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THE ANALYSIS OF EXTREME VOWEL REDUCTION*

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In this paper, I examine systems of vowel reduction that employ two "levels" of reduction: moderate and extreme. Phonetically, the occurrence of extreme reduction seems to be linked to (non-phonemic) duration, and typically causes reduction in vowel sonority. Moderate reduction, on the other hand, can cause increases as well as decreases in vowel sonority. Based on this type of observation, I hypothesize that two-pattern vowel reduction systems utilize two distinct forms of reduction. That is, extreme reduction and moderate reduction are distinct phenomena, not "stronger" and 'weaker" versions of a single process.

1. VOWEL REDUCTION: BACKGROUND

The term "vowel reduction" has been used in phonology to refer to a range of different phenomena, ranging from gradient changes in the quality of unstressed vowels to wholesale deletion of unstressed vowels. The definition of vowel reduction that will be used in this paper is somewhere between these two extremes. The definition I use is provided below:

(1) Vowel Reduction: The neutralization of two (or more) phonemic vowels when unstressed.

Most languages with vowel reduction phenomena possess only a simple type of reduction. There are others, however, that have a type of system I call two-pattern or compound vowel reduction. In this type of language, some unstressed syllables display moderate reduction, while others have more extreme reduction. The vowel reduction system seen in some Italian dialects (Maiden 1995) is an example of two-pattern reduction. In these dialects, pretonic unstressed vowels *except /a/* reduce to schwa, whereas post-tonically, all vowels (including /a/) reduce to schwa. The stressed vowel does not reduce. My focus in this paper will be two-pattern reduction systems, and how to account for the difference between moderate and extreme reduction. My hypothesis, based on examination of a number of two-pattern systems, is that two-pattern vowel reduction is a compound process: these languages possess two different processes of vowel reduction, which target slightly different subsets of unstressed vowels. This approach contrasts with another logically possible approach, in which moderate and extreme vowel reduction are analyzed as the results of a single process—a process which has a "freer hand" in some unstressed syllables (producing extreme reduction), but is under some sort of

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limitation in the remaining unstressed syllables (producing moderate reduction) (cf. Alderete 1995). After laying out the data concerning extreme reduction and my analysis for these facts, this alternative analysis will be considered and ultimately rejected.

2. VOWEL REDUCTION PARADOXES

The two-pattern vowel reduction system found in Southern Italian (Maiden 1995) described above is a rather simple form of two-pattern reduction. However, there are other, more complex types of two-pattern vowel reduction systems. Most importantly, some of these systems provide us with vowel reduction paradoxes. A vowel reduction paradox is a system where the neutralizations observed in moderate and extreme reduction are opposite in their action—for example, moderate reduction might require vowel lowering, while extreme reduction requires vowel raising. Since solving this type of vowel reduction paradox is useful in unraveling the nature of extreme vowel reduction in general, let's take a look at a concrete example of a vowel reduction paradox from dialectal Russian.

In many Russian dialects, the domain for moderate reduction is the immediately pretonic syllable. In other unstressed syllables, extreme reduction occurs. Consider the example forms provided below.

(2) Example of a vowel reduction paradox: South Russian dialects[1]

Comparison form:	[rétʃʲ] 'flow, speech'
In the immediately pretonic σ, /e/ *lowers*:	S. Russ. [rʲatʃnój] 'of rivers'
In other unstressed σ's, /e/ *raises*:	S. Russ. [rʲitʃʲavój] 'of speech'

As shown in (2), there's a kind of "reversal"—in moderate reduction, an unstressed mid vowel undergoes reduction via *lowering*, as in [rʲatʃnój]. In extreme reduction, however, there's *raising* of unstressed mid vowels—as in [rʲitʃʲavój]. (The comparison form [rétʃʲ] is provided to demonstrate the underlying quality of the vowel.) So, the difference here between raising and lowering of unstressed vowels in these dialects depends on the syllable the vowel is in—moderate reduction (i.e., lowering) occurs in the immediately pretonic syllable, and extreme reduction (i.e., raising) occurs in the other unstressed syllables. As previously mentioned, there are two possible approaches to this type of situation: Either extreme and moderate vowel reduction are two sides of the same coin (i.e., a single vowel reduction process that is more constrained in the contexts where moderate reduction occurs), or moderate and extreme reduction are independent processes. The existence of vowel reduction paradoxes provides the first piece of

[1] The type of dialect illustrated is traditionally referred to as displaying "jakan'e".

evidence in favor of the latter approach: since some two-pattern vowel reduction phenomena produce opposite types of neutralization, it is doubtful that this is a unitary phenomenon. A second and related piece of evidence comes from considering a typology of vowel reduction.

3. TYPOLOGY OF VOWEL REDUCTION

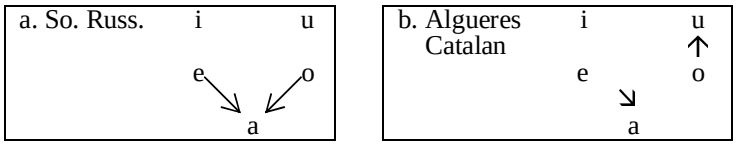
A survey of over 40 different vowel reduction patterns (Crosswhite, *in progress*) suggests for independent reasons that there are fundamentally two different types of vowel reduction phenomena: a type of reduction that improves vowel contrastivity, and a type of reduction that increases articulatory ease. These are referred to, respectively, as contrast-enhancement and prominence-reduction. By identifying contrast-enhancement with moderate reduction, and prominence-reduction with extreme reduction, a number of vowel reduction paradoxes can be solved.[2]

The general characteristics for contrast-enhancing vowel reduction are listed in (3)

(3) Contrast-Enhancing (Moderate) Vowel Reduction
- Obliterates fine-grained vowel contrasts
- Leaves a vowel sub-inventory with fewer and grosser contrasts
- Usually exploits the periphery of the vowel space
- Can occur in syllable-timed languages, unstressed syllables with "normal" duration (i.e., not ultra-short syllables)

Some examples of languages that have this type of reduction are exemplified in (4):

(4) Some examples of Contrast Enhancement:



The first example, Southern Russian, is an example where moderate reduction occurs as part of a two-pattern reduction system (as we've

[2] For convenience, I will discuss two-pattern reduction systems as though "moderate" reduction always equates with contrast-ehancement and "extreme" reduction always equates with prominence-reduction. Although this seems indeed seems to be the case for the two-pattern systems I have investigated, the formal mechanisms I suggest also predict that a single language could have two *distinct* forms of prominence-reduction or two *distinct* forms of contrast-enhancement. These types of systems, if they occurred, would not be problematic for this approach to vowel reduction, since they would necessarily apply in a set/subset relation.

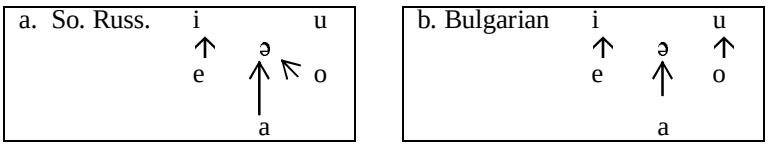
already seen). The second example—Algueres Catalan—is a language that lacks extreme reduction and has only moderate reduction. As you can see from these two examples, the actual neutralizations that enact the reduction can vary, but similar vowel sub-inventories result from both processes. (I should note that Algueres Catalan is actually a 7-vowel language. The additional two mid vowels (lax) reduce the same way the tense ones shown above.) These two patterns are not the only possibilities: there are many other attested patterns for contrast-enhancing vowel reduction.

Prominence-reduction (extreme vowel reduction) has a different set of characteristics. They are listed in (5).

(5) Prominence-Reducing ("Extreme") Vowel Reduction
- Associated with durationally impoverished syllables (ultra-short syllables)
- Sonorous vowels are avoided: they are incompatible with extreme shortness
- The resulting vowel sub-inventories exploit the low-sonority end of the vowel space

Some examples of languages with this type of reduction are given in (6). Again, the first example is from a language where extreme reduction co-occurs with moderate reduction in the same language. The second example, Bulgarian, is a language where extreme vowel reduction occurs in isolation. It should be emphasized that these are not the only two patterns of prominence-reduction that exist: there are many other attested patterns.

(6) Examples of Prominence-reducing ("Extreme") Reduction



To account for the existence of these two types of vowel reduction, I hypothesize that there are (at least) two different types of Optimality-Theoretic constraints that motivate vowel reductions. As a brief overview, I describe these constraint sets in informal terms below. These constraints will be discussed in more detail in later sections.

Moderate reduction (contrast-enhancement) is governed by perceptually based constraints: perceptually challenging vowels (esp. those in the center of the vowel space) are eliminated, except in the most favorable locations. Following recent research on perception in phonology (cf. Steriade 1994a, 1994b; Zoll 1998, Majors 1998) I will use a series of Licensing constraints to account for moderate vowel reductions. The basic idea here is this: Stressed positions are

perceptually favorable, since they provide additional vowel duration and loudness. Unstressed positions are perceptually detrimental, since they cause a vowel to shorten, become more quiet, and possibly undergo other insults (deletion, devoicing, etc.). Therefore, perceptually challenging vowel qualities are prohibited by Licensing constraints from occurring in perceptually detrimental unstressed syllables.

Extreme Reduction is governed by a group of articulatorily-based constraints: long-duration vowels (i.e. high sonority vowels) are eliminated in positions of extreme shortness. The formal statement of this constraint family relies on the idea of prominence alignment (Prince and Smolensky 1993), which states that prominence and sonority should co-occur, while non-prominence and non-sonority should also co-occur. The basic idea of prominence reducing vowel neutralizations is this: Sonorous vowels are inherently longer and louder (Lehiste 1970), while unstressed syllables are marked by brevity and decreased amplitude. The combination of diametrically opposed sonorous vowels and unstressed syllables is avoided due to Prominence-reduction constraints.

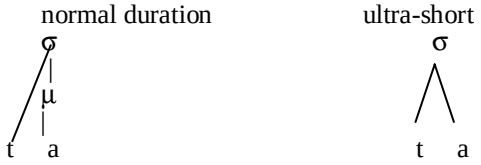
The only question remaining is this: How can a Licensing constraint and a Prominence-reduction constraint both occur in the same language, yet target different subsets of unstressed vowels? If both types of constraints target syllables that lack a stress, we would expect one or the other to win out in all unstressed syllables. However, what we actually observe is a partitioned application: Licensing constraints cause neutralizations in some unstressed syllables, while prominence-reduction causes neutralizations in others.

The answer to this question is based on the observation that prominence-reduction (extreme reduction) seems to be limited to those unstressed syllables that are marked by extreme brevity, while contrast-enhancement (moderate reduction) can occur in unstressed syllables with "normal duration", or in the unstressed syllables of syllable-timed languages (cf. standard Italian). However, the distribution of extra-short-syllables doesn't seem to be constant cross-linguistically. I've listed some of the possibilities in (7). These are all from languages with two-pattern vowel reduction systems.

(7) Extra-short syllables occur in different places in different languages:
- Russian: all unstressed syllables except the immediately pretonic one
- Brazilian Portuguese (Dukes 1993): Unstressed word-final and word-initial syllables
- Rhodope Bulgarian (Miletich 1936) and So. Italian (Maiden 1995): Post-tonic syllables

My conjecture is that these extra-short syllables are actually structurally nonmoraic. Some sample structures are shown in (8):

(8) Extra-short syllables as structurally nonmoraic



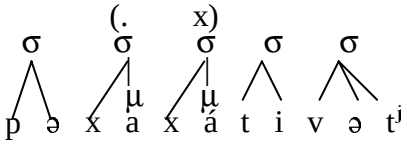
As will be discussed in the next section, this difference is almost certainly related to foot structure: Footed syllables are moraic; unfooted syllables are not.

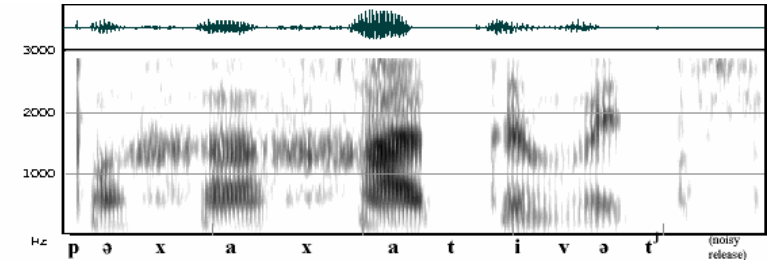
4. The Structure of the Russian Foot

Let's take a look at a sample case from Russian dialects. For most Southern and Central Russian dialects, the foot encompasses the pretonic and tonic syllables (i.e., it is structurally iambic). Under my analysis, outside of this foot, syllables must be nonmoraic.

It should be pointed out that it is reasonable to assume that the unfooted vowels of Russian are nonmoraic: they are very short (as previously mentioned), they are commonly elided in conversational speech, can undergo partial or complete devoicing, and are highly overlapped with surrounding consonants. For example, let's look at a sample word. The structural representation for the Russian word *poxaxatyvat'* ("to chuckle from time to time"), as well as an illustration of its actual pronunciation, are given in (9).

(9) Russian Foot Form





1st vowel [pə] = 44ms. 2nd vowel [xa] = 81 ms.
3rd vowel [xá] = 90 ms. 4th vowel [ti] = 48 ms.
5th vowel [vətʲ] = 48 ms.

You can see here that the stressed vowel and the immediately pretonic vowel are "normal" in their duration—they're about 90 and 81 milliseconds, respectively. The remaining three vowels are very short—all under 50 milliseconds apiece (and this is for an experimentally elicited word). For comparison, according to Chistovich (1976), a duration of approx. 40 ms. is necessary for *the presence* of a vowel to be perceived in a consonantal environment, while a duration of approximately 70 ms. is necessary for the perception of a vowel's quality. With this in mind, it is perhaps not surprising that the really short unstressed vowels of Russian are the ones that are subject to extreme reduction, and the longer unstressed ones are subject to moderate reduction. It should be emphasized that this result is not specific to this example (standard Russian). Researchers have shown that the presence vs. absence of two-pattern reduction in Russian dialects is linked to the durational profile just described (Vysotskii 1973, Al'mukhamedova and Kul'sharipova 1980, Kasatkina 1996, Kasatkina *et al.* 1996). Majors (1992) has also found similar results linking extreme reduction in Brazilian Portuguese to vowel duration. It should also be pointed out that simple prominence-reduction phenomena (i.e., not part of a two-pattern system) are typically found only in languages where duration is the primary cue for stress (cf. Bulgarian, European Portuguese).

5. ANALYSIS

As mentioned previously, moderate (or contrast-enhancing) vowel reduction will be accounted for using Licensing constraints. A sample licensing constraint, such as might be found in Southern Russian moderate vowel reduction, is provided below.

(10) Lic-Mid/Stress: Mid vowels cannot appear in unstressed syllables.

The use of this constraint is shown in the tableau provided in (11), where the So. Russian form /rʲetʃʲnój/ 'of rivers' is considered. Here,

the Licensing constraint has to outrank faithfulness constraints in order for vowel reduction to apply. Notably, it has to outrank a faithfulness constraint for [high] and [low]. In particular, note that the low rank of Max[-low] is what gives us reduction-via-lowering. If the constraint Max[-low] were ranked above Max[-high], the reduction-via-raising candidate would incorrectly be chosen as the winner.

(11) So. Russian Moderate Reduction

/rʲetʃʲnój/	LIC-MID/STRESS	MAX[-HIGH]	MAX[-LOW]
☞ rʲatʃʲnój			*
rʲitʃʲnój		*!	
rʲetʃʲnój	*!		

The analysis of So. Russian extreme reduction is a little more complex. Two constraints that will be necessary are given below:

(12) *Struc(μ): Output forms should have as few moras as possible.

(13) Foot-to-Mora: The terminals of a foot must be moraic.

These constraints should be ranked Foot-to-Mora » *Struc-μ in So. Russian in order to account for the moraic distribution described in previous sections (namely, footed syllables are moraic, unfooted syllables are not). That is, *Struc-μ militates towards avoiding moras altogether, while the higher-ranking constraint Foot-to-Mora constrains this tendency in footed syllables. These constraints will allow a prominence-reduction to correctly pick out only the *nonmoraic* vowels for extreme reduction. As I've mentioned before, extreme reduction favors low-sonority vowels, since they are inherently lower in duration. This can be formalized using a prominence-reduction constraint of the type provided below:

(14) Prominence-Reduction Constraints for Extreme Reduction:
*Nonmoraic/a » *Nonmoraic/e » *Nonmoraic/i » *Nonmoraic/ə

This type of constraint may be familiar from Prince and Smolensky's (1993) analysis of Berber syllabification. They used a similar constraint hierarchy to derive the idea that segmental prominence (or sonority) should line up with syllabic prominence (syllabicity). The constraints they use are shown in (15).

(15) Prominence Alignment Constraints
(Prince and Smolensky 1993)

Prominence Alignment
*Peak/t » *Peak/n » *Peak/a

Prominence Reduction
*Margin/a >> *Margin/e >> *Margin/i

So, whereas Prince and Smolensky's constraint *Margin/a means '*a* makes a lousy syllable margin', my constraint *Nonmoraic/a means '*a* makes a lousy nonmoraic vowel.

By ranking these constraints as shown in (16), the correct results are predicted. Here, the *Nonmoraic constraints rule out candidates with a nonmoraic low or mid vowel—these vowels are *too sonorous* to be nonmoraic. These means that we're left with the candidate that uses *raising* of the unstressed mid vowel, since raising an unstressed /e/ not only eliminates a mid vowel, but also lowers the sonority of the surface vowel. Recall that in tableau (11), a similar candidate had been ruled out Max[-low]. This faithfulness constraint is still violated here (see last column), but this violation is no longer relevant to choosing the optimal candidate.

(16) So. Russian Extreme Reduction

/rʲetʃʲovój/	*NON-MORAIC/ a	*NON-MORAIC/ e	LIC-MID/ STRESS	MAX [-HI]	MAX [-LO]
☞ rʲi (tʃʲavój) | | μ μ					*
rʲa (tʃʲavój) | | μ μ	*!			*!	
rʲe (tʃʲavój) | | μ μ		*!	*		

6. ALTERNATIVE ANALYSIS: FOOT-BASED POSITIONAL FAITHFULNESS

Now, let's look at a possible alternative analysis. As I mentioned before, a possible alternative rests on the idea the idea that vowel reduction might be "more limited" in certain unstressed syllables, and "freer to act out" in other unstressed syllables. Such an approach might use foot-based positional faithfulness. Indeed, Alderete (1995) takes this type of approach to the two-pattern vowel reduction system of standard Russian.

The main idea of positional faithfulness is that certain strong positions require more stringent faithfulness to the input. Such positions include prominent prosodic positions such as stressed syllables or footed syllables. This idea is enacted by position-specific faithfulness constraints. For example, the positional faithfulness constraint **Ident-[voice]-stress** would indicate that stressed syllables

must remain faithful to their underlying voicing specifications. This constraint would not apply to unstressed positions. The more general faithfulness constraint **Ident-[voice]** would apply to all syllables (stressed and unstressed), and might be ranked more lowly than the more specific constraint **Ident-[voice]-stress**.

The constraints that could be used in a positional-faithfulness analysis of So. Russian are listed in (17). It should be noted here that this type of analysis makes use of *context-free* markedness constraints. So, a constraint like *Mid says that mid vowels are bad *in all positions*. (This contrasts with the Licensing constraint Lic-mid used above, which only penalizes mid vowels *in unstressed positions*.) The last constraint listed is a foot-based positional faithfulness constraint. This constraint basically says that *footed* syllables need to be more faithful for [-high] than do unfooted syllables.

(17) Constraints used in the alternative analysis:
*Mid: Mid vowels are dispreferred EVERYWHERE (even under stress).
*Non-High: Non high vowels are dispreferred everywhere.
Ident-Ft(-high): Footed syllables must be faithful for [-high].

The tableau shown in (18) shows how this would work for moderate reduction. In this tableau, the *Mid constraint motivates the avoidance of mid vowels. However, the constraint Ident-Foot (-high) wants footed syllables to stay non-high if they were underlyingly nonhigh. The result is that reduction via lowering is the preferred option for reducing footed unstressed syllables.

(18) Alternative Analysis: Moderate Reduction

/rʲetʃʲnój/	*MID	IDENT-FT (-HIGH)	IDENT (-LOW)
☞ (rʲatʃʲnój)			*
(rʲitʃʲnój)		*!	
(rʲetʃʲnój)	*!		

Tableau (19) shows extreme reduction under the positional-faithfulness approach. Here, the foot-based positional faithfulness constraint is not relevant, since the unstressed syllable under consideration is not footed. (Note: only violations for the first syllable are shown in the tableau.) This means that the optimal candidate is chosen here by the next faithfulness constraint, which happens to be for [-low]. Result: reduction via raising wins.

(19) Alternative Analysis: Extreme Reduction

/rʲetʃʲovój/	*MID	IDENT-FT (-HIGH)	IDENT (-LOW)
☞ rʲi (tʃʲavój)			
rʲa (tʃʲavój)			*!
rʲe (tʃavój)	*!		

The problem with this analysis is that no link exists between the presence of reduction via raising and it's phonetic correlate of decreasing sonority. In other words, positional faithfulness generates the correct outputs, but leaves a significant generalization unexplained. For example, the exact *opposite* pattern can also be derived, simply by changing the features referred to in some of the constraints already discussed. This is shown in (20).

(20) Problem: This analysis also predicts the exact opposite pattern should be possible.

/rʲetʃʲnój/	***MID**	**IDENT-FT (-LOW)**	*** HIGH**
☞ (rʲitʃʲnój)			*
(rʲatʃʲnój)		*!	
(rʲetʃʲnój)	*!		

/rʲetʃʲovój/	***MID**	**IDENT-FT (-LOW)**	***HIGH**
☞ rʲa (tʃʲavój)			
rʲi (tʃʲavój)			*!
rʲe (tʃavój)	*!		

In these tableaux, the foot-based positional faithfulness constraint refers to [low] instead of [high], and the other (general) faithfulness constraint refers to [high] instead of [low]. The result is exactly what we don't want: a high vowel is used in the footed, longer-duration unstressed syllable, and a time-hogging low vowel is used in the unfooted, durationally impoverished, nonmoraic unstressed syllable. This result would be impossible under the prominence reduction approach. The reason for this is that the only constraint that is specific to the nonmoraic environment in the prominence reduction account always enforces moving to a low sonority vowel.

7. CONCLUSION

In conclusion, in this paper I've tried to show that extreme reduction is a phenomenon limited to durationally impoverished syllables, and that it motivates reduction-via-raising. This is phonetically reasonable, since low-sonority vowels are inherently shorter, and therefore more compatible with extra-short syllables. I've

also demonstrated that two different theoretical devices—prominence reduction and foot-based positional faithfulness—are both capable of accounting for the two-pattern alternations under consideration, but that only the prominence-reduction account explains the phonetic facts associated with extreme reduction, and that the positional faithfulness approach predicts unattested patterns. In particular, these unattested patterns run counter to the observed and highly reasonable pattern of preferring low-sonority vowels in conditions of extreme shortness.

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