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Positional Neutralization and the Expression of Contrast

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"In view of incessant misunderstandings, it is necessary to reemphasize that any distinctive feature exists only as a "term of relation." " (Jakobson 1962:446)

1. Introduction*

Phonologists recognize several kinds of relations between segmental and prosodic structure. On the one hand, prosody is *expressed* by segmental means: stress, for instance, manifests itself variously as high pitch, pitch contours, increased duration, intensity, gestural magnitude[1]. These manifestations of accentedness are segmental properties: features - including tonal ones - or attributes of features. On the other hand, features and segments are said to be *licensed by* their association to prosody: the main empirical claim here, advanced in earlier studies of syllable structure[2], is that only the segments belonging to some syllable are phonetically realized. Without its proper place in prosodic structure, the segment would vanish. Related to this idea is the hypothesis that certain prosodic positions, and only they, permit the realization of certain features[3]. This is based on the observation that marked feature values or feature combinations are cross-linguistically more likely to be realized in prosodically prominent positions, for instance under stress, initially, or in long vowels. The distribution of vowel contrasts in English, where they are fully attested only in syllables possessing some degree of stress, is an example of this type of licensing.

It is this last relation between features and prosodies that I consider here: the licensing of features by prosodic structure. What is there to investigate? It seems intuitively clear that a relational property like accent would need to express itself through the intermediary of features. Features denote noises, or properties of noises, and noises can be heard. But prosodic *relations* cannot be directly perceived: it then stands to reason that features must help render them manifest.

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[1] Beckman and Pierrehumbert 1986 Phon. Yearbook, Beckman and Edwards 1994 Labphon 3.

[2] Harris 1983, Steriade 1982, Ito 1986.

[3] Goldsmith 1990

It also seems clear that a string of segments will benefit from possessing some form of higher level organization: it is prosody that integrates a collection of unrelated segments into a lexical unit with a distinctive identity. Whether or not every segment belongs to some syllable, this consideration helps us understand why segments must bear some prosodic relation to the rest of the string. What is far from clear is why certain features prefer to be realized in certain positions: for instance, why should stress be needed for the manifestation of vocalic contrasts in English? This issue is addressed here.

1.1. Positional Neutralization

The point of departure of this study is a set of observations made in a preliminary survey of positional neutralization (Steriade 1994). Positional neutralization (PN) is the absence of segmental contrast in certain positions of the word. Some examples appear below, and many others are found in Trubetzkoy (1958(=1939))[4].

(1) Positional neutralization [**PN**]:

a. vowels do not contrast for nasality in the stressless syllables of Guarani (Kiparsky 1985 and refs. there) Copala Trique (Hollenbach 1977)

b. voiced, voiceless, aspirated, glottalized C's do not contrast in the coda of Maidu, Russian, Klamath (Lombardi 1992)

c. C's do not contrast for place features in the coda of Japanese, Diola (Ito 1986, 1989; Goldsmith 1990)

d. vowels do not contrast for rounding in non-initial syllables of Mongolian, Turkic, Yokuts (Steriade 1979, Kaun 1993)

PN is the converse of prosodic licensing: we may characterize the facts in (1.a) either by focusing on the contexts where nasalization contrasts are selectively licensed (under stress) or by focusing on the contexts where they are neutralized (in the absence of stress).

1.2. The argument previewed

There are two questions to ask about PN. First : what is the connection between the feature and the structure that licenses it? Why does stress license nasality in vowels (cf. (1.a)) and

[4]Trubetzkoy distinguished two types of neutralization. One was feature-induced neutralization i.e. neutralization caused by assimilation or dissimilation: his term for it was *contextual neutralization*. The other neutralization type, the one we're interested in here, is referred to as *strukturbedingte Aufhebung*, structure-conditioned suspension [of contrast] (1958=1939:206). I chose a different term, PN, but the facts discussed belong in the family of Trubetzkoy's structure-conditioned suspension.

not in consonants; why does the onset (or non-coda) position license place features in consonants, regardless of accent (cf. 1. b))? Second: does PN limit the occurrence of contrasts or the occurrence of the individual features through which the contrast is realized?

In abbreviated form, here are the answers I propose. The thing being licensed is the contrast, not the feature: it is not nasality that's disallowed in the stressless syllables of Guarani, but rather *distinctive* nasality, i.e. the contrast between nasal and oral vowels. And the licensing factor is not the prosodic structure per se but rather associated phonetic properties which facilitate the production and perception of the contrast. Thus extra duration, a correlate of stress, facilitates both the perception and the production of vocalic contrasts: we will see that all prosodic positions endowed with extra duration - including but not limited to stressed syllables - will selectively license such contrasts. Conversely, all positions where vocoids are shorter - including but not limited to the nuclei of stressless syllables - will tend to neutralize vowel quality contrasts. The relation between prosody (as a licenser) and features (as licensees) is mostly epiphenomenal.

How do we show this? I will point out that the generalizations about PN can be explained by reference to the *conditions under which feature contrasts can be perceived*. Thus, I will suggest that *the positions* of neutralization are precisely those where the relevant contrast would be difficult to perceive. So, to preview briefly, consonantal place is neutralized typically in coda because that's the position where consonants carry their weakest acoustic cues to place. Neutralization occurs in the coda then not because this is a difficult position to produce a velar, coronal or labial constriction in coda but because it's hard to tell which one was produced: it's the contrast that is hard to realize, not the individual gesture. Next, I will show that *the segments* most inclined to suffer from PN are those in which a particular contrast is harder to perceive or execute. Rounding, for instance, is positionally neutralized in non-high vowels before it is neutralized in high vowels, no doubt because lip pursing and the jaw lowering inherent in [-high] are, to a degree, antagonistic gestures. We get less rounding in [-high] vowels (Linker 1978, Kaun 1994), hence a greater likelihood that the relatively difficult contrast between round and unrounded [-high] vowels will be positionally neutralized. The overall picture then will be that PN affects contrasts that are, to begin with, harder to perceive or execute, in positions that further add to the initial difficulty. Finally, I will review a number of PN cases which simply cannot be descriptively characterized by means of filters on specific features: these are the cases where neutralization leads to free variation along a certain articulatory parameter rather than to a fixed feature value.

Throughout the discussion we will observe that there is no systematic connection between prosodic structure and the manifestation of contrasts. On the one hand, many featural contrasts are licensed in positions that have nothing to do with either the syllabic, the metrical or the grammatical organization of the utterance. We will consider these in some detail below. On the other hand, those licensing positions (such as *stressed syllable, onset, nucleus*) that do appear to involve the prosody turn out to be more truthfully characterized by direct reference to properties like duration, intensity, burst, C-V transitions. These, and only these, are the licensers of featural contrast: these are the properties that facilitate the manifestation of the contrast.

1. 3. A brief history of PN

It seems likely that Trubetzkoy, the first phonologist to characterize the PN phenomenon, believed that what disappears under all varieties of neutralization is the contrast, not the feature[5]. Thus, a Trubetzkoyan analysis of the place neutralization encountered in Japanese or Diola Fogny (the facts of which are summarized in (2)), would be to say that the place correlation is suspended in coda, not that the actual features [coronal], [dorsal], [labial] etc. are disallowed there.

(2) Japanese and Diola Fogny coda place neutralization (Steriade 1982, Ito 1986):

- possible clusters: coda C homorganic to following onset C:
  e.g. {pp, tt, kk, mp, nt, ŋk}
- disallowed clusters: heterorganic CC:
  e.g. {*pt, *mt, *tk, *nk, *kp, ŋp}
- word-final codas (Japanese): N (nasal C approximated against soft palate or uvula, "with tongue not quite touching the top of the mouth" (Martin 1954)

general pattern: place features in coda are present, but not contrastive.

(3) A Trubetzkoyan statement characterizing the pattern in (2)

[5] There is, nonetheless, some uncertainty on Trubetzkoy's exact views on this matter: he avoids in general the use of the term *distinctive feature* and substitutes, wherever possible, the term *opposition* . It is thus conceivable that, even if he had believed that PN eliminates the feature - not the contrast - he would have discussed the relevant phenomena using the same terminology. It is passages like the following (1958: x
) that shed some light on this matter: "in many languages one observes a preference for certain types of neutralization or for specific positions of neutralization. In certain phonological positions several contrasts are neutralized, whereas in other positions all contrasts are maintained. The result is that in one and the same language there exist positions *of maximal differenciation and positions of minimal differenciation among phonemes.* " (italics Trubetzkoy's; D.S.) Trubetzkoy emphasizes here what he views as the important consequence of neutralization: the loss of phonemic contrast ("minimal differentiation").

The opposition of place is suspended in coda[6].

The statement in (3) does not forbid any particular consonantal gesture in the codas of Japanese and Diola Fogny. Such gestures are possible codas provided they are non-distinctive as to place. The statement in (3) is transparently supported by the facts: in Japanese and Diola we *do* observe labial, coronal and dorsal codas, but these features occur non-contrastively in that position, since they are contextually predictable from the features of the following onset.

In the post-Trubetzkoyan generative tradition the unexamined assumption has been that PN represents a ban on individual feature values in certain positions. Consider again the case of place neutralization in coda. Typical of the modern analysis of this kind of fact is Ito's Coda Condition (Ito1986, 1989; cf. Ito and Mester 1993), which disallows all place features when occupying the coda. That means that the actual feature values [coronal], [dorsal], [labial] are unacceptable in coda, whether or not they generate a contrast there. The fact that they can in fact be present in surface codas, when they get there by assimilation, is viewed as stemming from the nature of the phonological derivation (as in (4.a)) or is attributed to the principles of inalterability (as in 4.b)) or licensing (as in (4.c)).

(4) <u>Three post-Trubetzkoyan analyses of the Japanese-Diola pattern of coda place neutralization</u>

a. Place features are ill-formed in the coda underlyingly, though not necesarily on the surface; alternatively, place features are eliminated by deletion or delinking in the coda, and this rule feeds regressive assimilation. (cf. Mascaró 1987, Cho 1990).

b. All place features are ill-formed in the coda, but violations of this constraint are not detected when the place features are multiply linked to onset and coda. (Ito 1986, 1989, building on Hayes's 1986 Linking Condition)

c. Place features in consonants are licensed only in the onset. Features must be licensed in some position but may associate to other positions as well, in this case the coda. (Goldsmith 1990)

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[6] The statement in (8) reflects the spirit but not the letter of Trubetzkoy's statements about neutralization: for obscure or invalid reasons, Trubetzkoy claims that only bilateral oppositions can be neutralized (p.81 of French edition). The opposition of {p, t, k} is not bilateral but multilateral and thus it could not be neutralized. I nonetheless use the example of place neutralization because it has received considerable attention more recently and because it can illustrate, with only minor modifications, Trubetzkoy's ideas.

Essential here is that all three analyses in (4) view PN as the relation between a feature or a class of features - not a contrast - and some position. But the particulars of these accounts must be noted too. Analyses along the lines of (4.a) sanction a homorganic cluster like **mp** by noting that the labial gesture in the coda can be attributed to assimilation and thus need not be underlyingly present. Central here then is the possible discrepancy between the degree of specification of the coda consonant at different derivational levels.

(4.b) is based on a static constraint - *Place-in-Coda - and asserts that only singly linked features can be successfully detected as violating it. Multiply linked features (e.g. the multiply linked Labial in **mp**) cannot be identified as violating any constraint, unless the latter explicitly mentions the possibility of multiple linking[7] . The view expressed in (4.b) can be disputed on the grounds that the desired interpretation of the Linking Constraint misgenerates in many other cases (cf. Ito and Mester 1993, Inkelas and Cho 1993, McCarthy 1994, Steriade 1994).

(4.c) states that all features must be licensed by some position and that only the onsets of Japanese or Diola license the place features of consonants. This analysis - based on ideas presented in Goldsmith (1990) - has been developed in recent work by Ito and Mester (1993) and it avoids both the derivational nature of (4.a)[8] and the technical problems associated with (4.b). For this reason, I will count it as the most promising instantiation of the view that PN represents a ban on features. The discussion below will refer to (4.c) only, but my objections to it carry over to the other two analyses reviewed above.

So far, we've seen that the major difference between approaches to PN revolves around the object of the ban: is it the feature or the contrast that's being suspended in cases of neutralization? But on the question of possible licensing factors, there has been general agreement: the feature - or the contrast - is licensed by a *prosodic structure* or *position*. The only noticeable differences on this point involve the range of positions that may serve as licensers. Thus Trubetzkoy's taxonomy of PN (1958:254) provides a list of neutralization sites which includes the word margins, the stressless syllables, the pre-tonic or post-tonic syllables. The recent work on licensing tends to focus on intrasyllabic positions like coda and onset (Ito 1986, Goldsmith 1990), to the exclusion of prominence or boundary-based sites. This is no doubt due to the view - expressed

[7] See Hayes's (1986) discussion of how this idea applies to rule statements and the critical comments in Schein and Steriade 1986.

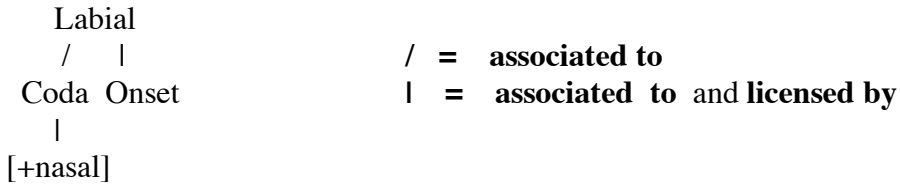
[8] Some of the arguments against derivational approaches to PN (such as (4.a)) and related patterns of specification appear in Stanley (1967), Mohanan (1991), Steriade (1994) and Broe (1993).

most clearly in Ito 1986 - that prosodic licensing patterns of the sort exemplified in (1) and (2) are a reflex of the way in which features can be prosodically incorporated: features link up to the syllable first, and relate to higher levels of prosodic structure only through the intermediary of the syllable.

1.4. Why Trubetzkoy was right.

I now outline a general objection to the idea that PN blocks the occurrence of features rather than the contrast among them. Consider (4.c) again as an account of PN in coda place features. This analysis of place neutralization must allow for the cases in which the place features of a coda consonant are linked to an onset segment, as in (5). To do so, we must distinguish between licensing from association: the analysis in (4.c) claims that the consonantal place features are associated to the coda in a geminate cluster but that they are not **licensed** there.

(5) Licensing as distinct from association in the homorganic cluster **mp** of Japanese and Diola:



For this to be meaningful we must understand what it means to say that *Position P licenses F*, in what sense this is an improvement over the descriptive statement *We find F to occur distinctively in P* and what are the relations between the phonological notion of licensing and the physical or cognitive realities of speech. The general principle proposed as subsuming (4.c) is that features may manifest themselves only to the extent that they are properly incorporated into prosodic structure: this idea underlies Ito's (1986) and Goldsmith's (1990) Prosodic Licensing. *Properly*, in this context, means that the level of attachment for any given unit (feature, segment or prosodic constituent) must obey a strict hierarchy, with features associating to segments, segments to syllables and so forth. But the empirical support for the principle of Prosodic Licensing varies greatly in strength, suggesting that very different phenomena are being illegitimately conflated under this name. Syllables frequently surface even when metrically unincorporated (Mester 1992, Hayes 1994). Although the evidence on this point is less clear, it appears segments too may surface when lacking syllabic affiliation (Bagemihl 1991, Cook 1994)[9].

[9] It should be noted here that the primary argument for the proposition that *All segments belong to some syllable* and its corollary principle of Stray Erasure - as formulated for instance in Steriade 1982: chapters. 3 and 4 - can probably be dismissed as circular. That argument consisted of two steps. The first was the proposition that some language, say Greek, observes a certain a syllable canon. The second step was to observe that segments are deleted whenever they cannot be incorporated into Greek syllables that respect the proposed canon. The conclusion drawn was that deletion is

Features are clearly able to associate directly to higher prosodic levels (Pierrehumbert and Beckman 1988; and earlier the Firthians: cf. Palmer 1970), with no obvious grammatical limits on the range of possible linkages between features and prosodic levels. In this context, a statement such as *All features must be licensed; and consonantal place features are only licensed in the onset* loses its original appeal: no general theory of licensing stands behind it.

The point that should emerge from these remarks is that without some understanding of the empirical content of the term *license*, we do not have an account of the facts of PN. The position advanced here is the proper interpretation of licensing statements such as *Position P licenses the a/b contrast* must be that *the perception or production of the a/b contrast is enhanced by a property available in position P*. PN is simply the limitation of contrasts to the positions where they can be identified (or produced as distinct) more reliably. We will see below that this proposition can be verified in detail. My general claim then is that the notion of positional licensing can be given some substance only if we focus on how contrasts - rather than individual feature values - are expressed. This is what argues for a return to the Prague School views on neutralization[10].

1.5. Outline

The remainder of this study is divided as follows. Section 2 characterizes some of the major PN types. Section 3 discusses the general properties of PN emerging from the survey and shows that that licensing and neutralization are caused by the need to limit featural contrasts to positions where they are clearly expressible. Section 4 discusses durational factors in the implementation of vocalic contrasts. Section 5 takes up the issue of formulating grammatical statements which express the generalizations established earlier.

2. A typology of PN

This section surveys distinctive contrasts which are selectively licensed in certain positions. They are classified in terms of the position where the contrast is permitted. All cases cited involve PN, in the sense that the relevant contrast is possible only in the positions listed. I am providing an

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the consequence of the syllabically stray status of these segments. But in fact the syllable canon, which reflects surface generalizations, cannot be established independently of the effect of these deletion processes which supposedly are motivated by it. It is not clear how one can distinguish between cause and effect in this situation. Alternative approaches to clustering restrictions, and hence cluster simplification, can be explored which do not rely on the idea of Stray Erasure: see Mattingly 1981.

[10] Trubetzkoy's writings on PN are exempted from the criticism sketched here only because Trubetzkoy's objectives - at least in the PN sections of *Grundzüge* - were clearly taxonomic rather than explanatory. No explanation is claimed and indeed none is offerred for the existence of neutralization.

extended list of PN types primarily in order to drive home the point that the familiar cases - such as coda place neutralization - belong in a much larger family and that individual cases of PN must be understood in this wider context.

The survey includes, without further explicit distinction, two patterns of PN which were discussed earlier (in Goldsmith 1990 and Steriade 1994) under the terms of *direct* (or *primary*) and *indirect (* or *secondary) licensing*. The difference between the two is the occurrence of assimilation in neutralized positions. Thus Copala Trique (Hollenbach 1977) allows nasal vowels only in the stressed syllable, while Guarani (Lunt 1969, Gregores and Suárez 1965) allows them in the stressed syllable and, under indirect licensing, in the stressless syllables onto which nasality has spread. Guarani thus allows an indirectly licensed [nasal]-plus-[vocoid] combination, but Trique does not: stress must directly license every nasal vowel in this language. We need not further concern ourselves with the distinction between direct and indirect licensing once *contrast* is the focus of discussion: for both Trique and Guarani disallow the contrast between oral and nasal vowels in stressless syllables. Nasality does occur in the stressless syllables of Guarani, but non-distinctively so. From the point of view of contrast distribution, the Guarani and Trique patterns are identical.

To simplify the exposition, I have not included in the PN survey segmental properties that are not strictly featural, such as length contrasts (e.g. the contrast between long and short vowels, typically neutralized in stressless syllables) and timing contrasts (e.g. the contrast between nasal contour segments and primary nasals, typically neutralized in coda, or that between level and contour tones). Some of these are surveyed by Trubetzkoy (1939). They are not irrelevant to the issues discussed here and will be brought up in future installments.

2. 1. Stress-related licensing effects

A recent survey and discussion of the role of stress in licensing featural contrasts appears in Flemming (1993), who inventories the effect of accent on vocalic and laryngeal contrasts, and suggests that segmental processes refer to metrical structure only in terms of licensing conditions such as *Feature F is licensed by association to a stressed (or main stressed) syllable*. The data presented below, culled primarily from Flemming (1993) and Kamprath (1988), is classified in terms of the featural distinctions being licensed.

2.1.1. Stress-related licensing of vowel features

For stress-related PN affecting vowel features, two distinctions must be made: that between corner vowels (a, i, u) vs. all others, and that between central or centralized vowels vs. peripheral ones. What happens to stressless vowels is a combination of three factors: undershoot, PN proper and the preference for corner vowels. The first of these is the tendency towards centralization, rooted in articulatory undershoot (Lindblom 1963), i.e. the shift from i to ɪ or ɨ, u to ʊ, e to ë or ə, and a to ɐ or ɜ. Various degrees of centralization could be distinguished, the most extreme of which is the shift from any vowel to schwa, the ultimate central vowel. But centralization does not automatically result in a loss of vocalic distinctions: intermediate degrees of it may indirectly lead to neutralization, only because they shrink the vocalic space within which the oppositions can manifest themselves. Thus a second factor, related to but in principle independent from centralization, is PN itself: the simplification of the system of vocalic contrasts in a context - here the stressless syllable - where such contrasts would be harder to express[11]. The necessary distinction between PN and centralization is illustrated by languages like Maidu (Shipley 1970), where stressless vowels are considerably centralized relative to their stressed counterparts but no neutralization takes place. The third factor involved in the process of stressless vowel reduction is the preference for maximally differentiated corner vowels: once PN eliminates a set of underlying contrasts from the stressless syllable, the remaining vocalic categories tend to be realized either as corner vowels (a, i, u) or as their centralized versions (ə, ɪ, ʊ). The corner vowels (including their centralized variants) are favored only to the extent that *some* vocalic contrasts persist in the stressless position: in languages like English, where vowel reduction eliminates all vocalic oppositions from the stressless syllable in favor of one vowel category, this category is realized, in the vast majority of cases, as schwa. This illustrates the point, made by Lindblom, that corner vowels are useful only as as the terms of some contrast, not because of some inherent advantage each one of them might possess.

An example illustrating the interplay between the three factors identified here is that of Chamorro vowel reduction (Topping 1968). The stressed vowel phonemes of Chamorro are {a, æ, e, o, i, u}; the stressless vowels are {ə, ɪ, ʊ}. The neutralization aspect of Chamorro vowel reduction is the loss of the high-mid opposition (i vs. e, o vs. u) and of the front-back opposition between a and æ. (Note that the front-back opposition is eliminated only in the pair a, æ where it lacks [round] enhancement (Stevens, Keyser and Kawasaki 1987), another illustration of the idea that PN affects the least discriminable pairs.) These mergers reduce a six-member

[11] See Lindblom 1975 for related remarks: Lindblom assumes that neutralization of vowel contrasts is triggered when the members of the centralized vowel inventory fall below a certain threshold of discriminability. The data surveyed here suggest that no such threshold can be established crosslinguistically, but that relative loss of discriminability is indeed the main factor in vocalic PN.

inventory to a three-member system. This is the PN aspect of Chamorro reduction. To understand the choice of vowel qualities in the reduced system, we may assume that stressless syllables possess a pre-shrunk vowel space. Within this space, the vowels {ɪ, ʊ} can be identified as the corner vowels; and, perhaps, so can ə, if this symbol stands for actual [ɐ]. Note that, on this account, vocalic undershoot plays two distinct roles in Chamorro: the *expectation* that stressless vowels will be realized with some undershoot causes PN, the loss of certain vocalic distinctions; and *actual undershoot* is the likely cause of the centralized realization of the corner vowels {a, i, u} as {ə, ɪ, ʊ}.

Further examples of vocalic neutralizations in stressless syllables appear below: As in the case of Chamorro, I suspect that the notation [ə] for a reduced vowel is frequently a convenient symbol for lower-mid ɐ, rather than a genuine higher-mid schwa.

(6) Vocalic PN in stressless syllables:

a. Italian (Nespor and Vogel 1986):
stress licenses laxness contrasts:
• main stressed vowels {a, e, ɛ, o, ɔ, i, u}; other vowels {a, e, o, i, u}

b. Brasilian Portuguese (Nobre and Ingemann 1987):
stress licenses laxness contrasts:
• main stressed vowels {a, e, ɛ, o, ɔ, i, u}; non-final stressless vowels {a, e, o, i, u}.

c. English (Bolinger 1981, Hayes 1994): stress licenses all vowel quality distinctions; all stressless vowels reduce to schwa.

d. Latin (preclassical) (Niedermann 1952): stress licenses all vowel quality distinctions; all non-final stressless vowels (i.e. short, in open syllables) reduce to ɪ, or contextually-conditioned variants of it: u before w or velarized l, e before (C)r[12].

[12] Pre-classical Latin is one of the few cases known to me in which the complete elimination of vowel quality contrasts from stressless syllables appears to yield a corner vowel (i or ɪ) rather than a central vowel such as schwa. Given the poor quality of our evidence on this point, I will refrain from further speculations on what might be the cause of this pattern of reduction. One possible argument that the Latin reduced vowel was in fact central rather than front is its readiness to assimilate to the quality of surrounding consonants, including labials (e.g. maximus ~ maxumus). Genuine front vowels typically resist labial assimilation (Casali 1994).

e. Catalan (Mascaró 1976): stress licenses palatality contrasts (a vs. e, ɛ), laxness contrasts (e vs. ɛ) and height contrasts in round vowels (o vs. u).
• stressed vowels {a, e, ɛ, ɔ, o, u, i}; stressless vowels {ə, i, u}

f. Ukrainian (Kenstowicz and Kisseberth 1977: 234) stress licenses the height contrast between e and æ.
• stressed vowels {a, æ, e, o, i, u}, stressless vowels {a, ə, o, i, u}

g. Russian (Halle 1959) : stress licenses brightness (back/round) distinctions among non-high vowels (a vs. e vs. o).
• stressed vowels {a, e, o, i, u}; stressless vowels {ə, i, u}.

h. Chamorro (Topping 1968, Kenstowicz and Kisseberth 1977: 62) stress licenses height (i vs. e, u vs. o) and palatality contrasts (a vs. æ).
• stressed vowels {a, æ, e, o, i, u}; stressless vowels {ə, ɪ, ʊ} .

i. Romantsch (Kamprath 1991) stress licenses height distinctions in non-low vowels (i vs. e, u vs. o) and brightness (back/round) distinctions in low vowels (a vs. ɛ vs. ɔ).
• stressed vowels {a, e, ɛ, ɔ, o, u, i}; stressless vowels {ə, i, u}.

j. Bulgarian (Scatton 1975) stress licenses micro-height distinctions, i.e.high vs. mid (i vs. e, o vs. u) and low vs. mid (a vs. ɐ).

• stressed vowels {a, ɐ, e, o, i, u}; stressless vowels {ɐ, i, u}

The reader will note that most vocalic place distinctions may be subject to neutralization in stressless syllables: [lax] in Italian and Brazilian Portuguese, palatality in Catalan and Chamorro, height in Bulgarian, Catalan, Romantsch, Ukrainian, and brightness (the combination of round and back) in Russian, Romantsch[13]. I lack examples of languages where [round] or ATR are neutralized in stressless syllables to the exclusion of other vocalic distinctions, but I suspect this is not a systematic gap. A second observation is that stress licenses contrasts, not features. This point can be anticipated in connection to the cases listed in (6. e-j). Note that in Ukrainian the height distinction is neutralized only for the front lower vowels (æ and e), not for the entire vowel system: it is not the [+high] or the [-high] features - or the gestures expressing them - that are forbidden in the stressless syllables of Ukrainian, but rather the height contrast between front non-

[13] On brightness, a perceptual feature, see Trubetzkoy (1939).

high vowels. The step-wise raising evidenced by stressless vowels in Bulgarian (from a to ɐ and from e, o to i, u) illustrates the same point: we cannot say that [-high] is an impossible feature in stressless syllables, since ɐ **is** [-high]. Rather, Bulgarian stressless syllables disallow the low-mid and high-mid **contrasts**. It is these that disappear under neutralization. Finally, the patterns of stressless vowel reduction illustrated in (6) indicate that it is difficult, or relatively difficult, contrasts that are the first to neutralize. In Chamorro, palatality (a phonologically relevant feature for all the front vowels i, e, and æ) is neutralized only among the low vowels: only a and æ merge in stressless syllables. This is due both to the absence of the enhancing effects of rounding and to the fact that a low jaw position will necessarily inhibit the lip spreading which facilitates the perception of [-back]: the opposition of i vs. u is maintained because its terms are enhanced, u by lip rounding, and i by lip spreading.

2.1.2 Stress-related licensing of [nasal]

While nasal consonants tend to be freely distributed, the more marked combination of nasality and a continuant oral oral constriction found in nasalized vowels is frequently limited to stressed syllables. Typical cases are those of contrast between nasal and oral vowels nasality in Guarani, Trique and Applecross Gaelic (Kiparsky 1985, Hollenbach 1977, van der Hulst and Smith 1982).

2.1.3. Stress-related licensing of laryngeal and nasality features

Relevant cases include the stress licensing of [+voice] in the sonorants of Southern Paiute, and in Chatino (Kenstowicz and Kisseberth 1978: 40).

2.2. Initial syllables as positions of selective licensing

It is well known that contrasts involving the vocalic features [round], [front], [ATR] and [low] are frequently limited to the word initial position. Examples involve [round] neutralization in the non-initial syllables of in Bashkir (Poppe 1962), Ostyak (Abaev 1965), and Mongolian (Steriade 1979); [front] neutralization in the non-initial syllables of Uralo-Altaic (Suomi 1983, 1984); and the neutralization of [round], [high], [low] in Tiv (Pulleyblank 1988). Occasionally, vocalic nasality is selectively licensed in the first syllable (Gokana: Hyman 1982). While the initial syllable is frequently a selective licenser for vowel place features, I have not yet encountered a case in which the consonantal place contrasts - or a subset thereof - is limited to the first syllable. We will take up this point below.

2.3. Final syllables

The last syllable of the word is also a frequent site for the selective licensing of vocalic place features. Cases of this sort include the limitation of [lax] contrasts to final vowels in Pasiego (McCarthy 1983); the limitation of [round] contrasts among non-high vowels in Murut (Prentice 1979, Steriade 1987[14]). Contrasts of [round] and [back] among the short vowels are limited to the last vowel of the Cheremiss word (Sebeok 1962, Hayes 1979). My sources refer to the final short vowels of Cheremiss as tense. Finally, the combination [round]-[back] is distinctive among high vowels in Hausa (Schuh 1971) only when the high vowels are distinctively long or when they are final within the phrase. When phrase-final, the vowels of Hausa are subject to extensive, though non-neutralizing final lengthening. We may infer then from the Hausa and Cheremiss data that the selective licensing of vocalic contrasts in the final syllables is related to the process of final lengthening.

2.4. Selective licensing in the syllable nucleus

Non-nuclear continuants (including non-syllabic vocoids) do not possess distinctive nasalization in almost any language. Thus Navajo, French, Hindi and other languages displaying a contrast of nasality among the vocoids, limits this contrast to the nuclear vocoids. Neutralization of place features among glides is also widely encountered, in the sense that the range of place distinctions found among high vowels shrinks when the vocoids become non-nuclear. French provides a clear example of this generalization: i, u and y contrast in all word positions, whereas the corresponding contrast among glides is mostly limited to j, w. The ɥ glide is limited to the context before i.

2.5. Selective licensing in long nuclei

Certain vocalic place contrasts are sometimes limited to the long vowel inventory. This is the case with [round] and [front] in Tigre (Palmer 1956, McCarthy 1979, Flemming 1993), Cheremiss (Sebeok 1962), and Hausa (non-final high vowels: Schuh 1971), as well as Ossetic (Abaev 1964). In Ossetic there are two vocalic sets: the strong vowels (relatively longer, attracting stress) are {a, e, i, o, u}. The weak vowels (relatively shorter, getting stress only by default) are written as {æ, ɨ } but possess only height values, not backness-rounding. This is suggested by the fact that /æuæ/ contracts to [o] - with height value coming from the weak vowels but [round]/[back] values from the strong vowel (Abaev 1964: 5). In Tigre (McCarthy 1979:198) long vowels (which occur only in open σ) are {a, e, i, o, u}. Short vowels (which occur only in closed σ) are central high (written ∂) and central non-high (written ä). Long vowels trigger backness/frontness harmony onto short vowels, indicating that

[14]In Murut the contrast of rounding among non-high vowels occurs also - in more limited fashion - in the stressed syllable, which occurs in penult position. Thus final o] contrasts with a] in words of any shape, whereas penult o contrasts with a only in words in which the final is an o.

they latter possess no [back] or [round] values of their own. In Hausa (Schuh 1971) long vowels are {a:, e:, i:, o:, u:}, possessing distinctive backness-rounding in all contexts, while short vowels are {a, e, i, o, u}, with {i, u} distinctive only word-finally, under considerable (though non-neutralizing) final lengthening. The distribution of non-final {i, u} is predictably based on the quality of neighboring C's only.

Nasality is limited to the long vowels of Hindi (Kenstowicz and Kisseberth 1978) and Sunwari (Genetti 1992): in Hindi, only the *longest* nuclei - containing long vowels in open syllables - carry distinctive nasality. Long vowels in closed syllables are not nasalized.

Before examining a different class of PN effects, we should note that many of the positions of selective licensing identified so far are distinguished by the relatively greater duration they afford to segments. This is clearly true for long vowels, but it is equally true for nuclear vocoids (as against glides), for stressed and for final vowels. Extra duration is perhaps not the only factor responsible for PN in vowels, but it may emerge as a critical unifying factor for many of the effects surveyed so far.

2.6. Selective licensing in stem syllables

A distinct class of PN cases involves the stem syllables: vocalic contrasts are typically allowed in stem but not affixal position. I believe this may also be the case with laryngeal contrasts in consonants (Copala Trique laryngeals: cf. Hollenbach 1977). Examples of stem-restrictions involving vowel-place features include: [round] in the Galab non-high vowels (Sassse 1979); [round] in Yokuts vowels (Newman 1941); non-peripheral vowels (e, o, ï as against a, i, u) in Chumash (Applegate 1979); and mid vowels in Bantu (Guthrie 1970). In Galab the rounded mid vowels may occur in non-stem syllables, but only through the effects of vowel harmony. Similarly, the Chumash {e, o, ï } may occur in affixal syllables, provided they occur there by harmony: what is prohibited is the distinctive occurrence of affixal {e, o, ï }, that is, the contrasts generated by the presence of these vowels in the same contexts as the corner vowels {a, i, u}. The same remarks can obviously be applied to the rounding feature of Yokuts.

2.7. Selective licensing of place contrasts in consonants before vowels

The case of coda nasals and its pattern of PN will give the reader a sense of the type of generalizations that I believe ought to be incorporated into a formal account of PN and licensing. The contrast in this case is typically that between **m** and **n** (or **m** vs. **n** vs. **ŋ** vs. **ɲ**, in languages with richer nasal inventories). This is, relatively speaking, a perceptually difficult contrast: nasals are more confusable amongst each other than corresponding oral consonants (cf. Kurowski & Blumstein 1993, Ohala 1990:261 and Maddieson 1984: 70 for earlier references). This is in part reflected in the

fact that nasal inventories never exceed the richness of place distinctions of corresponding inventories of oral non-continuants (Ferguson 1975, Maddieson 1984)[15]. As for all consonantal place features, the essential factor in the correct perception of the **m/n** contrast is the presence of C-V transitions (Maddieson 1984, Ohala 1990). Coda nasals are frequently neutralized as to place precisely because the relevant C-V transitions are typically missing when the consonant is in coda position. Why then can coda nasals possess place features when homorganic to following onset (as in the Japanese and Diola cases discussed earlier) ? Because the C-V transitions are present in that case, and they provide information about the place features of the entire constriction, in both its nasal and oral portions. Finally, why are nasals more frequently subject to place PN than the corresponding oral consonants (as noted by Greenberg 1978 and Mohanan 1993)? Because, as noted above, the place contrast is in general harder to perceive among nasals, in all positions. By way of summarizing these observations we may rank consonants and contexts in terms of the robustness of the cues to place they carry, as in (7), as suggested in Jun (1994):

(7) Ranking non-continuants (C) in terms of the robustness of their place cues:
[the notation **»r** reads "possessing more robust place cues than"]
a. prevocalic C »r word-final C »r preobstruent C[16]
b. oral C »r nasal C

The coda nasals in heterorganic clusters emerge from (7) as those possessing the weakest cues: they suffer from the double effect of being nasal and of lacking C-V transitions. My proposal then is that the greater propensity of coda nasals to place PN reflects directly the fact that they rank lowest on any cue robustness scale. The basic idea is not new (see Ohala 1990 and Mohanan 1993): what may be new is the insistence that a grammatical statement - PN - must refer to and be conditioned by the perceptibility effects summarized in (7)[17]. We need to note that whatever

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[15] My impression, from reading Maddieson's (1984: 67-68) remarks on prenasalized consonants and inspecting his sample, is that the inventory of place distinctions among *prenasals* is as rich as that of the corresponding oral series. In this respect prenasals pattern exactly like oral consonants: prenasals have oral releases, hence their C-V transitions provide cues to place distinctions that are as reliable as those of the oral stops. This observation, if verified, will also support the view (expressed most recently in Ohala 1990) that it's the C-V transitions that provide the major cues to place in non-continuant consonants: had the V-C transitions played an equally important role, one would expect the inventory of place distinctions in prenasals to occasionally display restrictions similar to those observed among the fully nasal segments.

[16] Left out of the picture - because of irrelevant complications - is the position of non-continuants occurring before glides and liquids. See Jun (1994) for details and a general approach to place neutralization based on the idea of cue robustness.

[17] It is in this respect that I differ from Ohala (1990 and elsewhere), who appears to deny the importance of incorporating the explanation for sound patterns into grammatical statements.

grammatical statements may be appropriate for the characterization of the Japanese and Diola facts in (2), they will have to refer not to the status of individual place features in coda but to the status of the place contrast in coda: the gestures of coronal, labial , dorsal constriction are all well-formed in the coda, but the contrast between them may be disallowed there, because it is not perceptually robust. The grammar of languages like Japanese uses PN as a preemptive strike against the possibility that consonantal categories might be misidentified: and the likelihood of this happening is very high in the case of coda nasals, hence the preemptive strike is more likely too.

2.8. Selective licensing of place contrasts in consonants before non-consonants (= before vowel and in absolute word-final position)

In languages like Marshallese (Byrd 1991) and Diola Fogny (Steriade 1982, Ito 1986) distinctions of place among consonants are permitted in prevocalic position and postvocalic, word-final position. The result are languages which allow word-finally syllables closed by consonants with a distinctive point of articulation. Such closed syllables do not occur medially: in the C_1C_2 clusters of Diola and Marshallese, the place features of C1 are not distinctive.

2.9. Selective licensing of place contrasts after a vowel, regardless of syllabic organization.

The contrast between retroflexes and apico-alveolars is allowed in many Indic, Dravidian and Anboriginal languages only after a vowel. The result is that the contrast is neutralized in post-consonantal and initial position. A typical example of this is that of Gooniyandi, which was first brought to my attention by Philip Hamilton. The facts appear in (8):

(8) The Gooniyandi place contrast among apicals (McGregor 1990:57; Hamilton 1993]

a. The apico-alveolars and retroflexes are acoustically very similar, with differences present only in F3.

b. Initially there is free variation between apico-alveolars and retroflexes:
duwu ~ ɖuwu 'cave', laŋgiya ~ □aŋgiya 'midday'.

c. The contrast is present only *after a V* : see below (c) and (e).

d. Contrast in coda: possible Gooniyandi clusters include Vɖ.bV , Vɖ.gV, Vɳ.bV, Vn.bV, V□bV, Vl.bV.

e. No contrast in postconsonantal onset: apicals occur postconsonantally only after a homorganic apical . e.g. Vn.dV, Vɳ.ɖV

f . Apicals in initial position harmonize in tip position with the nearest available apical:
ɖiɾipindi 'he entered' (no *diɾipindi variant)
dili 'flame' (no *ɖili variant)

Similar distributional patterns, with or without harmony are found in Diyari (Austin 198?), Gujarati, (Cardona 1965), Badimaya (Dunn 1988), Walmatjari and related pidgin (Fraser 1977), Toda (Spajic 1993), Tiwi (Anderson 1993) and others; variations on this pattern are reviewed in Gnanadesikan 1993. As noted earlier, the contrast between apico-alveolars and retroflexes is disallowed in the absence of preceding vowel. We infer that the licensing factor here are the V-to-C transitions. What we must understand then is why the V-C (rather than C-V) transitions are essential in the realization of this particular, aand not for others. An answer is suggested in work by Butcher 1992, Anderson 1993 andSpajic 1993, three phonetic studies of Australian Aboriginal languages: the retroflexes (apicals, articulated with the tip up) are acoustically almost indistinguishable from apico-alveolars (apicals, tip level) *at and after release*. The C-V transitions are therefore useless in this case and *the only reliable cues to retroflexion appear on the preceding vowel*.

The facts just reviewed suggest that the difficulty associated with the positions of neutralization involves not the production of an individual articulation but the perception of its contrast with another, closely related articulation. It's not that retroflexes cannot be produced initially or after C: they can. But if produced in those contexts, they are hardly distinct from the other apicals, namely the alveolars. Two observations about Gooniyandi confirm this: first, both alveolars and retroflexes are phonetically observable initially, where they occur in free variation. This means that neither gesture type is ill-formed there, but that their contrast is disallowed. Second, we get stable, invariant retroflexes and stable, invariant alveolars initially, in words where they are derived by apical harmony: recall the examples in (8.f). This fact too is, on the face of it, inconsistent with an account under which individual features - say [-anterior] or [+anterior] - are banned in the position of neutralization: they can occur there, but non-distinctively so. Therefore A statement like *[$_{word}$ [retroflex] will not do[18].

We must also note that the vowel preceding a distinctively retroflex consonant may be tautosyllabic with it (in strings such as CVCVʈ, where ʈ is a coda) or not (in strings such as CVʈV, where ʈ is an onset). This difference of prosodic assignment does not affect the ability of the vowel to act as the licenser of theretroflexion contrast.

2.10 Selective licensing of laryngeal contrasts after a vowel, regardless of syllabic organization

[18]You may wonder how the non-distinctive occurrence of retroflexes and alveolars can be detected in the positions of neutralization: how do we know we get a retroflex initially in ɖi̪ɾipindi 'he entered' rather than an alveolar. I suspect that in these cases the entire first syllable is articulated with the tongue tip up, in anticipation of the distinctive retroflex gesture that appears in the second syllable. Hence the CV transitions correctly cue retroflexion in such cases.

The contrast between glottalized and non-glottalized sonorants is licensed in Yokuts (Newman 1941, Archangeli 1984) and other California Indian languages (Whistler 1984) only after a vowel, in strings such as Vn'V, Vn'CV or word final Vn'. Here too, the vowel that acts as licenser may, but need not be in the same syllable as its licensee.

2.11 Selective licensing of laryngeal contrasts before sonorants, regardless of syllabic organization

Voicing and aspiration are distinctive features in the stops of both Sanskrit and Ancient Greek. These features are distinctive before a sonorant (vowel, liquid or nasal) within the same word; they are neutralized before obstruents and word-finally. (Greek disallows word final stops, hence the properties of this position can be documented only in Sanskrit). In Sanskrit, as well as certain Greek dialects, syllabic divisions - inferrable from the metrical scansion - are V.CV and $VC_1.C_2V$, regardless of the nature of C_1 and C_2. Thus a Sanskrit string like *yunajmi* 'I yoke' is syllabified *yu.naj.mi,* with a distinctively voiced j [dʒ] in coda position. The licenser of voicing in j is the sonorant m occurring across the syllable boundary. Greek *Admetos*, syllabified in all dialects as *ad.me.tos*, illustrates the same point: a following sonorant is needed to license laryngeal contrasts, but the relation between the licenser and its licensee cannot be specified in prosodic terms. The two may, but need not, be tautosyllabic.

Blevins (1993, IJAL) points out that the same statement characterizes the licensing of laryngeal contrasts (aspiration and ejection) in the stops of Klamath: a stop is distinctively aspirated or ejective only when followed by a modal (voiced, non-glottalized) sonorant, regardless of whether the sonorant is or is not in the same syllable as the stop. As Blevins shows, following Clements and Keyser (1983) - the syllable division in all VCCV sequences is VC.CV.

3. Discussion of PN typology

What needs to be retained from this partial survey are two observations. First, some of the licensing contexts we have noted could be viewed in prosodic terms, but many cannot be: particularly those where specific segment types are required to license the features of neighboring segments, regardless of the prosodic organization of the string, as in 2.9-2.11. This casts significant doubt on the general idea (which previous analyses of licensing bank on) that the licensing of features is entirely a function of their being properly incorporated into prosodic structure: for instance, the contrast between alveolars and retroflexes must frequently be licensed by a preceding vowel, regardless of whether this vowel and its licensee belong to the same syllable. It is clearly not the prosodic relation between this vowel and the following apical consonant that licenses the

alveolar-retroflex contrast. As we see below the critical factor in this relation is the ability of the vowel to carry essential cues to the contrast between the apico-alveolar and the retroflex consonant.

Second, I note that different featural contrasts require different licensers: for instance, the presonorant positions (roughly the onset) appear to license gross distinctions in consonantal place features, a fact related to the presence in that position of the C-V transitions and of the burst, which provide the main cues to place, as well as to the fact that in prevocalic position there is no following consonant which, by overlapping the first C, might further compromise its cues to place. However, the finer distinction between retroflex and alveolar apicals is licensed only by a **preceding** vowel, in coda as well as onset segments.

(9) To each contrast its own licensers:

the contrast	where licensed	why there
major place in C	before V before non-consonant (_V, _#)	burst, C-V transitions burst, no chance of overlapping C
retroflex vs. apico-alveolar	after V	V-C transitions
round in V's	initially finally under stress in long V	initial strengthening? extra duration extra duration extra duration
nasal in vocoids	in nucleus in long nucleus in long open syllable under stress & in nucleus	extra duration extra duration extra duration extra duration
voicing, aspiration, ejection in stops	before sonorant	VOT cues
glottalization in sonorants	after V	preceding V glottalized

A similar point can be made by comparing the licensing positions for place features in vowels vs. consonants: stress, length and word-peripheral position emerge from this survey as the most frequent licensers for vowel place features. This is illustrated with the example of rounding in vowels, but inspection of (9) should make it obvious that all place distinctions in vowels are selectively licensed under essentially the same positions. What do these positions have in common and why do they improve the chances of occurrence of a vocalic distinction? The answer may be duration: stressed vowels, vowels subject to final lengthening and vowels lengthened under the extra prominence provided by the word-initial position are longer (even if non-phonemicallly so) than the corresponding stressless, medial vowels[19]. For the listener, extra duration means extra exposure to a dubious vowel quality and thus a better chance to identify it correctly. For the speaker, extra duration means the ability to complete a gesture rather than fall short of the articulatory target.

Notice now that stress, length and word-initial position play a much smaller role in licensing consonantal place contrasts. It is never the case that geminates exhibit greater diversity of place distinctions than corresponding non-geminate stops. The range of place contrasts among consonants is also typically the same with or without stress, in marked contrast with the vowel place distinctions. Why does the range of contrasts in consonantal place fail to expand under lengthening? Because the primary cues to consonantal place come, in the case of stops, from the transitions into and out of neighboring vowels, which do not lenghten. What lengthens in a long stop is the silent phase, the

[19]Flemming 1993 also notes the effect of phonetic duration in vowel reduction.

closure which provides no cues to the place features. One typically consonantal feature is frequently distinctive only under stress: aspiration. I would guess that the motivation in this case is articulatory and probably involves the conditions under which aspiration can be saliently realized: concretely, the conjecture (inspired by Silverman 1994) is that the realization of aspiration benefits from the heightened subglottal pressure characterizing stressed syllables.

I draw from these observations the conclusion that licensing of the type surveyed here has feature-specific aspects which cannot be reduced to the general proposition that features must be properly incorporated into the prosodic hierarchy.

Let me return now to the other aspect of our proposal: the idea that what is being licensed is the contrast rather than the feature. What we have seen so far is that the clearest instances of PN involve the relation between featural contrasts within a segment class and the positions where such contrasts can best be identified. Let me put this diferently: we found a clear connection between phonological licensing and the perceptual factors facilitating the discrimination among segment types. This suggests that what is being licensed in the cases discussed here is the contrast; and conversely, that what is being *disallowed* in positions of neutralization is the contrast, not a particular feature which realizes it.

To see this in clearer detail, we consider again the effect of duration on the realization of vocalic contrasts.

4. Durational effects in the licensing of vocalic contrasts

One observation suggested by the PN survey is that stress, length and word-peripheral position typically license the vocalic contrasts that are relatively more difficult perceptually. Thus, we may note that vowel contrasts *other than those based on major height distinctions* (high vs. low) are typically subject to positional restrictions involving stress, the proximity of a word edge, or length. Lindblom (1986) - in the course of an examination of preferred vocalic inventories - notes that height contrasts appear to be the ones that are most perceptually reliable. It is thus possible to speculate that the typical targets of PN in vowels - illustrated in (10) - involve vocalic contrasts that would be harder to identify in any position.

(10) Some vocalic contrasts frequently targetted by positional neutralization

- [round] among non-high vowels (Kaun 1993)

- [low] in front or round vowels (Tiv (Pulleyblank 1988), Yoruba (Archangeli and Pulleyblank 1989))
- vowel quality - both height and color - in nasal vocoids (Wright 1985)

Let us consider one of the more difficult contrasts listed in (10), that of rounding (see also Kaun 1994). The following is a list of languages where [round] in non-high vowels is licensed only in initial position or else in nuclei that are phonetically or phonologically longer.

(11) (a) Mongolian: o, ö distinctive only initially (Steriade 1979); u, ü are distinctive throughout word.

(b) Murut: o is distinctive under stress (on penult) and in final position; u occurs throughout word. (Prentice 1979, Steriade 1987)

(c) Pashto (Maddieson 1985): contrast beween mid-round and mid-unround occurs only in long vowels. Short vowels are {i, u, ∂, a}, long vowels are those plus {e:, o:}.

(d) Kurdish (Maddieson 1985): roughly the same situation. Short vowels are {i, ɨ, u, ∂}, long vowels are {i:, u:, e:, o:, a:}. Other systems similar to Pashto and Kurdish (all from Maddieson 1985): Karok, Yurak, Ostyak, Dagbani, Brahui, Telefol.

The same factor of duration may well explain the relative markedness of nasal vowels vs. nasal non-syllabic vocoids: the latter are typically shorter, hence offer less time for relevant contrasts to be detected. In the specific case of vowel nasality the hypothesis that PN bans contrasts, not features, has an interesting consequence: rather than allow nasal vowels in the system and limit them to salient positions - which is the typical solution - a language may allow nasal vowels to occur in all positions of the word, but may limit the range of possible contrasts within the class of nasal vowels. Thus Cherokee and Mohawk possess five oral vowels (a, e, i, o, u) but only one nasal vowel (the central ɐ̃). This vowel is distributionally unlimited: it may occur anywhere in the word. It may do so precisely because it does not contrast with any other nasal vowel. The problem of identifying correctly the distinctive features of the nasal vocoid has been solved in these languages by depriving the nasal vocoid of all distinctive oral properties. Both the neutralization facts of Guarani and Mixtec and the inventory restrictions observed in Mohawk and Cherokee represent structural solutions to the same problem: how to detect the contrastive properties of a vowel, despite the spectral distortion introduced by nasality. The prediction we make is that no system with a unique nasal V will impose PN-type limitations on the occurrence of this V. It is the perception of place

features among nasal vowels that is difficult, not the perception of the nasal-oral contrast. A system with a unique nasal vowel does not need to limit its occurrence, because its place features are non-distinctive.

We may now consider briefly the idea that harmony, especially vowel harmony, is an auxiliary mechanism to PN. We build here on observations made by Gorecka (1991), Kaun (1993), Suomi (1978) about the connection between vowel harmony and markedness in vowel inventories. Kaun notes that there exist vocalic harmony systems in which rounding spreads not from the unmarked rounded vowels (the high back ones) but from the marked ones (the non-high or front ones). The suggestion we adopt is that spreading takes place in such cases precisely because the combination round and -high (or round and -back) is dispreferred: the dispreferred combination is dispreferred precisely because it yields a delicate system of contrasts. Harmony helps in such cases by providing a longer span for hard-to-identify contrasts to manifest themselves. Similar suggestions are made about the perceptual motivation of front harmony (in Suomi 1982) and of harmony among non-peripheral vowels, in languages like Chumash and Bantu. Gorecka (1991) points out that **all** cases of wide-spread vowel harmony (round, ATR, front) involve featural contrasts that are relatively hard to identify: on the other hand, height, the most salient vocalic distinction, rarely, if ever, leads to across-the-board harmony. Even more striking is the fact that harmony involving [front] and [round] is much more frequent (indeed, perhaps inevitable) in large vocalic inventories (such as those of Finnish, Hungarian, Turkish and Mongolian), where round and front cross-classify rather than standing in an enhancement relation to each other.

Building on Kaun's, Suomi's and Gorecka's discussion of round, front and ATR harmony, we may generalize as follows. Harmony has two possible motivations: one is articulatory (let the articulators go on doing what they've been doing) while the other is perceptual: the latter aims to extend the temporal span of a difficult-to-identify vowel quality. We may refer to this second type harmony by the dictum: **Bad vowels spread**. Extended exposure increases the chance of correct identification, as in the case of the PN limitations to stressed, initial or final syllables. Harmony differs from PN in that in that it is a form of gestural lengthening. It differs however from plain vowel lengthening in that it maintains intact the prosodic structure of the word. This advantage of prosodic invariance may explain the observation that while bad vowels spread, or are subject to PN, they typically do not lengthen within their syllable.

In any given language harmony may be articulatorily motivated, perceptually motivated or both. The three cases can be distinguished empirically: the cases that may not be clearly distinct are those where harmony has only a perceptual motivation vs. those where it is justified both

articulatorily and a perceptually. The comparison between Gbeya (Samarin 1965) and Yoruba (Pulleyblank 1988, Archangeli and Pulleyblank 1989) ATR harmony might clarify this. In Yoruba low spreads from both the unmarked low vowel a and from the marked ɛ and ɔ vowels. In Gbeya only the latter (ɛ and ɔ) spread. The harmony systems are otherwise highly similar. We might conjecture that Yoruba harmony is in part motivated by the need to extend the harder-to-identify vowel gestures (ɛ and ɔ) beyond the positions where they're licensed (at the right edge of the word). But this cannot be the whole story, since a spreads its low value as well. Thus the Yoruba system, while it incidentally benefits the perceptibility of the ɛ / ɔ contrast, is at least in part articulatorily motivated. In contrast, the Gbeya system - one in which only bad vowels spread - can be understood solely by reference to perceptual factors: the reason why a does not spread in Gbeya is that the function of harmony here is solely to render perceptible the difficult ɛ vs. ɔ contrast. Other harmony systems in which only the bad vowels spread are Chumash (where stem e, o, ɨ propagate onto the affix vowels: Applegate 1970), Mongolian (where only non-high rounded vowels spread: cf. Steriade 1979) and Kirghiz (where only front rounded vowels spread across all height categories: cf. Herbert 1978, Steriade 1981).

5. How to express the notion of *contrastive gesture* in a grammar

I turn now to the task of encoding the grammatical distinction between contrastive and non-contrastive articulations. Wehave seen in the analysis of the Gooniyandi facts that PN means the absence of contrast rather than the absence of a feature value in some position. For instance, we compare the non-distinctive retroflex that may occur at the beginning of *duwu* ~ *ɖuwu* 'cave', with the distinctive retroflex ocurring intervocalically in *ɖiɽipindi* 'he entered' . They are both retroflex articulations: how do we distinguish them? How do we express grammatically the idea that PN represents a ban on contrast?

The suggestion I will make here is that the notion of potentially contrastive gesture can be made precise by reference to the notion of articulatory window proposed by Keating (1990). A window is a range of values along a given articulatory parameter. As Keating observes, in order to properly characterize the inherent variability of speech, we must characterize articulatory targets not as precise points in the vocal tract where the constriction must be made but as regions within which any particular point is an acceptable constriction site. Keating notes that certain segments have narrower windows than other segments: in a narrow window the acceptable constriction points fall within a narrower range of values. An example will clarify this: English voiced non-continuants (bdg and mn) have narrower windows for velum height (i.e. nasality) than English vowels. That means that a given English vowel may be articulated with a greater variety of velum positions than an English voiced non-continuant. This can be observed in diagrams (26.2) from Keating

(1990:459) the width of a segment's velum height window is indicated by the vertical distance between the two horizontal lines. You can observe that the windows of oral and nasal C's are non-overlapping whereas the window of vowels covers a wider range and overlaps both the oral C and the nasal C window. In this case, as in many others, it 's quite clear that the relative width of windows is at least in part determined by the facts of phonemic contrast within the language: voiced consonants contrast for nasality and thus it's important for their nasality windows to be non-overlapping. Vowels do not contrast, hence can afford to possess a wider nasality window, a wider range of acceptable velum positions.

(12) **Window** (defined articulatorily, after Keating 1990): a continuous range of values within a given articulatory parameter.

You will notice that the definition of windows given in (12) is articulatory: nothing however precludes a comparable acoustic definition, as the range of acoustic values within which a given speech sound must fall in order to properly belong to some segmental class.

Keating's original motivation for defining articulatory targets as windows rather than points is that such a definition permits a better account of coarticulation: in a CVN sequence in English, the velum height varies continuously during the articulation of the vowel. This doesn't mean that the vowel possesses a large number of intermediate target points for velum height, but simply that the velum trajectory during the vowel falls entirely within its wider window. The location of individual points on the trajectory is determined by the need to get expeditiously from the narrower velum position of an oral C to that of a nasal C. Linguistically speaking, the vowel's nasality target doesn't change at all: all observed values fall within the acceptable range. It is interesting to compare the facts of English (to which Keating's figure 26.3 corresponds), with those of French. In French, unlike in English, there is a phonemic contrast between oral and nasal vowels. The remarks made so far suggest that nasality windows will be significantly narrower in French vowels: a cannot reliably contrast with ã if the nasality windows of these two sounds overlap. Indeed, as Abby Cohn has observed in her dissertation, there is a corresponding difference in nasal coarticulation between French and English: French oral vowels have significantly narrower windows. The observed range of variation in velum position - as inferred from nasal airflow - is considerably more reduced than in English. To summarize then, the existence of phonemic contrast determines (or is one of the determining factors for) the width of articulatory windows. The width of windows accounts for (a) the range of acceptable free variation and (b) the extent of coarticulation. We get more extensive coarticulation in segments with wider windows.

(13) Window determines

(a) the range of acceptable free variation and
(b) the extent of coarticulation. (cf. Cohn 1990)

These phonetic facts are remarkably similar to the phonological facts we reviewed earlier. In Gooniyandi, it appears that initial apicals have very wide site windows, which encompass both anterior and non-anterior articulations. It is precisely the fact that they have wide site windows which explains why these initial apicals are subject to anteriority harmony. On the other hand, the postvocalic apicals are distinctively retroflex or alveolar: have narrow articulatory windows. You cannot produce freely fluctuating apicals postvocalically, since in this position they contrast as retroflex or alveolars. I suggest then that the distinctive character of a gesture relative to some featural parameter should be expressed directly, in the phonology, by reference to the width of its articulatory window. Gestures with are distinctive for some feature F have a narrow window for the corresponding articulatory parameter. Gestures which are non-distinctive for feature F will have either a wider window for the corresponding articulatory parameter or will have a window size determined by additional factors. Let us see then how we can develop an account of PN along these lines: I provide first some auxiliary notions.

(14) Feature F: a continuous range of values R along some physical dimension.

(15) Feature specification for F: a narrower range of values within R.

(16) Example: [anterior]: entire region accessible to the tongue blade and tip $\{p_1, p_2 \ldots . p_n\}$.
[+anterior] : the subregion $\{p_1, p_2 \ldots p_k\}$
[-anterior] : the complement subregion $\{p_k, \ldots p_n\}$

(17) A segment specified for [anterior]: its constriction site must fall within either $\{p_1, p_2 \ldots p_k\}$ **or** (excl.) $\{p_k \ldots . p_n\}$.

(18) A segment unspecified for [anterior]: its constriction site may fall anywhere within $\{p_1, p_2 \ldots . p_n\}$.

(19) Other interpretations of the notion *segment unspecified for F* :

a. derivational underspecification: a segment lacking F values in underlying representation; ready and eager to receive one through redundancy rules.
(Halle 1959, Kiparsky 1985, Archangeli 1985 etc.)

b. permanent underspecification: a segment which may not possess F values at any point.
(Steriade 1987 CLS)

(20) Suggestion (inspired by Trubetzkoy + Keating): contrast within some dimension D depends on the size of the D windows. Contrastive gestures have relatively narrower windows.

[cf. Dresher and Rice 1994, Rice and Avery 1993 for related thoughts]

(21) Selected window types :

a. **articulator window**: the range of moving objects able to form a constriction.

b**. site- window (of some articulator A)**: the entire continuum of points against which it can form a constriction.

c. **shape-window (of A)** : the totality of shapes it can assume during constriction.

[e.g. shape- window of Coronal encompasses tip-up, tip-down, perhaps slit, grooved, etc.]
shape-window of Labial encompasses spread and pursed.]

(22) Hierarchy: All windows can be further subdivided.

Possible subdivisions within each window are determined by the interaction of articulatory and perceptual constraints.

Example: the articulator hierarchy

Mouth -> Oral (vs. Tongue Root) -> Lingual (vs. Labial) -> Coronal (vs. Dorsal) -> Tip (vs. Blade)

0 1 2 3 4

We assume then that the size of windows determines "feature composition" of segments, hence degree of underspecification and contrast potential. What then determines the size of windows ? The following is a set of possibly relevant considerations:

(23) **Max**: Maximize the number of distinct categories.

***Precision**: Do not demand articulatory precision.

***Acuity**: Do not demand perceptual acuity.

Positional neutralization: Do not demand perceptual acuity in positions where cues are weakest.

Uniformity: Limit phonetic variability within a given phonological category.

Sloth: Minimize the number of articulatory gestures.

Preferred articulator/side/shape:

We interpret all constraints are relative to a specific window:

(24) Max (Coronal) = distinguish apicals (tip) from laminals (blade) !

*Precision (Coronal) = let either tip or blade do the job !

*Acuity (Coronal) = don't attend to the cues distinguishing apicals from laminals !

Positional neutralization (Coronal) = don't attend to the cues distinguishing apicals from laminals in positions where V-C or C-V transitions are absent !

Uniformity (Coronal) = realize all coronals as either apical or laminal !

Preferred articulator (Coronal) = use the tip.

Such preferences are both articulatory and perceptual and the two frequently conflict: articulatorily speaking the preferred position of the velum is down (the non-linguistic position is velum down) where the force of gravity puts it, but the perceptual consequences of the velum-down position are sufficiently severe (oral constriction features are poorly discriminable in the presence of nasality) that in most cases sounds are articulated with velum up. In general the fact that the constraints in (25) conflict sets the stage for the sort of constraint conflict for which the language of Optimality Theory seems appropriate. I therefore adopt Prince and Smolensky's (1993) idea that constraints are universal, violable and ranked in individual languages: the possible differences in relative ranking will now be seen to express the extent of variation observed here with regards to the distribution of contrasts.

(25) Inventories as the results of variable ranking (on constraint ranking in general and related issues see Prince and Smolensky 1993)

Notation: t = apical coronal; T = coronal fluctuating between apical and laminal

{p, **t**, k} : Uniformity, *Acuity >> *Precision, Max ; PN irrelevant

{p, **T**, k}: *Precision, *Acuity >> Uniformity, Max; PN irrelevant

{p, **t, c**, k} : Max >> *Precision, *Acuity, *PN ; Uniformity irrelevant

{p, **t, c**, k} before V, {p, **T**, k} before non-V :
Max, PN >> *Precision, *Acuity, Uniformity

{p, **t, c**, k} before V, {p, **t**, k} before non-V:
Max, Uniformity, PN >> *Precision, *Acuity

The essential part of this analysis is that PN is expressed as the case of a language which makes limited use of a featural contrast by allowing the narrow windows corresponding to the contrastive gestures only in the positions where there is a perceptual facilitator. In the positions lacking a perceptual facilitator we get - for this class of languages - either wide windows (as in Gooniyandi) or a specific articulation (i.e.narrow windows) that has compensating advantages (as in Gujarati). The notion of contrastive articulation is directly expressed: a contrastive articulation is one possessing a narrow articulatory window.

A possible worry in pursuing this kind of analysis is that in the best understood cases of PN - coda place neutralization or coda laryngeal neutralization - there is no sense in which we get surface free variation and hence no obvious reason to say that coda consonants have big windows of any sort. For instance, in Japanese, if we simply say that the coda consonants have big windows for oral constriction (meaning that no articulator or site is specified) then we might expect free variation between p, k and t in coda, when in fact we get either no constriction at all (word finally) or a stable constriction determined by the following onset. In this case, I believe that a reasonable solution exists, based on the idea that what's perceptually difficult in the case of coda C's is not so much the determination that there is a consonant in the coda as the identification of that consonant's exact place of articulation. We can say then that Japanese contrasts a vowel and consonant articulations in the coda and that for consonants the narrowest articulator window permissible is Mouth. Hence, any articulator can in principle execute the coda gesture but **Sloth** will be satisfied only if the same articulator is responsible for both the coda and the onset gesture.

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