonetic initial strengthening of paradigmatic contrast. Absolute initial vowels often longer than word-internal counterparts (see ref's above for English and French, also Balasubramian 1981 on Tamil).

(4)   Initial vowels can undergo neutralizations not affecting word-internal vowels.

EXAMPLES:

*   Luganda five-vowel [i, e, a, o, u] inventory reduced to three vowels [e, o, a] morpheme-initially (Hubbard 1994). Contrast btwn. long and short vowels neutralized word-initially.

*   Runyambo dialects lower /i, u/ to [e, o] phrase-initially (Larry Hyman, p.c.).

PREDICTED?

Ψ: ?   Does this help segment the speech stream?

Φ: √(?)   Additional duration in initial position potentially cues lower vowels, obscures length contrast.

4.2. Initial Syllable Vowels: A Closer Look

- Vowels in word-initial syllables famously license more contrasts than vowels in non-initial syllables. Routinely cited examples come from the harmony systems of Finno-Ugric, Mongolic, Turkic, Tungusic and Benue-Congo languages. Dravidian and Yokuts examples are mentioned here as well.

PREDICTED?

Ψ: √   Positional Faithfulness expresses psycholinguistic imperative to realize contrasts in σ–1.

Φ: No (💣☀?)   Where tested, initial strengthening seems not to target non-absolute-initial vowels. But see Barnes 2001, 2002, and below for new evidence from Turkish.

- Here the psycholinguistic hypothesis makes a strong prediction which the phonetic hypothesis fails to match. Initial strengthening of word-internal vowels is at best less dramatic and less widespread than strengthening of absolute initial vowels.

- But is this a problem for the phonetic approach?

4.2.1. Confound #1: σ–1 = σ́

- Numbers of independent cases of initial-syllable vowels as strong licensers of contrast drop dramatically when we exclude from consideration languages in which the initial syllable is also the stressed syllable!

(5)   Finno-Ugric Languages (Smith 2002, Beckman 1998, Steriade 1994, *inter alia)*:

- Proto-Finno-Ugric reconstructs with initial stress and a form of σ–1 controlled palatal harmony (Sammallahti 1988, Abondolo 1998). Most daughter languages continue initial stress.

(6) Altaic Languages ((Smith 2002, Beckman 1998, Steriade 1994 *inter alia*):

- Proto-Altaic, to the extent that we wish to reconstruct it at all, reconstructs with initial stress and some form of σ–1 controlled harmony (Poppe 1960).

- Proto-Mongolic and Proto-Tungusic clearly reconstruct with initial stress and some form of initial-syllable PN. Most scholars reconstruct the same for Proto-Turkic (Johanson 1998). Here the evidence is spotty.

(7)   Dravidian Languages

- Tamil: mid vowels and round vowels in initial syllables only (Beckman 1998, Christdas 1988). Dhangar Kurux (Beckman 1998, Gordon 1976): quantity and nasalization contrasts in initial syllables only.

- Proto-Dravidian is reconstructed with initial stress (and exclusively monosyllabic roots) (Zvelebil 1970). Massive syncope and reduction of non-initial-syllable vowels in many daughter languages

- Most daughter languages (including Tamil) continue to show initial stress or some obvious derivative thereof.

4.2.1. Confound #2: σ–1 = [ROOT]

(8) Benue-Congo Examples:

- Tiv (Pulleyblank 1988, Steriade 1994): [high], [low] and [round] contrast only in σ–1 (of verbs). All verb roots are monosyllabic (etymologically, though synchronically perhaps not segmentably – Hyman, p.c.).

- Gokana (Hyman 1982, Steriade 1994): [nasal] contrasts only in σ–1 (of verbs). All verb roots are monosyllabic.

- Bantu: Contrastive mid-vowels only in σ–1 of the verb stem. Reconstructs to Proto-Bantu. In nouns, pattern implemented to varying degrees in various daughter languages. All verb roots are monosyllabic.

(9) Yokuts (Newman 1944, Kuroda 1967, Archangeli 1985, Steriade 1994):

- In Yowlumne, [round] is contrastive only in word-initial syllables. Elsewhere it is predictable.

- Exceptionless in verbs. No Yowlumne verb root has more than a single vowel specified underlyingly. Most verb roots are monosyllabic. Disyllabic roots have identical vowels underlyingly.

- 'Most, but not all, underived nouns have a single vowel quality. Polyvocalic nouns are rare, and those with a [+round] final vowel are rarer still' (Archangeli 1985: 351).

- Kuroda 1967 counts 20 nouns with [-round] followed by [+round] in Newman 1944. 12 more have a round vowel followed by an unround vowel of the same height.

THE PROBLEM: In each parade example of the initial syllable functioning as a strong position, that same initial syllable is (or was at the time the pattern arose) also equally an example of another classicly defined strong position: stressed syllable or root. Unconfounded, unambiguous examples of pure initial-syllable strong licensing are surprisingly hard to come by.

4.2.3. A Troubling Typological Gap

- Positional prominence often exempts relevant segments from other PN processes, such as unstressed vowel reduction or harmony (Recall the Nawuri and Russian patterns for vowels in absolute word-initial position).

- Barnes 2002 documents a robust cross-linguistic tendency for phrase- or word-final vowels (and in rare cases all final syllable vowels) to resist unstressed vowel reduction or assimilation processes.

- Unstressed vowel reduction systems systematically exempting all initial syllable vowels are entirely unattested:

RUSSIAN: /otoʃól/ → [ataʃól], *[ətaʃól]   but   /podoʃól/ → [pədaʃól], *[padaʃól]
          'He walked away'   'He approached'

PREDICTED?

Ψ: 💣   Positional Faithfulness expresses psycholinguistic imperative to realize contrasts in σ−1.

Φ: No.   Initial strengthening targets primarily domain-initial segments.

4.3. Initial Syllable Codas

- Initial syllable codas licensing more contrasts (or more structural complexity) than word-internal codas are virtually unattested.

- A single example: South Dravidian. Tamil (Beckman 1998, Christdas 1988) and Malayalam (Beckman 1998, Wiltshire 1992) both license independent place specifications in some initial syllable codas, but nowhere else in the word.

PROBLEM: Tamil has word-initial stress. Dravidian reconstructs with word-initial stress.

- Christdas 1988 (186) notes that in Tamil under emphatic stress, initial syllable codas undergo phonetic lengthening:

      raattiri na**l**.lɜ maɽɜ   'It rained heavily last night'
      night   good rain

PREDICTED?

Ψ: 💣   Positional Faithfulness expresses psycholinguistic imperative to realize contrasts in σ−1.

Φ: No.   Initial strengthening targets primarily domain-initial segments.

4.4. Does Initial Syllable Prominence Exist At All?

4.4.1. Gujurati

- Gujurati initial syllables license a contrast between breathy and plain vowels, and low and high mid vowels. These contrasts are neutralized elsewhere in the word.

- Gujurati stress?

1   Cardona (1965): a close derivative of the Classical Sanskrit pattern (i.e. not fixed initial)

2   Pandit (1958): all syllables have "even stress" except those which are "post-junctural". Initial syllables after juncture are carry a stronger stress than others (216).

- Evidence for a durational asymmetry (Pandit 1961):

Stage 1   [e, o] and [ɛ, ɔ] originally allophonic variants in initial syllables (syllable
                 structure and segmental context determining)

Stage 2   Monophthongization: [aj, aw] become [ɛ, ɔ] in initial syllables, [e, o]
                 elsewhere. Distribution no longer predictable.

- Lower, presumably longer realization of diphthongs in initial syllables suggests additional
  duration of initial-syllable vowels. Positional Faithfulness cannot be invoked.

QUESTION: What is this additional duration?

4.4.2. Turkish

- Barnes 2001 demonstrates a small-scale (± 10 ms) durational asymmetry between vowels
  of Turkish initial and non-initial syllables *where stress is not a factor*. Attributes this to a
  language-specific instantiation of initial strengthening.

- Provides account of how an asymmetry of this order might produce increased resistance
  to vowel-to-vowel coarticulation, and ultimately be integral to the rise of palatal
  harmony in Turkic.

- Assuming this pattern to exist outside Turkic at all, its small magnitude and comparative
  rarity would ensure relatively infrequent phonologization as initial-syllable PN.

5. Some Conclusions

5.1. Why (and how) are initial syllables prominent?

- Closer analysis of the typology of PN in initial syllables radically reshapes its profile. All
  genuine initial-syllable PN effects are explicable on the phonetically-driven account.

- The psycholinguistically-driven account of initial-syllable PN predicts equal attestation
  well-attested patterns and numerous patterns which are spottily attested, if at all.

- This conclusion IN NOWISE calls into question the importance of word-initial material in
  speech-processing. What it does question is the relevance of that importance to the
  typology of PN.

- If our question is why are phonological PN patterns the way they are in a given position,
  our answer must be that the phonetics of that position cause them to develop that way.
  Another equally valid but distinct question might be why the phonetics are that way in
  the first place.

5.2. Implications for Synchronic Analysis

- The typology of initial-syllable PN is best accounted for by the phonetic characteristics
  of domain-initial material.

- Must the phonetic (or psycholinguistic) grounding of a PN be built into its implementation in synchronic grammar? Both Direct Phonetics and Neo-Grounded Phonology approaches say yes.

- Another possibility: phonological patterns such as PN are "natural" or phonetically-driven to the extent that they represent the outcome of the (diachronic) phonologization of phonetic patterns. Sound change is phonetically natural because it is phonetically-driven (Ohala *passim)*.

- The typology of initial syllable PN thus arises from, but should not synchronically beholden to, the phonetics of initiality:

5.3. Cases To Ponder

CASE #1. Initial-syllables of Tiv verbs license more vocalic contrasts than non-initial syllables because they are also etymologically all monosyllabic verb roots. Synchronically, however, this morphemic analysis is not obvious (Larry Hyman, p.c.). Synchronically polysyllabic, unanalyzable roots are common enough.

QUESTION: Is initial-syllable PN undermined in Tiv by the fact that its functionally-grounded origins are synchronically opaque?

CASE #2. Initial-syllable PN in Tungusic may be attributed to the fixed initial stress that is reconstructed for Proto-Tungusic, and still present in many daughter languages. While most Tungusic languages still exhibit some form of initial-syllable PN, however, many of them no longer exhibit initial stress (Li 1996: 20-21)

QUESTION: Should the implementation or transmission of Tungusic PN patterns be altered by this shift in phonetic prominences?

CASE #3. Initial syllables are phonetically prominent in Modern Turkish, but palatal vowel harmony is no longer dependent on the initial syllable. The rightmost vowel in the base of affixation (root or suffix) determines the frontness/backness of alternating suffix vowels.

katil 'murderer'   ->   katil-ler 'murderers'

gitmek 'to go'   ->   gid-iyor-um 'I am going'

QUESTION: Why would Turkish speakers abandon a phonetically-grounded pattern of vowel harmony for one with no phonetic basis?

CONCLUSION: It is enough for speakers to know *that* their languages contain a given phonological pattern. They need not also know *why*.

References

Alderete, John. 1995. Faithfulness to prosodic heads. Ms. Rutgers Optimality Archive #94-0000.

Andronov, M. 1975. Observations on accent in Tamil. *Dravidian Phonological Systems*, ed. by Harold F. Schiffman and Carol M. Eastman, 3-10. The Institute for Comparative and Foreign Area Studies, University of Washington, Seattle.

Archangeli, Diana and Douglas Pulleyblank. 1994. *Grounded Phonology*. Cambridge, MA: MIT Press.

Balasubramanian, T. 1980. Timing in Tamil. *Journal of Phonetics* 8(4): 449-457.

Balasubramanian, T. 1981. Duration of vowels in Tamil. *Journal of Phonetics* 9(2): 151-161.

Beckman, Jill N. 1998. *Positional Faithfulness*. Doctoral dissertation, University of Massachusetts, Amherst.

Blevins, Juliette and Andrew Garrett. 1998. The origins of consonant-vowel metathesis. *Language* 74: 508-555.

Blevins, Juliette. *Evolutionary Phonology*. Ms., University of California, Berkeley.

Byrd, Dani. 2000. Articulatory vowel lengthening and coordination at phrasal junctures. *Phonetica* 57: 3-16.

Cardona, George. 1965. *A Gujarati reference grammar*. Philadelphia: University of Pennsylvania Press.

Casali, Roderic. 1995. Labial opacity and roundness harmony in Nawuri. *Natural Language and Linguistic Theory* 13: 649-663.

Casali, Roderic. 1997. Vowel elision in hiatus contexts: which vowel goes? *Language* 73: 493-533.

Cohn, Abigail. 1990. *Phonetic and phonological rules of nasalization,* Ph.D. dissertation, UCLA.

Cho, Taehong. 2000. Effects of morpheme boundaries on intergestural timing: Evidence from Korean. *UCLA Working Papers in Phonetics* 99: 71-108.

Cho, Taehong and Sun-Ah Jun (2000). Domain-initial strengthening as enhancement of laryngeal features: aerodynamic evidence from Korean. *UCLA Working Papers in Phonetics* 99: 57-79.

Cho, Taehong and Patricia Keating. 1999. Articulatory and acoustic studies of domain-initial strengthening in Korean. *UCLA Working Papers in Phonetics* 97: 100-138.

Crosswhite, Katherine. 2001. *Vowel reduction in Optimality Theory*. New York & London: Routledge.

Csató, Éva Á. and Lars Johanson. 1998. Turkish. *The Turkic Languages.* ed. by Lars Johanson and Éva Á. Csató, 203-235. London: Routledge.

Dilley, L., Shattuck-Huffnagel S., and M. Ostendorf. 1996. Glottalization of word-initial vowels as a function of prosodic structure. *Journal of Phonetics* 24: 423-444.

Emeneau, M. B. 1961. *Kolami: a Dravidian Language*. Publications in linguistics 2. Annamalainagar: Annamalai University.

Emeneau, M. B. 1984. *Toda Grammar and Texts*. Memoirs of the American Philosophical Society, v. 155. Philadelphia: American Philosophical Society.

Fischer-Jørgensen, Eli. 1967. Phonetic analysis of breathy vowels in Gujarati. *Indian Linguistics* 28, 71-139.

Flemming, Edward S. 1995. *Auditory Representations in Phonology*. Ph.D. dissertation, University of California, Los Angeles.

Flemming, Edward. 1997. Phonetic detail in phonology: Towards a unified account of assimilation and coarticulation. K. Suzuki and D. Elzinga (eds.), *Proceedings of the 1995 Southwestern Workshop in Optimality Theory (SWOT)*, University of Arizona.

Flemming, Edward S. 2001. Vowel reduction and duration-dependent undershoot. Paper presented at the Conference on the Phonetics-Phonology Interface, ZAS, Berlin. October 12, 2001.

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.

Fougeron, Cécile. 1999. Prosodically conditioned articulatory variations: A review. *UCLA Working Papers in Phonetics* 97: 1-73.

Fougeron, Cécile and Patricia A. Keating. 1996. Articulatory strengthening in prosodic domain-initial position. *UCLA Working Papers in Phonetics* 92: 61-87.

Gordon, Kent H. 1976. *Phonology of Dhangar-Kurux*. Summer Institute of Linguistics, Institute of Nepal and Asian Studies. Kathmandu: Tribhuvan University Press.

Hyman, Larry M. 1976. Phonologization. *Linguistic studies offered to Joseph Greenberg on the occasion of his sixtieth birthday*, ed. by Alphonse Juilland, 107-118. Saratoga: Anma Libri.

Hyman, Larry M. 1982. The representation of nasality in Gokana. *The structure of phonological representations (part I)*. ed. by Harry van der Hulst and Norval Smith, 111-130. Dordrecht: Foris.

Hyman, Larry M. 1987. Prosodic domains in Kukuya. *Natural Language and Linguistic Theory* 5: 311-333.

Hyman, Larry M. 1998. Positional prominence and the 'prosodic trough' in Yaka. *Phonology* 15(1): 41-75.

Hyman, Larry M. 1999. The historical interpretation of vowel harmony in Bantu. *Recent advances in Bantu historical linguistics,* ed. by Jean-Marie Hombert and Larry M. Hyman, 235-295. Stanford: C.S.L.I.

Inkelas, Sharon, Jonathan Barnes, Jeffrey Good, Darya Kavitskaya, Orhan Orgun, Ronald Sprouse, and Alan Yu. 2001. Stress and vowel-to-vowel coarticulation in Turkish. Paper presented at the annual meeting of the LSA, Washington D.C., January 2001.

Johanson, Lars. 1998. The history of Turkic. *The Turkic Languages.* ed. by Lars Johanson and Éva Á. Csató. 81-125. London: Routledge.

Keating, Patricia, Taehong Cho, Cecile Fougeron, Chai-Shune Hsu. 1999. Domain-initial strengthening in four languages. *University of California Working Papers in Phonetics*, 97: 139-151.

Kirchner, Robert. 1998. *An effort-based appoach to consonant lenition*. Ph.D. Dissertation, University of California, Los Angeles.

Konrot, A. K. 1981. Physical correlates of linguistic stress in Turkish. *University of Essex Language Centre Occasional Papers* 24: 26-53.

Li, Bing. 1996. *Tungusic vowel harmony: description and analysis*. HIL Dissertation 18. Den Haag: Holland Academic Graphics.

Lindblom, Björn. 1963. Spectrographic study of vowel reduction. *Journal of the Acoustical Society of America* 35, 11: 1773-1781.

Majors, Tivoli Jane. 1998. *Stress dependent harmony: phonetic origins and phonological analysis*. Ph.D. dissertation, University of Texas at Austin.

Mistry, P. J. 1997. Gujarati. *Phonologies of Asia and Africa 2*, ed. by Alan S. Kaye, 653-673. Winona Lake: Eisenbrauns.

Nord, L. 1975. Vowel reduction - Centralization or contextual assimilation? *Proceedings of the Speech Communication Seminar, Stockholm. Aug. 1-3, 1974*. ed. by G. Fant, pp. 149-154, Stockholm: Almqvist & Wiksell.

Nord, Lennart. 1987. Acoustic studies of vowel reduction in Swedish. *Proceedings of the Eleventh International Congress of Phonetic Sciences, August 1-7, 1987, Tallinn, Estonia, USSR. Volume 4,* pp. 157-160. Tallinn: Academy of Sciences of the Estonian S.S.R.

Ohala, John J. 1981. 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, 178-203. Chicago: CLS.

Ohala, John J. 1994. Towards a universal, phonetically-based, theory of vowel harmony. *Proceedings of ICSLP 94, Yokohama*. 491-94.

Pandit, P. B. 1955. e and o in Gujarati. *Indian Linguistics* 15: 15-44.

Pandit, P. B. 1958. Duration, syllable and juncture in Gujarati. *Indian Linguistics: Turner Jubilee Volume I,* 212-218.

Pandit, P. B. 1961. Historical phonology of Gujarati vowels. *Language* 37, 1: 54-66.

Poppe, Nikolaus. 1960. *Vergleichende Grammatik der Altaischen Sprachen*, *Teil 1, Vergleichende Lautlehre*. Wiesbaden: Otto Harrassowitz.

Pulleyblank, Douglas. 1988. Underspecification, the feature hierarchy and Tiv vowels. *Phonology* 5: 299-326.

Róna-Tas, András, 1998. The reconstruction of Proto-Turkic and the genetic question. *The Turkic Languages*. ed. by Lars Johanson and Éva Á. Csató, 67-80. London: Routledge.

Sammallahti, Pekka. 1988. Historical phonology of the Uralic languages, with special reference to Samoyed, Ugric, and Permic. *The Uralic Languages. Description, History and Foreign Influences*, ed. by Denis Sinor, 478-554. Leiden: E. J. Brill.

Smith, Jennifer. 2002. *Phonological augmentation in prominent positions*. Ph.D. dissertation, University of Massachusetts, Amherst.

Steriade, Donca. 1994. Positional neutralization and the expression of contrast. Ms., UCLA.

Steriade, Donca. 1995. Underspecification and markedness. *The handbook of phonological theory*, ed. by John A. Goldsmith, pp. 114-174. Oxford: Blackwell.

Steriade, Donca. 1997. Phonetics in phonology: the case of laryngeal neutralization. Ms., UCLA.

Steriade, Donca. 2001. Directional asymmetries in place assimilation. *The role of speech perception in phonology*, ed. by Elizabeth Hume and Keith Johnson, 219-250. San Diego: Academic Press.

Turk, Alice E. and Stefanie Shattuck-Hufnagel. 2000. Word-boundary-related duration patterns in English. *Journal of Phonetics* 28: 397-440.

Zhang, Jie. 2001. *The effects of duration and sonority on contour tone distribution - typological survey and formal analysis*. Ph.D. dissertation, UCLA.

Zoll, Cheryl. 1998. Positional Asymmetries and Licensing. Rutgers Optimality Archive #282-0998.

Zvelebil, Kamil. 1970. *Comparative Dravidian Phonology*. The Hague: Mouton.