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Feature Classes*

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1. Introduction

In work on Feature Geometry, class nodes have the status of the sine qua non. An example of the well known phonological strategy whereby we seek representational solutions to problems, class nodes literally embody the underlying insight of *feature classes*. This paper attempts a fresh look at this area, and argues for a disembodied alternative, called Feature Class Theory, in which such classes are seen as non-representational postulates of the theory. Much of the *geometry* is removed from a theory without class nodes, and features like Labial, Coronal, Dorsal and Pharyngeal, for example, are united in sharing the *property* of 'placeness' rather than in cohabiting under a node *Place*. That is, feature class theory postulates a set *Place*, of which these features are members. Constraints can mention a class like *Place*–hence the important idea of feature classes remains–but they thereby target the individual members of that set.

The occasional result of such individual feature targeting, and a central argument for the theory, is a certain type of *partial class behavior*, first broached by Sagey (1987) as 'non-constituent' behavior, and illustrated here with an example involving consonantal place features. In Gã (Niger-Kordofanian), nasal consonants assimilate in place to a following consonant. Within morphemes, the assimilation is complete before complex segments *gb/kp*, e.g., *ŋmkpai* 'libation'. Across a morpheme boundary, however, the apparently recalcitrant Labial articulator declines to spread, and remains

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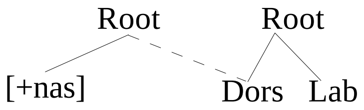
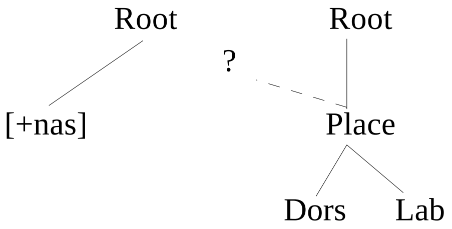
linked only to the source segment, e.g., *N* + *kpai* → *ŋkpai* 'my cheeks' (Ryder 1987, Padgett 1994, 1995), giving the partial linking scenario in (1).

(1) Partial class behavior in Feature Class Theory - Gã nasal place assimilation



Partial class behavior like this is unexpected in Feature Geometry Theory (henceforth FG): since constraints target class *nodes*, feature class behavior is an all-or-nothing affair. When a rule targets *Place* as shown below, either both Labial and Dorsal will spread, or (if the rule fails) neither one will.

(2) Total class behavior in FG



Partial class behavior as in (1) has received little mention by phonologists. (The rather common failure to assimilate completely to complex segments exemplified by Gã was not observed in Sagey's 1986 study, for example; see Padgett 1994, 1995). This is in part due to factual oversight, but this is not the most interesting reason. Rather, feature geometry theory, with its incarnation of feature classes as nodes, makes it difficult to *see* certain legitimate generalizations because they involve partial class behavior. This paper will focus on the proposed class *Color*, uniting the vowel place features [back] and [round] (Odden 1991, Selkirk 1991a). This grouping derives a great deal of support from patterns of vowel harmony, once we countenance the existence of partial class behavior like that illustrated here. Thus, I argue, feature class theory broadens the empirical and explanatory domain of feature classes to areas where feature geometry cannot go.

Crucial to an understanding of partial class behavior are the notions of constraint ranking and violability, and the work here draws heavily on Optimality Theory (henceforth OT, Prince and Smolensky 1993). A central claim here is that partial class behavior should be understood as the *gradient violability* of constraints targeting a feature class, often resulting from the constraint configuration C >> CONSTRAINT(CLASS), where C is any constraint, CONSTRAINT(CLASS) is a constraint targeting any class of features, and the two constraints conflict for some proper subset of the set *Class*. In the example involving Gã above, the class is *Place*, which is assimilated by nasals, and C is plausibly a constraint enforcing alignment (McCarthy and Prince 1993c) of features and morpheme edges (see Padgett 1994, 1995). In the remainder of this paper, however, the focus centers mostly on cases where C prohibits feature cooccurrences.[1]

With the abandonment of class nodes as a means of capturing feature class behavior, the question naturally arises whether class nodes (qua representational entity) have served any other purpose in the theory. Explicit argumentation to this effect has been surprisingly scarce, though it turns out that they have been invoked in accounts of segment transparency to feature spreading, and in explanations of feature interaction more generally. Here we will examine one of the relevant cases, involving translaryngeal harmonies, (see Padgett 1994, 1995, for others), and see that a number of criteria lead us away from a node-based understanding of transparency. The alternative explanation pursued here, which has potentially far-reaching implications for the theory, harnesses independently motivated notions involving locality and feature cooccurrence.

This paper can be construed as contributing to a broader theme emerging in work within OT, that of the reduced role of featural representation. In the last twenty years or so of phonological history, a reliance on representation-based solutions to problems has been an oft-noted and productive strategy, and has been responsible for a well-known shift away from attention to complex rules and their interactions. While this strategy is unlikely to disappear from the scene, one can already perceive properties of Optimality Theoretic thinking that tend to undermine it to some degree. One such property involves the direct harnessing by grammars of markedness relations, captured by universal constraint rankings along some dimension, e.g., sonority, place of articulation (Prince and Smolensky 1993), a property responsible for much of the appeal of the theory. Thus Prince and Smolensky (1993), Smolensky (1993) and McCarthy (1994) have argued that the special properties of coronals are a result of their unmarkedness in this sense, and not of any representational property they evince (underspecification). Another property of OT relevant to this theme is the central one of constraint violability, and of most concern here, *gradient* violability. While gradient violability is not inconsistent with the notion 'representation' broadly construed, it is nevertheless true that some proposed representational entities and their attendant properties have an all-or-nothing character that makes them at best irrelevant to the explanation of partial constraint violation (and at worst a real hindrance to it), at least as they are traditionally conceived. Class nodes fall into this category, as we will see.

Section 2 exemplifies partial class behavior with facts of vowel harmony, motivating the class *Color*, and introduces Feature Class Theory (henceforth FCT). Section 3 articulates the properties of FCT more fully, and discusses various

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[1] The ranking schema C >> CONSTRAINT(CLASS) oversimplifies the actual Gã situation. In Padgett (1994), the alignment constraint penalizing assimilation across the morpheme boundary conflicts for all features (and not just a proper subset) with a subordinate enforcing place assimilation. Other high-ranking constraints requiring that nasals receive *some* licensed place specification ensure that partial assimilation obtains, minimally violating alignment.

implications. In section 4 we take up an issue involving segment transparency and assimilation. Section 5 concludes the paper.

2. Partial class behavior: vowel color

We begin with a well-known generalization: across languages, certain features pattern together recurrently in phonological processes; these features fall into classes that are typically characterized with reference to certain phonetic dimensions, e.g., *Place*, *Laryngeal*. Given this relatively theory-neutral observation, how should we characterize these class of features in our theory? McCarthy (1988:87) articulates three potential approaches:

(3) Ways to capture feature classes

a. Organize the relevant features under abstract class nodes *Place*, *Laryngeal*, etc. Constraints target these nodes. (Clements 1985).
b. *n-ary* features for the relevant groupings, e.g., [nplace] etc.
c. Postulate the relevant classes non-representationally.

(3)a is the core of Feature Geometry Theory (FG), a solution quite well-known and widely adopted, due to Clements' (1985) influential study. (3)b is difficult to distinguish empirically in certain respects from both (3)a and (3)c, and we will not pursue it here. (See McCarthy 1988). This paper will develop an explicit understanding of (3)c called Feature Class Theory (FCT). Before giving it more content, let us turn to the facts involving vowel color that will be the primary impetus in this paper for FCT.

2.1 Color harmonies

In many Turkic languages we find patterns of harmony involving both roundness and backness in vowels. Perhaps the most familiar example is that of Turkish, the facts of which are summarized here.[2] Vowels in Turkish words agree in backness with a vowel to the left; if they are high, they also agree in roundness. In most accounts, spreading occurs rightward from the initial vowel of the root. (4)a illustrates harmony of both features with examples involving target vowels in roots and in suffixes. The different behavior of non-high target vowels–they do not acquire roundness from a preceding vowel–is shown in (4)b.

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[2] This account draws on the work of Lees (1961), Haiman (1972), Clements and Sezer (1982), van der Hulst and van de Weijer (1991), Kirchner (1993), and references therein. For our purposes the harmonizing features are assumed to be the familiar [back] and [round].

(4) Turkish vowel harmony

a. [back] and [round] spread from initial vowel

somun	'loaf'	iyi	'good'
son-un	'end, gen.'	ip-in	'rope, gen.'
öküz	'ox'	adïm	'step'
yüz-ün	'face, gen.'	sap-ïn	'stalk, gen.'

b. Only [back] spreads to [-high] vowel

köpek	'dog'
yüz-den	'face, abl.'
uzak	'far'
son-dan	'end, abl.'

The Turkish vowel inventory is given below. Since the pattern of vowel harmony requires reference only to the height distinction [+high] versus [-high], no more distinctions are indicated here.

(5) Turkish vowel inventory

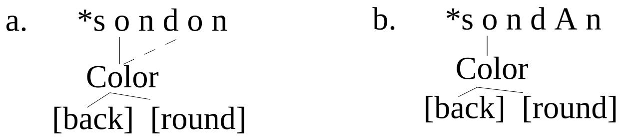
	[-back]		[+back]	
[+high]	i	ü	ï	u
[-high]	e	ö	a	o
	[-rnd]	[+rnd]	[-rnd]	[+rnd]

The point of interest here is the coexistence of back/round harmony within a single language. This is not an oddity of Turkish, but rather pervades the Turkic group (see for example Korn's 1969 survey of approximately 15 languages), and it is a feature of Altaic and Uralic more broadly (Hungarian being one well-known example from the latter group, Vago 1980). With effort one can find candidate cases outside of this group; thus, van der Hulst and Smith (1985) argue for the spreading of both frontness and labiality in two languages of Australia, Djingili and Nyangumarda, and Odden (1991) (arguing for a [back]/[round] constituent in FG) motivates cases from several other language families. In very many of these cases, roundness harmony is restricted in some way in contrast to backness harmony, a point to which we will return. The notable concentration of back/round harmony among the Ural-Altaic languages is a corollary of the near confinement to this group of [back] harmonies in general. The diverging patterns of back/round harmony found there, which do not resemble the random disintegration of a coincidental parental co-patterning, but rather reflect several plausible notions of markedness in vowel and harmony systems (see Kaun 1994, and below), testify to the individual viability of the systems. It seems clear that other imaginable harmonies involving arbitrary feature pairs, say [back] and [low], or [back] and [nasal], do not share the privileged status in the theory of [back] and [round]. It is the job of phonological theory to provide an account for the co-patterning of [back] and [round].

Attention to this feature class, defining a 'horizontal' range of vowel qualities often opposed to the 'vertical' axis of height, has a long history in phonological theory. Trubetzkoy (1939) opposes *timbre*, and Jakobson and Halle (1956) *tonality*, to the sonority/aperture dimension, motivating this bifurcation based on facts of acoustics, inventory markedness and alternation. (An example from inventories: non-low vowels tend to contrast in the color dimension more than low vowels, giving the familiar and common triangularity of vowel systems). Related to the phonological interdependence of [back] and [round] (on this interdependence see Schane 1972, a precursor to the *A/I/U* particle view of Schane 1984) is a much-discussed phonetic enhancement relation between the features (Stevens et al. 1986, Stevens and Keyser 1989). Selkirk (1991a) notes the significance of the harmony patterns, and Odden (1991) notably argues for a feature geometrical node *[back]/[round]* from more restricted (non-word spanning) examples of vowel place assimilation. Ewen and van der Hulst (1987) and van der Hulst (1988) posit a grouping of the elements *I* and *U* in a variant of Dependency Phonology theory (see Anderson and Ewen 1987 and references therein), based on considerations of inventories, and van der Hulst and Smith (1987) and van der Hulst (1988) argue for the role of this grouping in accounting for [back]/[round] harmonies. Mester (1986) analyzes Kirghiz [back] and [round] harmony in terms of a dependency relation between these features, thus making of them a phonological constituent foreshadowing Odden's *[back]/[round]*. Like Selkirk and others, I will use the term *Color* to designate this feature class.

In spite of a fair precedent for a class *Color*, virtually all researchers in the generative tradition addressing Turkish vowel harmony have assumed two separate rules/constraints of harmony, implicitly or explicitly: one harmony of [back], and one of [round], a state of affairs rendering color harmony as likely seeming as a co-patterning of [back] and [nasal]. It is particularly striking that no one working within FG has marshaled the facts of Turkish or similar harmonies, where [round] spreading is restricted in comparison to [back], as evidence for a *Color* node - though it is not difficult to see why. FG embodies what might be called a sour grapes understanding of assimilation: either all features must spread, or none will. Consider the case of spreading to a non-high vowel in Turkish, as in *sondan*, (4)b above. Assuming harmony as *Color* node spreading, we wrongly spread [round] to the non-high vowel, where it cannot occur (see discussion below), as shown in (6)a. If *Color* spreading fails for this reason, then we wrongly fail to spread [back] as well, leaving the target vowel underdetermined for this feature, (6)b. We cannot hope to be saved by any imagined default [back] value in general, since the same vowel in *yüzden*, for example, evinces the opposite value for [back]; [back] arrives by harmony. The essential point is that the FG representation itself makes no provision for an intermediate possibility, the spreading of [back] but not [round], a partial class spreading.

(6) Sour grapes spreading



Consider in this light an amendment to FG theory: to the convention of (7)a we add (7)b, a 'last resort' mechanism to allow for cases of partial class spreading (*class* stands for, e.g., *place*, etc.):

(7) a. To spread a set of features *class*, spread the node *Class*;
or, if spreading of *Class* fails,
b. Spread as many features dominated by *Class* as possible

It seems obvious that once we add this amendment, the standard (7)a itself is not required in the theory: spreading is *always* of as many features as possible. Further, the class node qua representational device has been seriously undermined; in a theory of only (7)b (compare Halle 1993) the class node is demoted to the status of mere feature class label. Below it will be excised entirely. As for FG proper, (7)a alone, its inability to illuminate partial class spreading presumably explains why no FG researcher has fingered Turkish and similar harmonies as evidence for the existence of *Color* (see Padgett 1994, 1995, for cases involving the class *Place* in consonants). If this feature class is real, then by obscuring it FG is failing on its own terms.

2.2 Feature Class Theory

Our proposed alternative, Feature Class Theory, fully exploits the basic principles of Optimality Theory (Prince and Smolensky 1993). Our central argument is that constraints mentioning feature classes like *Place*, *Color*, etc., are gradiently violable in the sense established by OT: partial class spreading is one gradiently violating result. In order to tease out the relative roles of OT and the representational simplification itself, it is worthwhile to continue in a derivationalist vein for the moment, pursuing only the representational issue.

Deferring a more formal discussion to section 3, let us regard 'placeness', 'laryngeality', 'color', etc., simply as *properties* of features. In the way that an object may be blue, or tall, a feature may be 'color' or 'place'.[3] To preserve the central insight of FG, we must allow rules to capitalize on these properties. There is no *Color node*; instead the relevant features are targeted directly and individually, by virtue of being color *features*. Thus 'Spread Color' means 'every feature that is a color feature should

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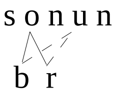
[3] This notion gets a set-theoretic interpretation in section 3. Of course, we might choose to label features for the relevant properties, e.g., $[\text{back}]_C$ indicates *Color*, Labial_P *Place*, and so on. (The retention of inert class nodes seen in Halle 1993, where individual feature spreading is advocated, is a labeling strategy as well). Since the feature classes are largely familiar, and their number small, this linguist's aid is usually unnecessary.

be spread'. The effect of such a statement is depicted below (here and below [back] and [round] are *b* and *r* respectively).

(8) Spread *Color*, without node

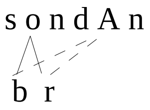


Individual feature spreading, as a result of a rule mentioning a class of features, is a possibility raised by Sagey (1987) under the rubric 'non-constituent spreading', though Sagey regards such spreading as a marked option, a deviation from the usual FG scenario of class node spreading. (The term 'non-constituent spreading' is inappropriate for us, since constituency itself as the key to feature classes is forsaken). Selkirk (1991a,b) and Padgett (1991) also advocate individual feature targeting, but as the only means of class behavior (abandoning the class-as-node), as argued for here. Though superficially distanced by a difference of notation, Hayes' (1990) understanding of 'diphthongization paradoxes' is essentially individual feature behavior as well (see the discussion of this issue in Goldsmith 1990:295-8, where the alternative view of class membership as properties of features is considered). Halle (1993) revives Sagey's argument, from spreading in Barra Gaelic, though Ní Chiosáin (to appear) provides a more convincing analysis of the Barra facts that recasts the issue. Here we are rooting the argument in new empirical territory, involving various languages showing diverse means of spreading *Color* only partially (with the focus on Turkish), and thus we find robust evidence for a genuine class where FG cannot. As we will see, the idea acquires a virtual conceptual necessity within Optimality Theory.

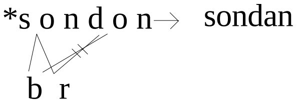
Consider now the case of *sondan* again. The first step in our provisional derivation spreads the class *Color*, as in (9)a. This move establishes an illicit link between [round] and the second vowel, an error repaired in (9)b. This second step requires the delinking of [round] only, a possibility that would be obscured by the presence of a node *Color* mediating the connection (see (6) above, and cf. Hayes 1990 on 'diphthongization paradoxes'). We might nevertheless retain FG and still effect the needed (more drastic) re-linkings, since they can surely be viewed as compelled by the condition forcing delinking. Indeed the most important point addressed here transcends the representational issue: feature class behavior displays gradient violability, and seeing this fact allows us to broaden the explanatory scope of the feature class idea. However, it is a theme here and in section 4 that feature classes qua *nodes* contribute little to the explication of this idea, and in fact make it difficult to see certain relevant generalizations, as noted earlier.

(9) Spread *Color* with repair

a.



b.



Our transition to Optimality Theory begins with the acknowledgment that there is no intermediate representation **sondon* at which 'Spread *Color*' has been fully obeyed. Rather, partial class spreading is precisely the (minimal) *violation* of the spreading imperative. The essential account capitalizes on the central properties of OT (Prince and Smolensky 1993):

(10) Core OT account

a. *Constraint ranking and violability*. [round] never gets to spread in (9)a, because of the higher ranking prohibition against [-high, +round]. 'Spread *Color*' is violated.

b. *Minimal, gradient violation*. Failure of 'Spread *Color*' is not sour grapes failure: the constraint is *minimally* violated ([back] does spread).

The prohibition referred to in (10)a involves a well-known markedness generalization noted already (Trubetzkoy 1939): color feature contrasts are more favored in higher vowels, less so in lower vowels, a fact underpinning the unmarked triangular vowel system. Further, environments of vowel reduction tend to display less marked inventories. Haiman (1972) and van der Hulst and van de Weijer (1991) note that the reduced vowel inventory found in non-initial syllables of Turkish, shown in (11), should be viewed as less marked in this sense.

(11) Turkish non-initial vowel system

i	ü	ï	u
e		a	

In practice, this reduction has sometimes been enforced through a stipulation on roundness harmony itself (e.g., Lees 1961, Clements and Sezer 1982). Yet the independent need in the theory for a markedness constraint against non-high round vowels, *[-high, +round], responsible for patterns in languages involving both underlying and reduction inventories, argues instead for factoring the constraint out of the harmony generalization altogether, as advocated by Haiman (1972). OT provides the theoretical context in which this strategy can be pursued to the limit. The fact that the effect of such a constraint is restricted to non-initial syllables (not a natural domain) suggests a special status for the first syllable as a position of prominence in some sense. I assume here, following Steriade (1994), that the initial syllable *licenses* the full range of vowel contrasts, while this status is not granted to [-high, +round] elsewhere (see Steriade on this role for the word-initial position across languages, and Itô 1986, Goldsmith 1990, and Itô and Mester 1993 on the notion 'license'). For convenience I will refer to a constraint LIC-O:

(12) LIC-O: Non-high round vowels are licensed only word-initially

Following Kirchner (1993), Smolensky (1993), Pulleyblank (1994) and others, I view harmony as the result of alignment in OT, building on Generalized Alignment Theory (McCarthy and Prince 1993a,b, extending ideas of Prince and Smolensky 1993). The constraint in (13) targets the feature class *Color*, the point of interest here. The bidirectional alignment to prosodic word edges is a conveniently simple formulation for our purposes, abstracting away from some issues.[4]

(13) ALIGN: Align(Color, Edge$_x$, Pwd, Edge$_x$) (bidirectional)
'Align all color features to both edges of a prosodic word'

A fuller analysis of Turkish than I can provide here requires grappling with the perennial disharmonic roots and suffixes (e.g., *peron* 'railway platform', disharmonic for both [back] and [round], *mezat* 'auction', disharmonic for [back], and the progressive suffix *-iyor*, whose second vowel does not harmonize). The issues involving disharmony, patterns of disharmony, underlying forms, and the status of harmony within roots are complex and would take us too far afield here (for proposals and interesting discussion see Clements and Sezer 1982, van der Hulst and van de Weijer 1991, Kirchner 1993, Polgardi 1994 and Inkelas, Orgun and Zoll 1994). These issues do not appear to interact in any crucial way with our claim that [back] and [round] form a class: this co-patterning is productively evident in most suffixed forms.

The source of partial class spreading in Turkish is the ranking between our two constraints, LIC-O >> ALIGN. Consider the following constraint tableau (capitals denote vowels unspecified for color features, *A* = [-high], *I* = [+high]). I assume for discussion that color features associated with a root are underlyingly unassociated, though they must be parsed by linkage to a segment (Clements and Sezer 1982). For typographic ease the links of [back] and [round] are notationally merged where these features link to the same vowel, though they are in fact linking individually. Candidate (14)a evinces color features fully aligned to the right and left edges of the prosodic word, and so is not charged for any alignment violation. However, the link between [round] and the second vowel segment violates higher ranking LIC-O. Since only this candidate violates this constraint, the decision is between (14)b and (14)c. Both violate alignment, but here is where minimal violation, (10)b above, becomes significant. In (14)b both features are misaligned, though nothing forces misalignment of [back] in Turkish. Satisfaction of LIC-O requires only the misalignment of [round], and minimal violation picks (14)c. ALIGN(COLOR) is thus gradiently violable, and partial class spreading is the minimal violation of such a constraint. Put another way, the reason why spreading is only *partial* is that LIC-O conflicts with ALIGN with respect to only a proper subset of the color features (namely, one).

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[4] It has been argued that vowel spreading in Turkish must be left to right (e.g., Anderson 1980). Besides the suggestively licensed status of the initial vowel, evidence comes from disharmonic forms, where some non-initial vowels are exceptionally specified for color features, a state of affairs that can lead to an unspecified vowel being surrounded on each side by [back] or [round]. Such vowels always receive these features from the left. For proposals in OT terms, see Kirchner (1993) and Polgardi (1994).

(14)

Input:	sAndAn r,b

Candidate	LIC-O	ALIGN
a. sondon \ / r/b	*!	
b. sondAn | r/b		**!
c. ☞ sondan |\ / r b		*

It is clear from the tableau that the reverse ranking, ALIGN >> LIC-O, picks candidate (14)a instead - the more familiar case (popularized by FG theory) of total class spreading. Such spreading has no special status in FCT next to partial class spreading (and rests on no assumptions about feature representation, as we have seen), but merely represents the case where no higher ranking constraint interferes with ALIGN (or whatever constraint induces class spreading in a particular grammar and configuration). Full *Color* spreading in fact exists in Turkish in forms with high non-initial vowels, as in *sonun* 'end, gen.' Here LIC-O is not violated by total alignment, since initial syllables are licensers, and following [+high] vowels are not subject to the constraint. In this case it is of course total alignment that is optimal:

(15)

Input: sAnIn
r,b

<table>
<tr><th>Candidate</th><th>Lic-O</th><th>Align</th></tr>
<tr><td>a. ☞ sonun
\ /
r/b</td><td></td><td></td></tr>
<tr><td>b. sonIn
|
r/b</td><td></td><td>*!*</td></tr>
<tr><td>c. sonïn
|\ /
r b</td><td></td><td>*!</td></tr>
</table>

Summing up so far: in contrast to FG with its virtually exclusive concern for cases of uniform feature behavior, FCT encodes feature classes non-representationally, and views a constraint mentioning a feature class as gradiently violable. This move has the great advantage of allowing us to extend the feature class idea to areas where FG has failed to venture (see Padgett 1995 on a variety of cases involving consonantal complex segments, for an extension of this idea). Before continuing in our characterization of the theory, let us consider some general issues relevant at this point.

Partial class behavior is a notion already immanent in the theory. Consider a more mundane example, the failure of nasal place assimilation to velars in English displayed by the prefix *in-*, e.g., ***im**placable*, ***in**delible* versus *i[**n**]competent* (see Borowsky 1986 and references therein).[5] This is a familiar sort of structure preservation effect, involving the assertion of segment wellformedness over an imperative of assimilation (Kiparsky 1985, Archangeli and Pulleyblank 1986). Such cases are legion, and a wide range of work in OT already capitalizes on the relevant rankings - in this case, something like *η >> Nassim (the latter a cover here for some account of nasal place assimilation). This case is identical in the essential formal respects to that of Turkish color harmony: here, as in Turkish, a constraint demanding assimilation of some class is violated when a higher ranking segmental markedness constraint is at stake. Violation is minimal (obviously not infecting cases like *indelible*), and the overall result is partial spreading of the class *Place*. With Turkish we have merely shifted our attention to a case where more than one feature of a class may happen to occupy one

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[5] The careful speech, lexical contrast is intended here (casual speech pronunciations like *i[η]competent* are possible). Nasal place assimilation to a velar will occur in other contexts, including in monomorphemic words and foot-internally. See Borowsky (1986).

and the same segment, and so should spread *jointly* from a single source. While FG is presented with no difficulties by partial class spreading across forms as in English, Turkish has been more elusive; yet surely the ideal theory will recognize what these examples have in common.

This account challenges the common strategy whereby rules are judged to be different due to different conditions placed on them. According to this strategy, [back] harmony and [round] harmony in Turkish are clearly different rules (and accordingly have been treated as such). Odden (1991) is a particularly relevant work in this regard: in order to establish the unity of [back] and [round] spreading in Eastern Cheremis, for example, Odden is careful to argue that the two feature spreadings are subject to identical conditions. (Cf. Goad 1993, who is not persuaded of a need for a class *Color*, but who shares the assumption about conditions on rules). Odden's case for the class *Color* is in fact made rather challenging by this strategy, because color harmonies very often display more restricted behavior by the feature [round] (see below). To the extent that conditions on rules are truly idiosyncratic (perhaps in the sense either of phonetically unnatural, morphologically restricted, or both), this strategy for equating - or distinguishing - rules may be quite valuable. However, to the extent that they manifest independently motivated dimensions of wellformedness, as they often do, our real imperative, in recent phonological theory and most clearly in Optimality Theory, is to factor the conditions away from the rules (constraints) altogether. A restriction on [-high, +round] occurrences is surely of the latter category, and the upshot of recent phonological theory, surprisingly, is that we have no basis on which to distinguish [back] and [round] spreading constraints in Turkish. In fact, given the cross-linguistic co-patterning of these features we pondered at the outset, our goal must be to unite them.

Though [round] spreading is often restricted in comparison to [back] spreading in color harmonies, the diverse patterns of restriction found are far from idiosyncratic or random, but rather can be approached and understood in terms of phonological wellformedness, often arguably grounded in phonetic constraints (in fact, the special status of [round] over [back] in being singled out for restriction in itself argues for this view, suggesting markedness issues at work, rather than randomly working conditions). Kaun (1994), building on Korn's (1969) survey of Turkic and Steriade's (1981) earlier discussion, among others, notes the following generalizations (Turkish is a case of (16)a):

(16) Rounding harmony can fail if

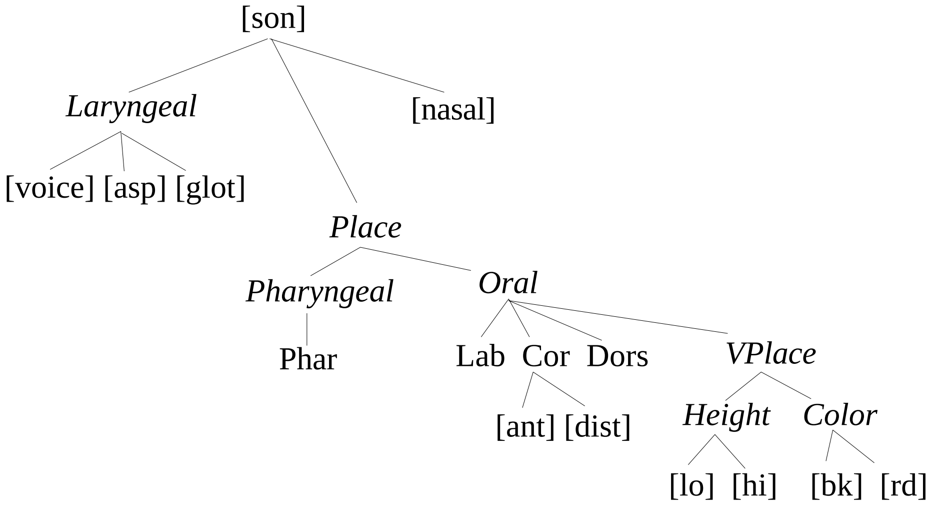
a. it would create a non-high round vowel; or
b. it would involve linking between vowels of different height; or
c. the trigger is high; or
d. the trigger is back

Kaun proposes a set of constraints intended to capture these patterns in an OT framework. For our purposes, the important point is that the patterns of harmony evince conditions that are plausibly viewed as reflecting general constraints on wellformedness, and so must be approached just as we have approached [back] and [round] harmony in Turkish. Factoring out the right wellformedness generalizations will leave us with the bare presence of *Color* harmony.

3. Capturing feature classes

In order to explicate the status of feature classes further, we begin with the FG representation shown in (17), with class nodes italicized. This representation builds on Clements (1985), Sagey (1986) and McCarthy (1988) in its incorporation of *Place* and *Laryngeal* classes, with the former dominating privative articular features (on the laryngeal features shown, see Lombardi 1991). Since the focus here is largely on the class *Color*, and in the following section on the behavior of place features more generally, I will focus more on this area of the geometry. (17) incorporates McCarthy's (1991) proposal for a separation of consonantal place features into *Oral* and *Pharyngeal*, and further assumes a class *VPlace* (see Steriade 1987, Prince 1987, Clements 1991, Ní Chiosáin 1994, Odden 1991, Hume 1992, and Ní Chiosáin and Padgett 1993, among others). Opposed to our class *Color* is that of *Height* (see Hyman 1988, Clements 1991, Odden 1991, Selkirk 1991a, Goad 1993 and others). This geometry remains underdetermined in various respects (not indicating the location of [ATR] feature(s), other features subsumed by *Pharyngeal*, and various manner features, for example), and assumes for discussion the traditional vowel place features [high], [back], etc. (Where privativity, and a unified feature stance, might be relevant below, they are explicitly addressed). However, this level of detail is sufficient for our purposes.

(17) Feature geometry representation



In his widely influential study, Clements (1985) roots the explanation of feature class behavior in two hypotheses: first, phonological rules may refer to any node in the representation, including the organizational class nodes. Second, rules target *single* nodes. Without this latter requirement, the explanatory basis of feature geometry would disappear: if rules could spread more than one node cost-free, then we would predict no patterns. Instead, if rules are limited to single nodes, a group of features can behave together only by virtue of the dominant class node. Such rules include the example formulations shown below ('Root' is used for [son], for the sake of familiarity):

(18) Rules targeting class nodes

Feature Class Theory approaches the notion of feature classes from a more 'semantic' and less 'syntactic' point of view. While classes are equally a part of the theory of phonology here, they are not incarnated as nodes, but instead acquire status as *sets of features* postulated in the theory. With FG, FCT assumes that these postulated classes are fixed and universal. Assuming the validity of the classes represented in (17), we therefore have the following:[6]

(19) Feature classes as sets of features

Laryngeal:	{voice, asp, glo}
Place:	{Lab, Cor, Dors, Phar, ant, dist, hi, lo, back, round...}
Pharyngeal:	{Phar,...}
Oral:	{Lab, Cor, Dors, ant, dist, hi, lo, back, round...}
VPlace:	{hi, lo, back, round...}
Height	{hi, lo}
Color:	{back, round}

In the context of recent phonological history with its emphasis on representation-based explanation, the notion of feature classes as postulated sets can at first be disconcerting. The claim can perhaps most easily be understood to mean that features have various properties attributed to them, namely, 'placeness', 'laryngeality', 'color', and so forth (see footnote 3), just as the property 'red' can be understood by semanticists as the set of all red objects. Naturally, if this move is to retain the basic insight of FG, then constraints must be allowed to refer to these properties, and hence to the relevant features, a matter we turn to momentarily.

With classes now disembodied, our representation becomes much flatter, shown below. (To emphasize the point that classhood has no graph-theoretic implications,

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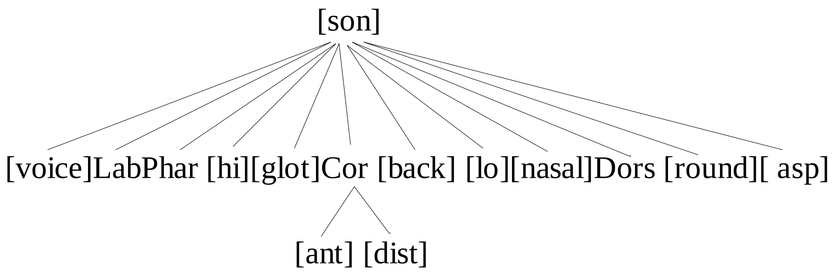
[6] These sets carry over the indeterminacy in the FG representation above. It should be clear that the central issue at hand is not the question of what classes exist, and what they consist of precisely (apart from the claims concerning *Color*). Rather, the question involves how we characterize classes. As we have seen, however, answering the latter question has implications for the former.

the features are scattered randomly). In fact, this structure is a close cousin to the 'bottlebrush' theory (see Hayes 1990 on this type of structure), though FCT incorporates the feature class insight of FG, unlike that theory.

(20) FCT representation



The hierarchy remaining is that related to true *featural* dependencies (Mester 1986, Selkirk 1988), that is, dependencies among features that bear real phonetic content. In other words, (20) is the minimal departure from the FG representation that is consistent with FCT, and assumes that total assimilation (via [son] = Root), and the spreading of [ant]/[dist] when Coronal spreads, remain representational issues. It may be that this assumption deserves further scrutiny as well, but for reasons outside the scope of this paper.[7]

The task is to design FCT so that classes may be picked out just as they are in FG. The intuition to be captured is that a constraint like Align(Color, PWd, R) requires of every member of the set *Color* that it be aligned with the right edge of the prosodic word. That is, in FCT, constraints can *mention* feature classes, but they thereby *target* the relevant individual features. The constraint repeated in (21)a will therefore target the configuration in (21)b containing [back], or the one in (21)c containing [round]. We must also ensure that this constraint targets *any number* of color features in the right configuration.

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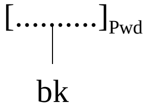
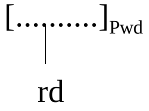
[7] One argument for these featural dependencies comes from the entailment: if the dependent feature is present, then so is the dominating feature. Thus an [ant] or [dist] specification requires the presence of Coronal, and the specification of any feature requires [son], the latter having the result that [son] is specified for every segment (see McCarthy 1988 for a review of these points). This is essentially an issue of feature cooccurrence, and in general FG has not proved an appropriate theory of this area - constraints on feature cooccurrence such as *[Dorsal, +nasal], *[+asp, +son] (and examples can be multiplied) target combinations that have no plausible class status on grounds of assimilation or neutralization (the latter grounds forming the empirical nucleus of FG). We might then compare the entailments above with positively formulated constraints like 'if [ATR] then [+high]' posited by Archangeli and Pulleyblank (1994a). Though the former are perhaps inviolable, in contrast to the [ATR] constraint, this merely puts them at the top of a markedness hierarchy of constraints, from relatively weak ones like *[Dorsal, +nasal] to virtually undominated ones like *[+nasal, +cont, +cons]. These musings still do not address the requirement that [ant] spread when Coronal does, and so on.

(21) a. ALIGN(COLOR, PWD, R) will target

b.



c.



There are two general approaches to this task that one might entertain, here dubbed the 'variable' approach and the 'meta-rule' approach.[8] The variable understanding is presented first.

(22) Variable approach to feature class targeting

Let *Class* denote a set of features {F, G, H...}, *x* range over features, *R* be any representation, and CONSTRAINT be any phonological constraint.

Then: CONSTRAINT(CLASS) is true of *R* iff for every $x \in$ *Class*, CONSTRAINT is true of *R* if we let the interpretation of CLASS be *x*.

Applied to our alignment example, this definition means the following: ALIGN(COLOR) is true of a representation if and only if alignment of [back] is true there, and alignment of [round] is also true there. Since alignment is trivially satisfied by a configuration in which the targeted feature is absent from the representation, the effect is simply that any instances of [back] or [round] present will have to be aligned. As it stands, though, this formulation is inappropriately absolute - alignment is either satisfied or not, and partial class alignment will be regarded as total failure. To bring the definition more in line with OT's notion of gradient violability, we require something like the idea 'N-true' - truth to some degree *N*. The definition is accordingly modified as shown below. In order to make the connection to number of violations most transparent, 'N-true' is recast as 'N-violated'.[9]

(23) Variable approach: amended consequent

Then: CONSTRAINT(CLASS) is N-violated for *R* iff for N elements $x \in$ *Class*, CONSTRAINT is violated for *R* if we let the interpretation of CLASS be *x*.

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[8] I would like to thank Donka Farkas, William Ladusaw, and especially Paul Portner for very helpful discussion of unfamiliar notions and notations here. They should not be associated with any continuing errors on my part.

[9] Since forms vary in the number of features from a given class they contain, the notion 'N-true' relates to the number of violations only indirectly: two forms may both score as '3-true', yet if one has 4 members in a relevant representation and the other 6, the first requires one '*' and the second 3 '***'. All discussion here ignores multiple violations as a result of distance from alignment destination, a well-known source of gradient violation of alignment (see McCarthy and Prince 1993a,b on this latter form of gradience). Alignment constraints are actually doubly gradient, then: violations are incurred not only for each unaligned feature, but also for each syllable (or other appropriate unit) by which alignment fails.

It might be helpful to mention a few configurations concretely and rate them with respect to the alignment constraint. First, words with no color features specified will satisfy ALIGN completely; that is, for both [back] and [round], alignment is trivially satisfied. In the configuration [......*b*]$_{\mathrm{Pwd}}$ ([back] aligned fully rightward), the constraint is likewise fully obeyed. In [...*r*...]$_{\mathrm{Pwd}}$ ([round] anchored to a non-final syllable) ALIGN is violated by [round], though trivially satisfied by [back]. In [...*r*..*b*]$_{\mathrm{Pwd}}$ [back] satisfies alignment in the more interesting sense, though [round] does not, and we have partial class alignment (see Turkish tableaux in section 2.2).

An interesting property of the variable approach is its reliance on a unitary formulation of the relevant constraint - there is simply one constraint ALIGN(COLOR), and its effect is to make demands of several feature types. We can contrast this to the second approach to feature class targeting, involving meta-rules - 'meta-constraints' would be more apt here, but the name and idea are loosely inspired by work in Generalized Phrase Structure Grammar (Gazdar et al. 1985). The idea behind the formulation is this: given a meta-constraint mentioning a class, e.g., *Color*, the grammar generates a number of subconstraints, one for each member of the relevant class, here each color feature. This antecedent-consequent relation is indicated here:

(24) Meta-rule approach to feature class targeting

Where *a/b* means substitute *a* for *b*,

$$\frac{\textsc{Constraint(Class)},\ x \in \mathit{Class}}{\textsc{Constraint(x/Class)}}$$

Therefore, from e.g., ALIGN(COLOR) we derive two constraints: ALIGN(BACK) and ALIGN(ROUND). The role of the meta-constraint in the theory is simply one of characterizing a number of related constraints, in effect. It is these subconstraints that are actually arrayed in the hierarchy of constraints that constitutes the grammar of a language, and so it is the subconstraints that do the real work. In effect, the meta-rule approach creates a *family* of constraints (see Prince and Smolensky 1993 on a family of sonority constraints, and Itô, Mester and Padgett to appear on one involving anti-interaction constraints). This approach can obviously lead to a grammar where both [back] and [round] are aligned, but it differs significantly from the variable approach, in that the subconstraints need not be ranked equivalently in the grammar. Should some general constraint disfavoring alignment come between ALIGN(BACK) and ALIGN(ROUND), the effects of these constraints will be sharply distinguished. In contrast, a unitary constraint ALIGN(COLOR) with variable interpretation can lead to distinct behavior on the part of [back] versus [round] only if some (higher ranking) constraint in the grammar conflicts with the alignment of one of these features *specifically*. The constraint LIC-O played this role in the previous account of Turkish, restricting alignment of [round].

The question of which approach to adopt is in part a question about where the burden of explanation should be placed when features of a class do not behave identically: is it because the grammar contains different alignment subconstraints for the relevant features (whose unity resides only in the meta-constraint), with some general constraint disfavoring alignment intervening? Or is it because the constraints disfavoring alignment are feature-specific, and any one of them can lead to the gradient violation of a unitary alignment constraint?[10] In much of the foregoing (including the discussion of Turkish) the assumption was that a unitary constraint exists. Though the relevant issues are subtle, there is reason to maintain this unitary-variable understanding of feature classes.

Optimality Theory makes the strong claim that grammars are simply rankings of universal constraints, an implication being that any grammar contains all constraints. In this light, consider the scenario in which FCT allows constraints to mention either a single class, as in (25)a, or single features, as in (25)b and c. This scenario might be viewed as a null hypothesis, since it carries this property over from FG.

(25) General and specific constraints

a. ALIGN(COLOR)

b. ALIGN(BACK)

c. ALIGN(ROUND)

Yet if all grammars carry all constraints, is it obvious that we require all of these formulations?[11] If not, there are in principle two possible means of reduction: eliminate the general, or eliminate the specific. Following a suggestion of Prince (p.c.), let us pursue elimination of the specific. It is helpful first to consider the opposite supposition: retention of the specific alone.

The reason that the theory cannot make do with (25)b-c alone is that their mere presence in grammars in itself cannot guarantee feature class generalizations. To see this, consider just the following: along with constraints aligning color features, we presumably would have others targeting height features, i.e., ALIGN(HIGH) and ALIGN(LOW) (not to mention constraints for other features potentially subject to alignment). Given other constraints that can dominate one or more alignment constraints, forcing the latter to be violated, we predict various possible harmony systems. Assume for discussion that alignment is prevented by a higher ranking constraint penalizing association lines not present in the input, termed FILL-LINK by Itô, Mester and Padgett to appear (or alternatively a constraint against multiple linking itself, NOLINK, op. cit.). Given the possibilities of cross-linguistic re-ranking, just two of the predicted grammars are shown below:

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[10] M. Liberman (p.c.) notes a conceptual similarity with the question posed in the transition to Government and Binding syntax about the burden of explanation for patterns of *wh*-movement. General formulations like ALIGN(COLOR) are like Move-α in that the explanation of actual differences in its effect must necessarily lie with independent constraints.

[11] Thanks to Mark Hewitt for first bringing the importance of this question to my attention.

(26) Freely ranked specific constraints

a. ALIGN(BACK), ALIGN(ROUND) >> FILL-LINK >> ALIGN(HIGH), ALIGN(LOW)

b. ALIGN(BACK), ALIGN(HIGH) >> FILL-LINK >> ALIGN(ROUND), ALIGN(LOW)

The problem is that grammars can now achieve color harmony, as in (26)a, but they just as easily achieve any random harmony pattern, including the one in (26)b. Barring grammar-extrinsic constraints demanding that certain constraints - say ALIGN(BACK) and ALIGN(ROUND) - remain near enough to each other on the constraint hierarchy (if we could even pin down what this means), this theory actually has no characterization of the real, recurrent feature class patternings in languages. The same point could be made for all feature classes. Whatever our general theory of harmonies, assimilations, neutralizations, etc., turns out to be, it will have to *somehow* single out, e.g., consonant place features, color features, laryngeal features, as classes evincing special and unitary behavior.

This brings us back to the meta-rule understanding of feature classes. Though it provides by decree a unitary characterization of classes in terms of family membership, there is nothing in this notion that prevents the same random ranking patterns in grammars themselves. Constraint family precedents like Prince and Smolensky's (1993) sonority constraint families, and the NOLINK family of Itô, Mester and Padgett (to appear), impose an intrinsic and universal ordering on the relevant constraints, having a presumed basis in phonetic considerations. On the other hand, it is not obvious that there are markedness implications involved here (roundness harmony could be said to imply backness harmony in languages only if cases of apparent [round] harmony alone could be understood as involving [back])[12], and the intrinsic ordering of constraints within a family would in any case fail to prevent the scenario in (26)b.

The intriguing alternative is to pursue the variable approach, involving unitary constraint formulations like ALIGN(COLOR) to capture class behavior, and to cast it in the strongest possible sense: there in fact are no constraints ALIGN(BACK), ALIGN(ROUND) available to the theory, nor constraints aligning any single feature. More generally, such constraints target classes *only*. Before further considering such a move, it is worthwhile to turn to some relevant facts.

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[12] As in a language where [back] and [round] are mutually dependent. Yawelmani Yokuts, said to have a rule of [round] harmony (and none for [back]), for example, has such an inventory. Yet the rule converts [a] into *o*, leaving an interpretation in terms of [back] less than obvious (see Archangeli 1984 and references therein on Yokuts, where [a] is treated as [+back]).

4. Transparency, interaction and segment markedness

Recall the different possible approaches to feature class generalizations noted by McCarthy (1988): FG is one of them, and FCT is a development of another, the postulation of classes in a non-representational way. If both types of theory capture the basic feature class idea, why has the representational one largely been the paradigm pursued? The likely answer is that FG follows a strategy well-known to modern phonological theory: posit representational elements, and in principle interesting unexpected things may follow from them. FCT may run counter to this strategy, but two points are worth note in this light. First, FCT follows another strategy that proves equally fruitful: posit rankings among simple constraints, and again interesting unexpected things may follow (Prince and Smolensky 1993). The preceding sections make this point, showing that FCT actually broadens the explanatory scope of the feature class idea, illuminating partial class behavior. Second, class nodes, apart from their central role in capturing feature class behavior, have in fact engendered very few results of interest. That is, once we take away the role for class nodes of explaining feature classes, there seems to be little left for them to do. However, a survey of the literature reveals a few limited cases where class nodes have been argued to play a further role; these cases involve issues of transparency versus blocking, and more generally the issue of feature interaction. Padgett (1994, 1995) discusses one general case relating to consonant and vowel place interaction, and recasts the issue in terms of an account appealing to segment similarity. Here we examine a different sort of case, involving the transparency of laryngeal segments to vowel place assimilation. Though unsolved issues will remain, the initial results here go a considerable distance towards reconciling these cases to the FCT perspective, and raise intriguing questions of their own.

Perhaps the best-known and most interesting use of class nodes to achieve results outside of feature class behavior is due to Steriade (1987), in a discussion of what she calls 'translaryngeal harmony'. To see the sort of facts intended, consider the data below from Kashaya Pomo (Buckley 1994). Within a morpheme, any sequences *V?V* and *VhV* must exhibit identical vowels (C' is glottalized):

(27) Translaryngeal harmony in Kashaya Pomo

a.	s'iʔi	'flesh'	nihín	'to oneself'
	heʔén	'how'	behe	'bay nut'
	maʔa	'food;eat'	ʔaha	'mouth'
	q'oʔo	'dance;song;sing'	sohóy	'seal'
	huʔúl	'a while ago'	yuhu	'pinole'
	cf. *seʔo, *q'uʔi, etc.		cf. *yeha, *ʔohu, etc.	

This constraint does not hold across supralaryngeally articulated consonants (T is alveolar):

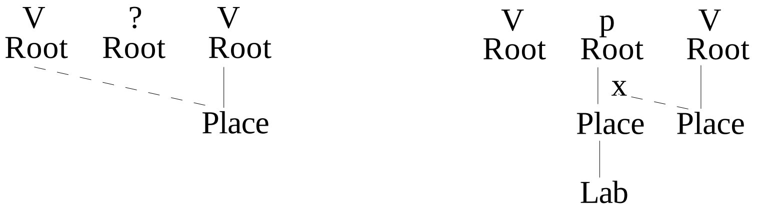
(28) No assimilation across supralaryngeal consonants

ʔimo	'hole'
hoya	'scoring sticks'
baco:	'boat'
buTaqá	'bear'
p^{h}aT'e:	'burr'

Following Steriade, let us use the term 'translaryngeal harmony' to mean not just assimilation across laryngeals (27), but assimilation across laryngeals *only* (28). The goal, as Steriade argues, is to provide a principled account for this pattern - one that does not stipulate arbitrarily that only laryngeals may intervene. Steriade proposes to relate this effect to a difference in representation between laryngeals and other consonants: since laryngeals lack place of articulation features (Clements 1985, McCarthy 1988), they lack a node *Place*, in contrast to supralaryngeals. If total vowel place assimilation involves spreading of this node, then only laryngeals will be transparent - spreading as in (29)b would entail a line crossing violation.

(29) *Place* as a blocker

a. Across a laryngeal b. Across a supralaryngeal



As Steriade notes, this understanding of translaryngeal harmony has the important virtue of simultaneously explaining another interesting fact about such harmonies: they are never of a single feature, but always involve *total* vowel place assimilation. Since translaryngeal harmony (as defined above) can occur only if spreading involves the node *Place*, total assimilation is exactly what should occur.[13] In its role as a blocker of assimilation, *Place* achieves a genuine status here as representational entity, independent of its role in explaining feature class behavior.

The question for FCT is whether there is another account available for these properties of translaryngeal harmony. It should be clear that there is no node-as-blocker explanation in FCT. In neither (30)a nor (30)b is there any line crossing issue. This point is independent of what vowel features spread, and independent of the

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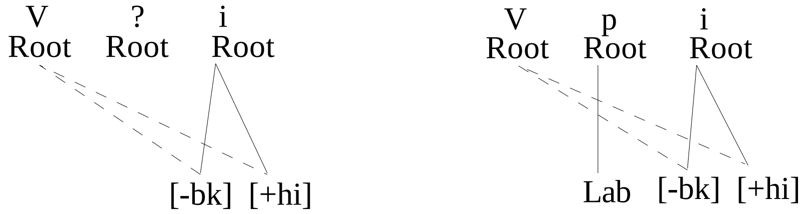
[13] Geometries employing a node *VPlace* (see references at the outset of section 3) have the same account available to them, as Clements (1991) notes. FG is free to write rules spreading either *Place* or *VPlace*. If the former occurs, total vowel place assimilation is translaryngeal. If the latter, assimilation spans *all* consonant types. On this latter kind of transparency without class nodes, see Padgett (1994, 1995).

choice we make of what vowel place features to assume. Thus, even if spreading were from *u*, and assuming the feature Labial to characterize roundness in vowels (Clements 1991, Selkirk 1991a, 1993, cf. Schane 1984, Anderson and Ewen 1987, among others), we cannot count on interference from the consonant *p*, because labials are most typically transparent to roundness harmony, and so must be treated as such somehow by any theory.

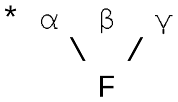
(30) No line crossing issue


a. Across a laryngeal

b. Across a supralaryngeal

The answer to this puzzle is also suggested by Steriade (1987), though not adopted: assume that linkage is subject to a constraint requiring strict locality, called NoGap here (Kiparsky 1981, Levergood 1984, Archangeli and Pulleyblank 1994a, among others, and cf. Smolensky 1993 on *Embed; see Ní Chiosáin and Padgett 1993 and Itô, Mester and Padgett to appear for recent applications).

(31) NoGap



where *β* is a legitimate anchor for *F*

An anchor for any feature is *legitimate* only if it respects the integrity of the feature hierarchy. In our terms, this means that [sonorant] is a legitimate anchor for any feature, except [anterior] and [distributed] (only Coronal provides a place for these two features). The important result here is that multiple linkage of vowel place features cannot skip any segment. This interpretation of NoGap is therefore more demanding than that of Archangeli and Pulleyblank (1994a), for example, who take only moraic segments to be vowel place anchors.

The strategy here is to follow McCarthy (1994) in understanding effects like that of Kashaya as cases not of segment transparency to linkage, but rather as instances of segment *participation* in linkage. McCarthy explores in detail the facts of coronal sonorant transparency to total vowel place linkage in a dialect of Bedouin Arabic. Pursuing ideas of Prince and Smolensky (1993), and Smolensky (1993), he assumes a universal markedness ranking among consonantal place features that places Coronal place at the bottom, i.e., *Dors, *Lab >> *Cor. McCarthy also calls on a universal harmonic ordering favoring simplex consonants over complex consonants, adopted here in the form below:

(32) Simplex ≻ Complex where *complex* = more than one place feature

Putting these two scales together, and giving priority to (32), the constraint ranking shown below is derived, ignoring Dorsal, which for our purposes can be substituted for Labial (*X* is any place feature, vocalic or consonantal):

(33) *[LAB, X] >> *[COR, X] >> *LAB >> *COR

From this perspective, coronal transparency effects are not due to any underspecification of Coronal place (pace Paradis and Prunet 1989). Instead they are in a direct sense the result of coronal unmarkedness itself. As McCarthy shows, coronal transparency follows in the scenario in (34), where *C* is a constraint whose effect is to solicit linkage between vowels (which happen to be separated by a consonant). As we will see below, this reasoning depends on the high rank of NOGAP, which requires that the multiple linking affect consonants as well, potentially creating the relevant complex segments. Segment 'transparency' is thus a matter of feature cooccurrence in a general sense.

(34) Coronal transparency from coronal unmarkedness

*[LAB, X] >> C >> *[COR, X]

Of particular relevance to us is the placeless status of laryngeals. We are now in a position to capitalize on this status, as Steriade does, in order to give a principled account of laryngeal transparency. However, the issue is now reformulated as one of segment markedness, a notion obviously quite general and wide-ranging in the theory, rather than as a matter of class node blockage. Extending McCarthy's ideas, the important result is that laryngeal segments do not even *appear* on the scale in (33), or the ranking configuration (34), because laryngeals have no place. They will therefore be the ideal linking partner for vowels.[14] Assuming alignment as the relevant harmony constraint, and higher ranking NOGAP, then laryngeal transparency, and supralaryngeal blockage, follow from the ranking given below, as we will see:

(35) Laryngeal transparency as a markedness effect

*[LAB, X] >> *[COR, X] >> ALIGN

Given this ranking, harmony by alignment cannot result in the formation of complex segments, consonants specified for extra place features. When NOGAP is high-ranking, these feature cooccurrence statements are inevitably at stake, as the following comparison shows:

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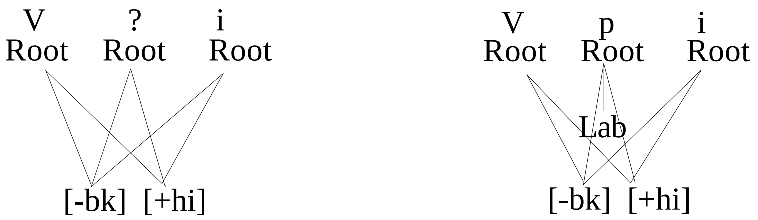
[14] This is a phonological rendering of the observed phonetic independence of laryngeals from oral articulations (Keating 1988). Perhaps a more important connection should be made to the absence of formant transitions imposed on vowels by laryngeals, in contrast to all other consonant types.

(36) Strictly local linkage can create complex segments[15]


a. not with a laryngeal

b. but with a supralaryngeal

Given the ranking in (35), the form in (36)b cannot be optimal (see below), nor can any form with an intervening supralaryngeal consonant. There is no markedness problem in the case of (36)a, however, and the general point is that vowel place assimilation across a laryngeal can never fail for reasons of place complexity. Of course it can fail if other constraints are militating against linkage - faithfulness constraints, for example, or anti-linkage constraints such as NOLINK (Itô, Mester and Padgett to appear).[16]

In order to illustrate the reasoning with constraint tableaux, let us first collapse constraints of the form *[CPLACE, X] into one block for convenience, called *COMPSEG, and define it as follows:

(37) *COMPSEG: Consonants may not have > 1 place specification

By 'consonant' we mean a segment with any consonantal constriction in the oral cavity. The understanding here excludes laryngeals (whether or not they are [+consonantal] themselves), because they lack any oral consonantal constriction and so are not relevant to any constraint *[CPLACE, X]. The constraints making up *COMPSEG rule out segments like *gb*, t^y, k^w, etc., while allowing simple *k*, *p*, etc., as well as any grouping of vocalic constrictions, e.g., *w*, *o* (assuming these vocoids have complex place specifications). For the sake of discussion, let us also assume a rightward-spreading translaryngeal harmony determined by alignment:

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[15] Representations like these with linking to a consonant raise the question of the phonetic interpretation of that consonant. Under the common assumption that vowels and glides are not featurally distinguished, these forms might seem to imply $ʔ^y$ and p^y. However, as McCarthy (p.c.) notes, these representations imply merely that the intervening consonant has some (in this case) palatal character, though it need not be phonologized in any way. This reasoning implies that a plain versus palatalized contrast should not be maintained in a language where [-back] links locally as shown here, i.e. no *ipi* versus ip^yi contrast in such a language.

[16] Presumably an account broadly along these lines can be extended to cases of guttural transparency (see McCarthy 1991 for facts, and an account within FG similar in structure to Steriade's 1987 account of translaryngeal cases). However, since Pharyngeal place is itself rather marked, this class of cases might suggest that the view here of the relation between simplex and complex segment markedness requires further thought.

(38) Align-R: Align-R(VPlace, Pwd)

The rankings that are of chief concern here are given below.

(39) Translaryngeal harmony rankings

a. *CompSeg >> Align-R
b. NoGap >> Align-R

The first tableau considers the Kashaya input /ʔimo/ 'hole', in which a supralaryngeally articulated consonant separates the two vowels:

(40) Input /ʔimo/ 'hole'

Candidate	NoGap	*CompSeg	Align
a. ʔ i m i \ / vpl	*!		
b. ʔ i m i \ │ / vpl		*!	
c. ☞ʔ i m o │ │ vpl vpl			*

Alignment requires that all vowel place features be right-aligned in the word (here for convenience they are collapsed together and abbreviated as 'vpl'). Though alignment is entirely satisfied in both (40)a and (40)b, the first comes at the expense of a fatal NoGap violation, since *m* is skipped, and the second fails because of linkage to *m*, violating *CompSeg. Though alignment is violated in (40)c, this form is optimal (the number of Align-R violations here will actually depend on the number of VPlace features at issue).

Compare now the form /nihin/ 'to oneself':

(41) Input /nihin/ 'to oneself'

Candidate	NOGAP	*COMPSEG	ALIGN
a. n i h i n \ / vpl	*!		
b. ☞ n i h i n \ | / vpl			
c. n i h i n | | vpl vpl			*!

The crucial difference here is that no amount of vowel place feature linking to *h* can violate *COMPSEG, since *h* has no primary consonantal place, and so the result is not complex in the right sense. With intervening laryngeals, therefore, there is no obstacle to alignment.

Although Steriade (1987) considered an account for translaryngeal harmony invoking strictly local spreading in derivational terms, this approach was not adopted. Steriade presented two challenges for such an account. First, some cases of translaryngeal harmony specify the target vowel. In Arbore, according to Steriade, the target vowel must be mid-front. The problem is that laryngeals are by no likely criteria themselves mid-front, and so cannot be viewed as targets of assimilation. If spreading is strictly local, then spreading must first occur to an intervening laryngeal, before passing on to the following vowel, and this is not possible in Arbore.

However, in the non-derivational setting of Optimality Theory, things look different, because the objects being evaluated involve multiple linking at the outset. The laryngeal is never an exclusive target at some intermediate stage of the derivation, since there are no such stages. Rather, linkage is driven by alignment over a legitimate domain like the prosodic word, as seen above. In concert with NOGAP, alignment itself is what ensures that linkage will span over, and include, any word-internal consonants - so long as no higher-ranking markedness constraints interfere. It remains an open question how we ought to encode special conditions on target vowels, as in Arbore.[17] But the existence of such conditions is no longer an obstacle to the feature cooccurrence approach to segment 'transparency', a point very much in favor of OT's non-derivational perspective.

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[17] A rather direct approach to the Arbore problem is possible: adapting ideas in McCarthy (1994), we might employ a constraint disfavoring the place feature combination for mid-front vowels, *[-back, -low, -high]. As McCarthy shows, such markedness constraints can themselves drive multiple vowel place linkage, without the need to posit alignment at all.

A much more pressing concern is Steriade's second challenge: recall that translaryngeal harmonies are observed to involve total vowel place assimilation, and never the assimilation of a single feature. This generalization follows from the node-as-blocker view of the facts, since translaryngeal harmony can occur in any case only if spreading is of the node *Place*. It is important here to remember the definition of translaryngeal harmony: harmony across laryngeals, and *not* across supralaryngeals. If spreading were of any lesser node in the hierarchy, *Place* would not block, and harmony would span supralaryngeal consonants as well.

To pursue the point, recall the conjecture reached in section 3 (Prince, p.c.): suppose alignment can never target individual features like [back] or [high], but only targets feature *classes*. This notion is interesting not only for reasons given in section 3, but because, given the resources of OT already available, it is *sufficient* for ordinary cases of single feature vowel harmony: Finnish [back] harmony, for example, can already be made to follow from a constraint ALIGN(COLOR), because of the independently required possibility of partial class behavior. If faithfulness constraints, for example, can be feature-specific, as suggested by various researchers (Kirchner 1993, Archangeli and Pulleyblank 1994b, among others), then such single feature harmonies will inevitably result from rankings such as (42)a and (42)b. Color harmony is made possible by ranking (42)c, and (42)d is the case of no harmony.

(42) Single and double feature harmonies from ALIGN(COLOR)

a. FILL-LINK(ROUND) >> ALIGN(COLOR) >> FILL-LINK(BACK)
b. FILL-LINK(BACK) >> ALIGN(COLOR) >> FILL-LINK(ROUND)
c. ALIGN(COLOR) >> FILL-LINK(ROUND), FILL-LINK(BACK)
d. FILL-LINK(BACK), FILL-LINK(ROUND) >> ALIGN(COLOR)

Assuming this understanding of alignment constraints, the most direct attempt to construct an (illicit) case of translaryngeal [back] harmony, say, will involve the constraint ALIGN(COLOR). Given this constraint together with *COMPSEG and the two relevant FILL-LINK constraints, there are 24 rankings possible. Some telling subrankings can be abstracted from these possibilities; note the following generalization first:

(43) ALIGN(COLOR) harmony types

a. ALIGN(COLOR) >> *COMPSEG

Any harmony existing (subject to FILL-LINK) spans any consonant.

b. *COMPSEG >> ALIGN(COLOR)

Any harmony existing is translaryngeal

Restricting our attention to cases of (43)b, any variation within this class will depend on the positioning of the faithfulness constraints, giving 12 rankings in all. In half of these, both FILL-LINK constraints outrank alignment, meaning that there is no harmony at all. The rest give three translaryngeal harmony types, two rankings for each:

(44) Translaryngeal harmony types predicted

a. *COMPSEG >> ALIGN(COLOR) >> FILL-LINK(BACK), FILL-LINK(ROUND)

Translaryngeal color harmony

b. *COMPSEG, FILL-LINK(ROUND) >> ALIGN(COLOR) >> FILL-LINK(BACK)

Translaryngeal [back] harmony

c. *COMPSEG, FILL-LINK(BACK) >> ALIGN(COLOR) >> FILL-LINK(ROUND)

Translaryngeal [round] harmony

Thus even assuming that alignment in itself targets only feature classes, we have not yet ruled out the unattested single feature translaryngeal harmonies (though we have obviously engendered fewer such rankings than a theory containing both class alignment and single feature alignment constraints). Whether translaryngeal harmonies of *Color* exist is a matter requiring further investigation, but Odden (1991) provides a candidate case.[18]

As a matter of interest, it is the decomposition of faithfulness into various feature-specific constraints - FILL-LINK(BACK), FILL-LINK(ROUND), and so on - that leads to this state of affairs. This decomposition seems required, though: assuming that alignment targets only feature classes, it is the decomposition of faithfulness that allows for the possibility of single feature spreading at all, as noted in (42). However, consider a different strategy for gleaning single feature harmonies from constraints like ALIGN(COLOR). Instead of decomposing faithfulness, we unpack *COMPSEG once again, allowing specific reference to the relevant vowel features in this manner: *[CPLACE, ROUND], *[CPLACE, BACK], etc. Such constraints penalize complex segments involving CPlace (any oral consonantal constriction) and a particular vowel

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[18] Tunica translaryngeal color harmony targets only the low vowel *a*. The output is low front *E* or low back *O*, regardless of the height of the triggering vowel (high, mid or low). One might attempt to reanalyze this case as one of total vowel place assimilation in principle, by requiring that the target's [+low] value remain parsed. This would have the effect of preventing the (inconsistent) height features of mid and high vowels from linking, giving partial class spreading. However, if *Color* is a legitimate feature class, it is not clear how a direct translaryngeal *Color* harmony can be (elegantly) ruled out in FCT. In any case, given the generally restricted occurrence of harmonies, and color harmonies, in languages, it is not clear what we can conclude from this paucity of attested translaryngeal color harmonies, and this issue will remain open here.

place feature. Substituted for the corresponding FILL-LINK constraints in (42), the effects will be intriguingly different:

(45) ALIGN(COLOR) harmony types, reconsidered

a. *[CPLACE, ROUND] >> ALIGN(COLOR) >> *[CPLACE, BACK]
b. *[CPLACE, BACK] >> ALIGN(COLOR) >> *[CPLACE, ROUND]
c. ALIGN(COLOR) >> *[CPLACE, ROUND], *[CPLACE, BACK]
d. *[CPLACE, BACK], *[CPLACE, ROUND] >> ALIGN(COLOR)

Assuming that faithfulness (now generally construed) and other constraints permit, the patterns predicted by (45) are the following: (45)d is translaryngeal color harmony, from the configuration already familiar; (45)c derives general color harmony, as in Turkish. Most interesting are the remaining cases. (45)b forces [round] harmony through any consonant, but allows [back] harmony only if a laryngeal (or nothing) intervenes. The surface effect of this configuration is a language displaying translaryngeal color harmony, as well as a general [round] harmony. (45)a gives the complement pattern: translaryngeal color harmony, with general harmony of [back]. Single feature translaryngeal harmony is not derived by these rankings.

Whether these predictions themselves are desirable is not entirely clear; yet in ruling out single feature translaryngeal harmonies this approach earns a legitimate claim to our interest. Should it turn out to be on the right track, it implies an understanding of individual feature behavior that motivates it not by virtue of proliferating feature faithfulness constraints, but rather by virtue of constraints on feature markedness. Constraints like *[CPLACE, X], after all, are simply members of a larger assortment of constraints disfavoring feature cooccurrences, or more generally disfavoring various segment types. The constraint informally dubbed LIC-O in the account of Turkish above belongs to this class as well. Given that constraints on segmental markedness (however stated) are an ineradicable part of the theory, where they already play a large role in constraining processes like feature spreading, perhaps the most interesting question raised by this discussion is whether they might actually suffice for singling out features where needed, allowing us to maintain rather monolithic faithfulness constraints on the order of PARSEFEATURE, FILL-LINK, etc.

As for the matter at hand, further discussion will be difficult until more is known about the properties of translaryngeal harmony cases. Questions also loom concerning the range of existing segmental markedness constraints, and the forms they may take; their answers will themselves bear on the issue of possible grammars concerning us above.

5. Conclusion

This paper finds its primary support for Feature Class Theory in facts of color harmony, an area rich in partial class behavior. Padgett (1995) locates arguments for

FCT in other areas - obligatory contour principle effects over place, and partial assimilation by nasals to complex segments - and explores the implications of FCT for accounts of the (non)-interaction of place features of consonants and vowels.

Presented with the argument for a class *Color* from Turkish, where [back] and [round] spreading do not even coincide all of the time, the skeptic might wonder how one can reliably infer a class from data at all - the inference involves a fair degree of abstraction from the data. In closing, it might be useful to recall that this issue already deeply pervades all work on FG. In his work introducing that theory, Clements (1985) considered a similar question in relation to some facts of Kikuyu. In this language, when a nasal consonant precedes a fricative, the fricative is hardened to a stop (see also Padgett 1991 for more detailed discussion):

(46) Fricative hardening in Kikuyu

mbureetɛ	'lop off'	cf. βura
ndeheetɛ	'pay'	cf. reha
ŋgoreetɛ	'buy'	cf. ɣora

When a nasal precedes a voiceless obstruent, the obstruent is voiced:

(47) Obstruent voicing in Kikuyu

ndomeetɛ	'send'	cf. toma
nǰineetɛ	'burn'	cf. čina
ŋgereetɛ	'cross'	cf. kera

As Clements notes, these facts on the surface resemble counterevidence to the claim that [voice] and [continuant] occupy independent areas of the FG hierarchy: the appearance is of a uniform process of obstruent hardening/voicing. Yet we do not rush to posit a grouping of [voice] and [continuant], for various mutually reinforcing reasons. Thus, these features represent independent phonetic dimensions, and more important, they are known to behave quite independently when the larger picture of cross-linguistic patterning is viewed - the chance cooccurrence of hardening and voicing after nasals, both widely-attested phenomena occurring alone, is expected in this larger picture. More generally, hypotheses about feature classes cannot be based on surface scannings of a single language. Rather, they must be informed by the larger context both of the theory, and of cross-linguistic patterning. It is just such considerations that motivated the class *Color* in this work: *Color* derives support from phonetic considerations, from patterns of vowel inventories, and from the cross-linguistic co-patterning of [back] and [round] in vowel harmony systems.

References

Anderson, John and Colin Ewen. (1987). *Principles of Dependency Phonology*. Cambridge University Press, Cambridge.

Anderson, Stephen R. (1980). 'Problems and Perspectives in the Description of Vowel Harmony'. In Robert M. Vago (ed.), *Issues in Vowel Harmony*. John Benjamins, Amsterdam, pp. 1-48.

Archangeli, Diana. (1984). *Underspecification in Yawelmani Phonology and Morphology*. Doctoral Dissertation, MIT, Cambridge, MA.

Archangeli, Diana and Douglas Pulleyblank. (1986). *The Content and Structure of Phonological Representations*. Ms., University of Arizona and University of Ottawa.

Archangeli, Diana and Douglas Pulleyblank. (1994a). *Grounded Phonology*. MIT Press, Cambridge, MA.

Archangeli, Diana and Douglas Pulleyblank. (1994b). 'Kinande Vowel Harmony: Domains, Grounded Conditions, and One-Sided Alignment'. Ms., University of Arizona and University of British Columbia.

Borowsky, Toni. (1986). *Topics in the Lexical Phonology of English*. Doctoral dissertation, University of Massachusetts, Amherst.

Buckley, Eugene. (1994). *Theoretical Aspects of Kashaya Phonology and Morphology*. CSLI Publications, Stanford, CA.

Clements, G.N. (1985). 'The Geometry of Phonological Features'. *Phonology Yearbook* 2, 225-52.

Clements, G.N. (1991). 'Place of Articulation in Consonants and Vowels: a Unified Theory'. Ms., version 1.1, Cornell University.

Clements, G.N. and Engin Sezer. (1982). 'Vowel and Consonant Disharmony in Turkish'. In Harry v.d. Hulst and Norval Smith, eds., *The Structure of Phonological Representations*, Part II, Foris, Dordrecht, pp. 213-255.

Ewen, Colin and Harry v.d. Hulst. (1988). '[high], [low] and [back] or [I], [A] and [U]?' In P. Coopmans and A. Hulk (eds.), *Linguistics in the Netherlands*. Foris, Dordrecht, pp. 49-58.

Gazdar, Gerald, Ewan Klein, Geoffrey Pullum and Ivan Sag. (1985). *Generalized Phrase Structure Grammar*. Harvard University Press, Cambridge, MA.

Goad, Heather. (1993). *On the Configuration of Height Features*. Doctoral dissertation, University of Southern California.

Goldsmith, John. (1990). *Autosegmental and Metrical Phonology*. Basil Blackwell, Cambridge, MA.

Haiman, John. (1972). 'Phonological Targets and Unmarked Structures'. *Language* 48.2, pp. 365-377.

Halle, Morris. (1993). 'Feature Geometry and Feature Spreading'. Ms., MIT, Cambridge, MA.

Hayes, Bruce. (1990). 'Diphthongisation and Coindexing'. *Phonology* 7.1, pp. 31-71.

Hulst, Harry v.d. (1988). 'The Geometry of Vocalic Features'. In Harry v.d. Hulst and Norval Smith, eds., *Features, Segmental Structure and Harmony Processes* Part II, Foris, Dordrecht, pp. 77-125.

Hulst, Harry v.d. and Norval Smith. (1985). 'Vowel Features and Umlaut in Djingili, Nyangumarda and Warlpiri'. *Phonology Yearbook* 2, pp. 277-303.

Hulst, Harry v.d. and Norval Smith. (1987). 'Vowel Harmony in Khalkha and Buriat (East Mongolian)'. In F. Beukema and P. Coopmans (eds.), *Linguistics in the Netherlands*. Foris, Dordrecht, pp. 81-91.

Hulst, Harry v.d. and Jeroen v.d. Weijer. (1991). 'Topics in Turkish Phonology'. In Hendrik Boeschoten and Ludo Verhoeven, eds., *Turkish Linguistics Today*, E.J. Brill, Leiden.

Hume, E. (1992). *Front Vowels, Coronal Consonants and their Interaction in Non-Linear Phonology*. Doctoral dissertation, Cornell University, Ithaca, NY.

Hyman, Larry. (1988). 'Underspecification and Vowel Height Transfer in Esimbi'. *Phonology* 5, pp. 255-273.

Inkelas, Sharon, Orhan Orgun and Cheryl Zoll. (1994). 'Subregularities as Cogrammars: the Theoretical Status of Non-productive Patterns in Grammar'. Ms., UC Berkeley.

Itô, Junko. (1986). *Syllable Theory in Prosodic Phonology*. Doctoral Dissertation, University of Massachusetts, Amherst.

Itô, Junko and R. Armin Mester. (1993). 'Licensed Segments and Safe Paths'. In C. Paradis and D. LaCharité (eds.), *Constraint-Based Theories in Multilinear Phonology*, special issue of the *Canadian Journal of Linguistics*.

Itô, Junko, R. Armin Mester and Jaye Padgett. (to appear). 'NC: Licensing and Underspecification in Optimality Theory'. *Linguistic Inquiry*.

Jakobson, R. and M. Halle. (1956). *Fundamentals of Language*. Mouton, The Hague.

Kaun, Abigail. (1994). 'An Optimality-Theoretic Account of Rounding Harmony Typology'. Paper presented at the West Coast Conference on Formal Linguistics.

Keating, Patricia. (1988). 'Underspecification in Phonetics'. *Phonology* 5, pp. 275-292.

Kiparsky, Paul. (1981). 'Vowel Harmony'. Ms., MIT, Cambridge, MA.

Kiparsky, Paul. (1985). 'Some Consequences of Lexical Phonology'. *Phonology* 2, 85-138.

Kirchner, Robert. (1993). 'Turkish Vowel Harmony and Disharmony: an Optimality Theoretic Account'. Ms., UCLA, of talk presented at the Rutgers Optimality Workshop I, New Brunswick, NJ.

Korn, David. (1969). 'Types of Labial Vowel Harmony in the Turkic Languages'. *Anthropological Linguistics* 11.3, pp. 98-106.

Lees, Robert. (1961). *The Phonology of Modern Standard Turkish*. Uralic and Altaic Series 6, Indiana University, Bloomington.

Levergood, Barbara. (1984). 'Rule-Governed Vowel Harmony and the Strict Cycle'. In *Proceedings of NELS* 14, GLSA, University of Massachusetts, Amherst, pp. 275-293.

Lombardi, Linda. (1991). *Laryngeal Features and Laryngeal Neutralization*. Doctoral dissertation, University of Massachusetts, Amherst.

McCarthy, John J. (1988). 'Feature Geometry and Dependency: A Review'. *Phonetica* 43, pp. 84-108.

McCarthy, John J. (1991). 'On Guttural Transparency'. Paper presented at the Workshop on Distinctive Features, LSA Summer Institute, Santa Cruz, CA.

McCarthy, John J. (1994). 'On Coronal "Transparency"'. Paper presented at the annual Trilateral Phonology Weekend, UC Santa Cruz.

McCarthy, John J. and Alan Prince. (1993a). 'Prosodic Morphology I: Constraint Interaction and Satisfaction'. Ms., University of Massachusetts, Amherst, and Rutgers University, New Brunswick.

McCarthy, John J. and Alan Prince. (1993b). 'Optimality in Prosodic Morphology: the Emergence of the Unmarked'. Paper presented at the 24th annual NELS conference, Amherst, MA.

McCarthy, John J. and Alan Prince. (1993c). 'Generalized Alignment'. Ms., University of Massachusetts, Amherst, and Rutgers University, New Brunswick.

Mester, R. Armin. (1986). *Studies in Tier Structure*. Doctoral dissertation, University of Massachusetts, Amherst, published 1988, by Garland Publishers, New York.

Ní Chiosáin, Máire. (1994). 'Irish Palatalisation and the Representation of Place Features'. *Phonology* 11.1.

Ní Chiosáin, Máire. (to appear). 'Barra Gaelic Vowel Copy and (Non-)Constituent Spreading'. Proceedings of WCCFL XIII.

Ní Chiosáin, Máire and Jaye Padgett. (1993). 'Inherent VPlace'. Report no. LRC-93-09, Linguistics Research Center, UC Santa Cruz.

Ní Chiosáin, Máire and Jaye Padgett. (1994). 'Feature Classes and Spreading'. Paper presented at the Second Phonology Workshop: from Cognition to Romance. University of Manchester.

Odden, David. (1991). 'Vowel Geometry'. *Phonology* 8, pp. 261-90.

Padgett, Jaye. (1991). *Stricture in Feature Geometry*. Doctoral dissertation, University of Massachusetts, Amherst, to appear CSLI Publications, Stanford, CA.

Padgett, Jaye. (1994). 'Feature Classes'. Paper presented at the University of Massachusetts, Amherst, October 21.

Padgett, Jaye. (1995). 'Feature Classes II'. Paper presented at the Second Holland Institute of Linguistics Phonology Conference, University of Amsterdam, January 1995. [To be published in proceedings].

Paradis, Carole and J.F. Prunet. (1989). 'On Coronal Transparency'. *Phonology* 6.2, pp. 317-348.

Polgárdi, Krisztina. (1994). 'Turkish Vowel Harmony in Optimality Theory'. Ms., HIL/Leiden University.

Prince, Alan. (1987). 'Planes and Copying'. *Linguistic Inquiry* 18.3, pp. 491-509.

Prince, Alan and Paul Smolensky. (1993). 'Optimality Theory: Constraint Interaction in Generative Grammar'. Ms., Rutgers University, New Brunswick, and University of Colorado, Boulder.

Pulleyblank, Douglas. (1994). 'Vowel Harmony in Optimality Theory'. To appear, *Proceedings of the Workshop on Phonology*, University of Coimbra, Portugal, September 1993.

Ryder, Mary Ellen. (1987). 'An Autosegmental Treatment of Assimilation to Labiovelars'. In proceedings of CLS 23 Part Two: Parasession on Autosegmental and Metrical Phonology, Chicago Linguistic Society.

Sagey, Elizabeth. (1986). *The Representation of Features and Relations in Non-Linear Phonology*. Doctoral dissertation, MIT, Cambridge, MA.

Sagey, Elizabeth. (1987). 'Non-Constituent Spreading in Barra Gaelic'. Ms., School of Social Sciences, UC Irvine.

Schane, S. (1972). '[back] and [round]'. In S.R. Anderson and P. Kiparsky (eds.), *A Festschrift for Morris Halle*. Holt, Rinehart and Winston, Inc., New York, pp. 174-184.

Schane, S. (1984). 'The Fundamentals of Particle Phonology'. *Phonology Yearbook* 1, pp. 129-155.

Selkirk, Elisabeth. (1988). 'Dependency, Place, and the Notion "Tier"'. Ms., University of Massachusetts, Amherst.

Selkirk, Elisabeth. (1991a). 'Major Place in the Vowel Space. Vowel Height'. Paper presented at the Workshop on Feature Organization, Linguistic Society of America Institute, Santa Cruz, CA. [manuscript University of Massachusetts, Amherst].

Selkirk, Elisabeth. (1991b). 'A Two-Root Theory of Length'. In E. Dunlap and J. Padgett, eds., University of Massachusetts Occasional Papers in Linguistics 14: Papers in Phonology. GLSA, UMass, Amherst.

Selkirk, Elisabeth. (1993). 'Labial Relations'. Ms., University of Massachusetts, Amherst.

Smolensky, Paul. (1993). 'Optimality, Markedness, and Underspecification'. Paper presented at the Rutgers Optimality Workshop I, New Brunswick, NJ.

Steriade, Donca. (1981). 'Parameters of Metrical Vowel Harmony Rules: the Underlying Representation of Harmonic Vowels'. Ms., MIT.

Steriade, Donca. (1987). 'Locality Conditions and Feature Geometry'. In proceedings of NELS 17, GLSA, Department of Linguistics, University of Massachusetts, Amherst, pp. 595-617.

Steriade, Donca. (1994). 'Underspecification and Markedness'. In John Goldsmith, ed., *Handbook of Phonological Theory*, Blackwell, Oxford, pp. 114-174.

Stevens, Kenneth and Samuel J. Keyser. (1989). 'Primary Features and their Enhancement in Consonants'. *Language* 65, pp. 81-106.

Stevens, Kenneth, Samuel J. Keyser and H. Kawasaki. (1986). 'Towards a Phonetic and Phonological Theory of Redundant Features'. In *Symposium on Invariance of Speech Processes*, J. Perkell and D.H. Klatt, eds., Lawrence Erlbaum, Hillsdale, NJ.

Trubetzkoy, N.S. (1939). *Grundzüge der Phonologie*. Vandenhoeck and Reprecht, Göttingen. [Second edition translated into Russian by A.A. Kholodovich. *Osnovy Fonologii*, Izdatel'stvo Inostrannoj Literatury, Moscow, 1960].

Vago, Robert M. (1980). *The Sound Pattern of Hungarian*. Georgetown University Press, Washington, D.C.

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