OCP Subsidiary Features

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Many languages put restrictions on the cooccurrence of consonants in some domain, such as the root. An example of this comes from Semitic. Consonants **within** any of the groups shown in (1) may not cooccur, while consonants from **different** groups freely cooccur (Greenberg (1960), McCarthy (1986)). C is emphatic (pharyngealized); χ, ʁ are uvular continuants; ħ, ʕ are pharyngeals.

(1)	Labials	f,b,m
	Coronal sonorants	l,r,n
	Coronal obstruents	θ,ð,t,d,s,z,š,ǰ,ṭ,ḍ,ṣ
	Dorsals	k,g,q,χ,ʁ
	Gutturals	χ,ʁ,ħ,ʕ,h,ʔ

The generalization seems to be that consonants involving the same articulator feature may not cooccur in a root in Semitic, though the role of [sonorant] and the existence of a guttural class raise some questions. (See below). So, for example, roots like those shown in (2) are rare or non-existent, since they contain two or more members from some group, while roots as in (3) exist.

(2) *dt, *fm, *lbr, *ʁk, *ʕsh, etc.

(3) ktb 'write', mqt 'detest', sm 'poison', dbk 'stamp the feet', ħlq 'shave', tʃb 'work hard', ʁsl 'wash', etc.

It seems less well-known that consonants that differ in stricture features can systematically violate the generalization given above. So, for instance, roots such as in (4) are not exceptional, though they contain **three** coronals. In all of these roots, the coronals differ in values of [sonorant] and/or [continuant].

(4)	drz	'sew'	drs	'study'
	dls	'swindle'	dns	'be soiled'
	zrd	'choke'	srd	'pierce'
	slt	'extract'	snd	'support oneself'

In this paper I focus on such exceptions to cooccurrence generalizations, and I claim that they require a revision of the Obligatory Contour Principle.

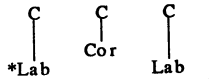
The cooccurrence facts of Semitic were treated rigorously by Greenberg (1960), and have been extensively analyzed by McCarthy, especially in McCarthy (1986). McCarthy's explanation of the basic phenomenon hinges on the Obligatory Contour Principle, which is given in (5).

(5) Obligatory Contour Principle (McCarthy (1986))

At the melodic level, adjacent identical elements are prohibited.

The relevant 'elements' in Semitic are the articulator features, which is to say that the OCP in Semitic applies over Place. In fact, McCarthy used the cooccurrence facts to make an argument for autosegmental and privative articulator features, a point later treated in Yip (1989). With an exception I will note later, the cooccurrence restrictions apply equally to adjacent and non-adjacent consonants. Since [coronal] does not mean [-labial], the [labial] nodes in (6) are adjacent, even though the relevant consonants are not, and so the representation is ill-formed.

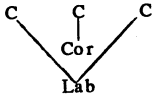
(6)



OCP violation

I follow McCarthy (1979) in assuming planar C-V segregation for Semitic underlying representations. Hence, for our purposes, 'non-adjacent consonants' means consonants separated by another consonant. This OCP analysis requires the added assumption that the place features cannot be multiply linked, as they are in (7), since this would otherwise wrongly make the representation well-formed.

(7)



In (8) I give a featural characterization of the relevant classes in Semitic, following McCarthy (1986). The grouping is based on McCarthy's analysis of about 3000 triconsonantal verb roots in Modern Standard Arabic. Based on a chi-square analysis, consonants within each group were found to cooccur significantly infrequently. I will call the groups 'identity classes', borrowing a term from Yip (1989).

(8) Semitic identity classes in featural terms:

[Labial]	f,b,m
[Coronal, +sonorant]	l,r,n
[Coronal, -sonorant]	θ,ð,t,d,s,z,š,ǰ,ṭ,ḍ,ṣ
[Dorsal]	k,g,q,χ,ɣ
[Pharyngeal]	χ,ɣ,ħ,ʕ,h,ʔ

The feature [pharyngeal]-- which is not, properly speaking, an articulator feature-- is argued for extensively by McCarthy (1991). The status of this feature is not important for our purposes, and I will not comment further on it.

There is a problem with the OCP analysis as it stands, discussed by McCarthy (1986), and later by Selkirk (1988) and Yip (1989). The OCP analysis wrongly prohibits roots such as those shown in (9), since they contain adjacent [coronal] nodes. In fact, coronal obstruents cooccur freely with coronal sonorants in Semitic.

(9) [+son] [-son]
Cor Cor — Well-formed, but wrongly ruled out by OCP

It is tempting to appeal to underspecification to explain such exceptions. We might suppose, for instance, that Coronal is unspecified in sonorants, and that these roots are therefore allowed because there is no OCP violation, as shown in (10).

(10) [+son] [-son]
Cor — No OCP violation

This cannot be right, though, because the coronal sonorants themselves form an identity class; that is, the OCP rules out the cooccurrence of coronal sonorants due to the presence of their adjacent identical Coronal nodes:

(11) [+son] [+son]
*Cor Cor

To account for the sonorant identity class, we cannot appeal to a separate OCP effect over the feature [sonorant] alone, since only sonorant coronals are prohibited from cooccurring. The labial nasal, for example freely cooccurs with the coronal sonorants, as do glides. One might suppose that non-coronal sonorants are unspecified for [sonorant], in order to pursue the analysis. However, this tack seems wrong for two reasons. First, it entails an unprincipled approach to underspecification, while at the same time leaving it an apparent accident that shared place is relevant to the constraint, a fact that becomes clear from observation of similar constraints in other languages. (See below). Second, it cannot explain the non-occurrence of forms like *lCr, where C can be specified for [sonorant] and hence render the [sonorant] values of l and r invisible to each other. (Again, see below). Clearly [sonorant] is playing some role in the computation of identity for the purposes of the OCP; I will try to define its role below.

It turns out that the feature [continuant] plays a similar role among both the coronal and dorsal obstruents, a fact suggested even by Greenberg's discussion. As Yip (1989) observes, McCarthy's data reveal such a role, though only among non-adjacent obstruents. Recall that 'non-adjacent' here means that another consonant intervenes, since we are concerned only with the consonantal plane. When non-adjacent, coronal fricatives cooccur with coronal stops, and dorsal fricatives with dorsal stops-- no significant infrequency was found. So, though (12)a is ill-formed, (12)b is not, since the coronals differ in [cont] values. Since this effect holds only for non-adjacent consonants, (12)c is ill-formed, in spite of the different [cont] values.

(12) a. [+cont] C [+cont] b. [+cont] C [-cont]
*Cor Cor Cor Cor

c. [+cont] [-cont] C
*Cor Cor

I do not mean to commit to any claim about the location of [continuant] in feature geometry at this point, though I will return to the question of geometry later. The facts depicted in (12) mean that, at least under non-adjacency, the computation of identity concerns both the articulator feature and [continuant], in a way similar to the case of [sonorant]. Again, we cannot appeal to place underspecification for either the fricatives or the stops, since these two groups form their own respective identity classes. And we cannot appeal to a separate OCP effect over [cont] alone, because fricatives otherwise cooccur freely, as do stops. Cooccurrences are ruled out only if place is shared as well.

We have, then, not just 2, but 3 coronal identity classes, as shown in (13).[1] Also shown are the 2 dorsal identity classes just referred to.

(13) Cor, [+son]: l,r,n
Cor, [-son], [-cont]: t,d,ʈ
Cor, [-son], [+cont]: θ,ð,s,z,ʃ,ʒ,ʂ

Dor, [-cont]: k,g,q
Dor, [+cont]: χ,ʁ

In what follows I will try to account for the joint role of the stricture and articulator features in these effects. Something I cannot explain is the role of adjacency on the consonantal plane in the effects involving the feature [continuant], and I will have nothing more to say about that fact.

I will make a distinction between regular OCP features on the one hand, and what I call 'OCP-subsidiary features' on the other. In Semitic, Place is an OCP feature, while both [sonorant] and [continuant] are subsidiary features for Coronal, and [continuant] is subsidiary for Dorsal:

(14) Semitic OCP features: Place

OCP-subsidiary features: Coronal: [son], [cont]
Dorsal: [cont]

I propose the Revised OCP given in (15), which builds on proposals of Yip (1989) and Selkirk (1991a):

[1]Not shown is emphatic ɖ, which groups with the coronal fricatives by this analysis. Greenberg (1960) uses this fact to argue that ɖ is derived historically from a fricative.

(15) Revised OCP

At the melodic level, adjacent identical elements 'F F' are prohibited, iff all features subsidiary for F are also identical.

The term 'subsidiary' is not meant in any geometrical sense at all and does not imply dependence. The proposal is that the OCP in Semitic applies in essentially two steps. First, a representation is checked for adjacent identical articulator nodes. If such nodes are found, then the representation is further checked for all OCP-subsidiary features relevant to the articulator feature. Only if the subsidiary features are identical-- or if none are relevant-- will the representation be ruled out.

I can find no principled alternative to the stipulation of particular subsidiary features for particular articulator nodes. Consider the labial identity class, which includes the segments f, b and m. Yip (1989) suggests that [continuant] plays no role within the labials due to underspecification: Assuming that f and b are distinguished by [voice], there is no need to specify either for [continuant]. These segments are therefore identical in the relevant respects, and so we predict their failure to cooccur. However, m also fails to cooccur with these segments; there is no principled reason for underspecifying m for [sonorant]-- recall that the coronal nasal must be specified for [sonorant], given the cooccurrence facts. So, if m is specified [+sonorant], assuming that subsidiary features are relevant for all articulators, we would predict that m cooccurs freely with f and b, contrary to fact. Perhaps the designation of subsidiary features for certain articulators is analogous to the stipulation of features in rule formulations; in fact, OCP-subsidiary features can play a role in language-particular rules, something we will see later. Accepting these stipulations allows us to pursue a principled approach to underspecification.

The distinction between normal OCP features and subsidiary ones is meaningful in two ways. First, as noted, while the articulator features always matter in the computation of identity, features like [sonorant] and [continuant] play a role only for certain articulators. Second, the subsidiary features matter even though they may not be adjacent on their tiers for the segments in question. The familiar requirement of tier-adjacency in the OCP holds only for the articulator nodes. Hence the Revised OCP in (15) says nothing about adjacency of subsidiary features. For example, as we have seen, [sonorant] plays a role among coronals even when the relevant consonants are non-adjacent. [sonorant] figures crucially in ruling out (16)a while allowing (16)b, even though the relevant [sonorant] features are not adjacent on their tier.

(16) a. [+son] [-son] [+son] b. [+son] [-son] [-son]

Lab Lab

*Cor Cor Cor Cor

We might claim that [sonorant] is not specified for the intervening consonant in some cases, but it seems clear that under any view of underspecification, there will be some segments with specified [sonorant] values, and these segments may intervene. The same argument holds for [continuant].

Let us apply the analysis to a few representations. We have adjacent identical articulator nodes in both (17)a and b. I assume that [continuant] is unspecified in sonorants, since it is redundant. Neither sonorant has a [continuant] specification in (17)a, then. The coronals are identically specified for the only subsidiary feature that is specified at all, [sonorant], and so we have an OCP violation. In contrast, the coronals in (17)b differ in [sonorant] specifications, and so this representation is allowed.

(17) a. [+son] [son] [+son] b. [+son] [son] [-son]
(cont)
*Cor Lab Cor Cor Lab Cor

In (18) we see cooccurrences of obstruents. The adjacent identical articulator nodes in (18)a are prohibited, since the relevant segments are identical in subsidiary [sonorant] and [continuant] values also. In contrast, (18)b is well-formed, since the segments in question differ in [continuant] values. I assume that if [-cont] is unspecified in (18)b, as the default value of [continuant], the segments can still be said to differ in [continuant] specifications. (Compare the discussion of (non)-distinctness in Yip (1989)). Clearly questions of underspecification will be very important in the computation of identity, and this is an area that calls for further research.

(18) a. [-son, +cont] [son] [-son, +cont] b. [-son, +cont] [son] [-son, -cont]
*Cor Lab Cor Cor Lab Cor

An examination of cooccurrence phenomena from various languages leaves one with the impression that the role of subsidiary features is by no means a rare effect. Though I am familiar with cooccurrence restrictions involving place in only a few languages, subsidiary features play a role in each one of them. A look at Russian roots, for example, gives results that are very similar to the Semitic facts. Russian has at least the identity classes given in (19). (On the nature of the Dorsal class, see below). C' is palatalized.

(19) Russian identity classes

a.	Lab		p,p',b,b',m,m'
b.	Cor:	[+son]	l,l',r,r',n,n'
c.	Cor:	[-son, -cont]	t,t',d,d'
d.	Cor:	[-son, +cont]	s,s',z,z'
e.	Dor		k,g,x [č,š,ž]

These facts are based on a chi-square analysis performed on about 500 Russian roots. Once again the basic breakdown of identity classes is by place of articulation, but again we see that [sonorant] and [continuant] play a role among the coronals. Coronal sonorants freely cooccur with coronal obstruents, and obstruent fricatives freely cooccur with obstruent stops. In this analysis, cooccurrences among consonant **clusters** were not counted. That is, in a form like gr'eb, only two cooccurrences were counted: g-b and r'-b. Since there is no planar C-V segregation in Russian (relative order of consonants and vowels is not

predictable), the effects reported are all for consonants that are separated by a vowel.

Some example roots are shown in (20). Those in (20)b in particular illustrate the role of stricture. Though they all have two coronals, the coronals differ in either [sonorant] or [continuant] values.

(20) a. gr'eb- 'dig'
koz- 'goat'
poln- 'full'
bod- 'awake'

b. brat- 'brother'
tolk- 'explain'
sad- 'sit'
etc.

In contrast, the roots in (21) are ill-formed.[2] Those in (21)b involve coronals that share these subsidiary feature values.

(21) a. *map-
*kag-

b. *lor-
*s'oz-
*dat- etc.

The analysis of cooccurrence restrictions involved grouping together Russian consonants in an informed trial-and-error manner and comparing the expected frequency of cooccurrence of segments within a group to the actual frequency. The grouping that was most informative, that is, in which the most effects were noted, is given in (22).

(22) Consonant groupings for the purpose of the chi-square evaluation:

p = p,p',b,b',m,m'
w = w,w',y
t = t,t',d,d',c
s = s,s',z,z'
l = l,l',r,r',n,n'
k = k,g,x,č,š,ž

The symbol at the left of each group represents that group in the charts in (23). The expected frequencies are computed in a standard way based on the actual frequencies. (For explanation see Padgett (1991)). For instance, based on the the overall occurrence of labials and the total number of roots, we would expect labials to occur together 7 times, while the actual value is 0.

(23) Cooccurrence Frequencies (out of 500 roots)

a. Actual

	p	w	t	s	l	k
p	0	3	21	18	25	32
w	2	1	15	6	17	4
t	9	6	5	4	21	19
s	3	3	9	0	13	8
l	10	10	30	24	3	36
k	12	7	31	19	27	10

b. Expected

	p	w	t	s	l	k
p	7	6	23	15	22	23
w	3	2	10	6	10	10
t	4	4	15	9	14	15
s	2	2	8	5	8	8
l	8	7	27	17	25	26
k	8	6	25	16	24	24

[2] It should be kept in mind that, as with the Arabic facts, these are statistically significant generalizations, not exceptionless ones.

The chi-square evaluation determines the significance of the deviation of the actual from the expected, where a value greater than .95 is considered significant. Only the significant effects are reported in (24), and in each case the actual frequency is less than the expected frequency. From these results we derive the identity classes given at the outset.

(24) Chi-square Percentile Values >/= .95

	p	w	t	s	l	k
p	99					
w						
t			99			
s				98		
l					99	
k						99

A few comments are in order at this point. First, no cooccurrence effects were found involving the glides (except a near-significant effect on occurrence of glides with dorsals, only in that order), nor was there evidence for grouping either of them with any other class of segments, and so they are not treated further. Second, it is not clear whether the coronal affricate c belongs with stops or fricatives, based on this analysis. Third, palatal č and alveopalatal š and ž were found to interact with the velar segments. In roots, these segments largely derive historically from velar segments themselves. I will not treat them as velars here, but instead regard this as historical residue. Finally, I should note that the sample of roots was fairly small, and that some effects may have been missed simply for that reason.

In Russian, then, as in Semitic, the OCP applies over Place, with the features [sonorant] and [continuant] subsidiary for Coronal:

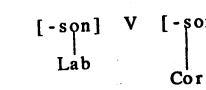
(25) Russian OCP features: Place

OCP-subsidiary features: Coronal: [son], [cont]

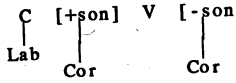
The analysis is just as with Semitic: The OCP first checks for adjacent identical articulators, and if they are found, checks further for identical specified subsidiary feature values, in the case of coronals. Again, we must assume that articulator nodes cannot be multiply-linked.

Some roots are shown below. (26)a is well-formed because there are no identical articulator features at all. (26)b is well-formed in spite of the adjacent identical Coronal nodes, because the relevant segments differ in [sonorant] values.

(26) a. bod- 'awake'

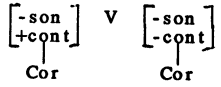


b. brat- 'brother'



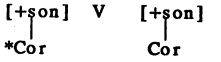
Similarly, the coronal segments in (27) differ in [continuant] values.

(27) sad- 'sit'



(28) is ill-formed, because of the identical [sonorant] values.

(28) *lor-



It should be noted that the lack of planar C-V segregation in Russian raises serious questions that cannot be pursued here about the role of the vowels in the cooccurrence restrictions. Should vowels be characterized in terms of some or all of the place features relevant to consonants? If so, then the articulator features of consonants separated by vowels will not always be adjacent in the usual sense.

I will now briefly note some other cases of cooccurrence restrictions known to me, and the subsidiary features involved. For a fuller account of these facts, refer to Yip (1989), Padgett (1991) and the references cited below.

Yucatec Maya has separate, independent OCP effects over Place, [+continuant] and [constricted glottis], as McCarthy (1987) and Lombardi (1990) have argued. In addition, though, [cont] acts as a subsidiary feature for Coronal.

(29) Yucatec Maya

OCP features: Place, [+cont], [constr. gl.]

Subsidiary features: Cor: [cont]

Besides accounting for a constraint on possible roots, the analysis lends insight into a rule of Yucatec Maya, in which stops reduce to h and affricates become fricatives, all before homorganic stops. Examples are given in (30), with the segments in question in boldface. In (30)a we see k reducing to h before k, and in (30)e we see č reducing to š before t.

(30) Stop reduction in Yucatec Maya (See Lombardi (1990)).

Stops --> h
Affricates --> fricatives Before homorganic stop

a. taaŋ k pak'ik k kool --> taaŋ k pak'ik h kool 'we're planting our clearing'

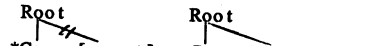
b. leʔ iŋ w ot čo --> leʔ iŋ w oh čo 'that house of mine/my house there'

c. tun kolik k'aaš --> tun kolih k'aaš 'he's clearing bush'

d. ʔuc t iŋ w ič --> ʔus t iŋ w ič 'I like it (goodness is at my eye)'

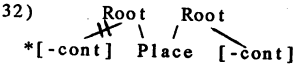
e. c'u hoʔoč tik --> c'u hoʔoš tik 'he scratched it'

Following Lombardi, I analyze this as the delinking of a [-continuant] value, as shown in (31). Affricates are thereby reduced to fricatives. Stops debuccalize, since a place specification without a [continuant] specification is ill-formed.

(31) 

Triggered by OCP over Cor, with subsidiary [-cont]

Unlike other researchers, though, I maintain that the rule is triggered by an OCP effect over Coronal and [continuant] together, since shared Coronal and shared [-continuant] are both crucial for rule application. Consider the alternative, shown in (32), which is to say simply that linked place is a prerequisite to the application of this rule, an approach taken by Lombardi (1990).

(32) 

This does not seem right, because the relevant segments must be homorganic only in the loose sense of having identical articulator features. They are not actually place linked, because they may differ in minor place features, as seen in (30)e. š, in reducing to s̆, remains [-ant] before [+ant] t̆.

In Javanese, [sonorant] is subsidiary to Coronal (Mester (1986), Yip (1989)). There is evidence also for a subsidiary feature that distinguishes the coronal nasal from the liquids, since the liquids l and r seem to form an identity class separate from n. In fact, though no statistically significant effect of this sort was found in Semitic or in Russian, there is an apparent numerical tendency in that direction in both languages. Exceptional roots containing two coronal sonorants largely contain the nasal and a liquid, rather than two liquids, in both Semitic and Russian (e.g. Russian len' 'lazy'). Clements (1990) has proposed that the feature [approximant], which makes the necessary distinction here, be incorporated into the theory. I suggest in Padgett (1991) that this stricture feature is playing a subsidiary role in at least Javanese.

In Alur, it seems that the feature [anterior] is subsidiary to Coronal (Mester (1986), Yip (1989), Padgett (1991)). Though dentals may not cooccur with alveolars in Alur roots, either may cooccur with the [-anterior] segment č.

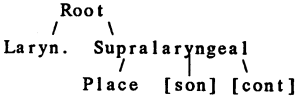
Finally, subsidiary features seem to be at work in cooccurrence restrictions in Coeur d'Alene (Bessell and Czaykowska-Higgins (1991)), Pomo (Yip (1989)) and Takelma (Lee (1991), Goodman (1992)).

In conclusion, I would like to raise the question of whether the class of features that may be OCP-subsidiary is restricted in any principled way, and whether such a restriction should be stated in geometrical terms. Following McCarthy (1986), Yip

(1989) and Selkirk (1991a), I believe that the answer must be yes to both of these questions. All of the cases I am aware of involve basic OCP effects over place. The features that can be subsidiary in the sense outlined here seem to be the stricture features, and minor place features like [anterior]. There seem to be no cases where the feature [nasal], for instance, or the laryngeal features, are subsidiary, though there are sometimes OCP effects on these features themselves. There is an OCP effect on [constricted glottis] in Maya (see above), and on [voice] in Japanese (Mester and Itô (1989)). Takelma has an OCP effect on [nasal] itself (see references above). Yet I have seen no case, for instance, in which two coronals are disallowed unless they differ in some laryngeal feature or in [nasal]. An optimal theory of feature geometry should therefore be able to characterize all of the place and stricture features to the exclusion of features like [nasal] and [voice].

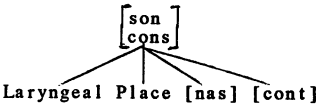
One way of doing this is with a node that groups all and only these features together, such as one version of Supralaryngeal, as shown in (33).

(33)



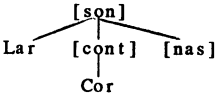
However, there is little independent evidence for any class node Supralaryngeal, as argued by McCarthy (1988), Iverson (1989) and Padgett (1991). Yet a geometry such as that advocated by McCarthy (1988), shown in (34), leaves no way of characterizing the right features, a problem shared by most proposed geometries.

(34)

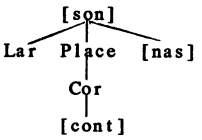


In recent work, Selkirk (1991a), (1991b) and Padgett (1991) have focused on the frequent interaction of place and stricture features in phonological processes, a phenomenon unexplained by standard geometries. To explain such effects, Selkirk argues for the geometry given in (35)a, while I argue for (35)b.

(35) a. Selkirk (1991a), (1991b)



b. Padgett (1991)



I refer the reader to the references cited for arguments for these geometries. Here I wish only to point out that the geometries in (35) have the added advantage of allowing a fairly straightforward characterization of just the right features. We can characterize

the stricture and minor place features as those either dominating or dominated by the articulator feature.

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