PRO-SEGMENTS AND SYLLABLE STRUCTURE

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Introduction[1]

In the history of generative linguistics syntax and phonology have shared many properties. The analysis of categories into features, an integral part of phonology since Jakobson and Halle (1956) and Halle (1959), appeared in syntax in Chomsky (1965). Context-sensitive rules of the form A --> B / C__D were integral to early work in syntax (Chomsky (1957)) and from the first, and still today, play a central role in generative phonology. In Chomsky and Halle (1968), there are rules with the formal structure of transformations to permute elements (metathesis) as well as to contract them. Also in that work the cyclic application of stress rules was developed along the model of the transformational cycle in syntax spelled out in Chomsky (1965). However, there was always a major difference in the nature of the formal mechanisms in syntax and phonology. While rules in syntax involved constituents and were structure dependent, rules in phonology applied to numbered items in a string and were structure independent. For example, the rule which relates the sentences in (1) could not be "permute the first two words in a string."

(1) a. John is here.
b. Is John here?

Such a rule would for other examples give the results in (2).

(2) a. The boy is here.
b. *Boy the is here?

Furthermore, it would not do to say "identify the first instance of the copula and move it to the beginning of the sentence", since that would for still other examples give the results in (3).

(3) a. The boy who is here is my brother.
b. *Is the boy here is my brother?

Rules in phonology, however, are exactly of that type. They take the form "in-

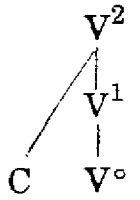
sert a glottal stop before a word initial vowel", "make a vowel lax in the third syllable from the end of the word", or "assimilate *s* for the feature [voice] to the last segment the stem". Thus, while rules in syntax apply to hierarchically structured constituents, rules in phonology apply to numbered items in a string. I believe it is this difference between generative syntax and phonology that has left phonology as a largely descriptive enterprise while syntax has moved, at least in principle, towards the goal of explanatory adequacy.[2]

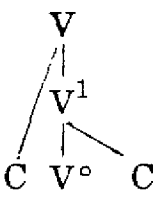
The structure dependence of syntactic rules allows for general contraints, like structure preservation, to be placed on their application, which in turn leads to the reduction of their expressive power to a single rule like "move α". Such a reduction in the expressive power of phonological rules is not possible if they apply to numbered items in a string. In what follows I suggest ways in which the expressive power of phonological rules can be reduced, in fact, to an operation like "move α" in syntax, by making them structure dependent and subject to structure preservation. I show how this approach moves generative phonology in the direction of explanatory adequacy. I focus specifically on the distribution and interpretation of the abstract segments C and V (consonants and vowels with unspecified properties), which play a traditional role in phonology. I refer to such segments as pro-segments (Pro-C and Pro-V), since like pronouns in syntax, their interpretation is largely dependent on other elements under quite specific structural conditions. I begin by outlining certain assumptions about constituent structure and interpretation in phonology, illustrating how they work with well known examples. Then, I turn to the treatment of pro-segments in phonology.

Syllable Structure Theory

It is a curious fact about sequences of sounds that consonants spliced off from following vowels and sounded out are not identifiable as speech sounds at all, nor do they sound the same, even if they were the same consonant, if the vowel which is left behind was different (Liberman et al. (1967)). Typically, consonants do not occur in isolation in words, but are grouped around vowels in syllables. I assume (following Kahn (1976)) that this grouping is not incidental, but that syllables are the basic constituents of phonology. Syllables are traditionally analyzed into an onset consonant and a rhyme. The rhyme is further analyzed into a nucleus vowel and a coda consonant. The structure is, therefore, hierarchical (but see Clements and Keyser (1983) for a nonhierarchical view of the syllable). Since syllables are headed by vowels, it is appropriate to represent them as vowel projections in an X-bar framework as illustrated in (4) (see Levin (1985) for a similar proposal).

(4) *Syllable Structure* (Hong and Michaels, 1985)

a. 

b. 

In (4a), the lexical vowel (V°) projects a category V^1 (rhyme), which further projects a category V^2 (syllable), which dominates V^1 and a specifier (or onset) consonant. In 4b), the V^1 projection dominates V° and a complement (or coda). The fact that complements are optional under the rhyme constituent has important consequences, since it is here that language differences in syllable structures are largely expressed. This will be discussed further below under the section on the coda parameter.

Given structures such as those in (4), it is possible to view phonetic interpretation of phonological representations as interpreting the properties of segments in lexical representations at the syllabic categories that dominate them. Thus, for example, the onset consonant in (4) is interpreted at V^2 along with the vocalic properties which percolate to that level.
Phonetic interpretation of onset consonants at the syllable level (V^2) is consistent with the observations of Liberman et al (1967) that consonants have no phonetic interpretation independent of the vowel that they are syllabified with. Interpretation at dominating categories also makes it possible to do without context sensitive phonological rules. But first it is necessary to assure that all categories in a syllable structure configuration will have an interpretation. This we can do by requiring full interpretation of phonological segments in syllable structures in the following ways.

(5) *Principles of Interpretation*
- a. *Segment Preservation*: Every segment that can be syllabified must be syllabified.
- b. *Phonetic Interpretation*: Phonetic interpretation is at V^2. Thus, only segments in syllable structures are phonetically interpreted.
- c. *Percolation*: Dominating categories are interpreted by the content of the categories they dominate.
- d. *Full Interpretation*: Every category in a syllable structure must have an interpretation.

Markedness Theory

The central purpose of phonological rules is to relate alternating forms to a single lexical representation. This is accomplished by selecting a suitably abstract lexical representation for related words and morphemes from which to derive the surface alternants by the simplest set of rules. Here I will assume that the abstractness of lexical representations of alternating segments is constrained to representations in terms of unmarked and marked features. That is, segments which do not alternate will be specified with plus or minus features. Those which do alternate will be specified with unmarked and marked (u/m) values for the features that alternate. The u/m feature values can be thought of as "jokers" which can be interpreted as plus or minus values in appropriate contexts or by default universal conventions such as those in Chomsky and Halle (1968, Chapter 9). I assume that default interpretation is a last resort. This can be formalized by allowing interpretation of u/m values by universal conventions only at V^2. That is, any u/m values that percolate up to the highest node in a syllable structure will receive a default interpretation there. U/m values will only reach V^2 if they are not given a structural interpretation at some lower category. Thus, default interpretation is characterized in (6).

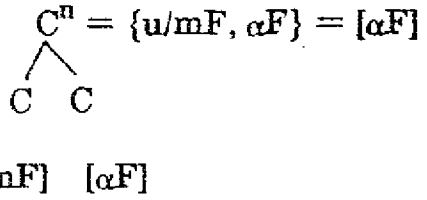
(6) *Default Interpretation*
Interpretation of u/m values for features is by universal markedness conventions at V^2 (syllable).

Structural interpretation of u/m values for features is what replaces context sensitive rules in phonology. By structural interpretation, I assume that u/m values are nondistinct from +/- values for the same feature at a dominating category. Segments which alternate for some feature are unmarked or marked for that feature in lexical representations. If a segment with u/m values for features is structured together with another segment specified +/- for those features, then at the dominating category, we get the interpretations in (7) (from Michaels and Tiedeman, 1986; Tiedeman, 1987).

(7) *Structural Interpretation of u/m feature values*
a. {[uF], [+F]} = [+F]
b. {[uF], [-F]} = [-F]
c. {[mF], [+F]} = [+F]
d. {[mF], [-F]} = [-F]
e. {[uF], [mF]} = [mF]

Structural interpretation of u/m values for consonants is exemplified in the diagram in (8).

(8) *Consonant Assimiliation*



To illustrate, consider the case of the assimilation for voice in English of the plural morpheme to the final consonant of the stem to which it attaches as in *dogs* [z] and *cats* [s]. In a rule based account, the lexical representation of the plural can be *z*, and a rule formulated to unvoice *z* after a voiceless consonant as in (9).

(9) [z, plural] --> [-voice] / [-voice] __

The rule in (9) is a straightforward statement of voicing assimilation. However, it fails to explain the assimilation, since nothing in the rule based theory or in the lexical representation of the plural morpheme forces assimilation. This is characteristic of analysis by rule. For any given rule, a rule with the opposite effect could equally well describe the event (say, with the plural represented as voiceless lexically and a rule which voiced it in voiced contexts). Worse yet, any number of rules with irrelevant or wrong effects for the plural assimilations would have to be considered and ruled out as possibile hypotheses (say, with the plural represented as voiced lexically and a rule which devoices it in voiced contexts).

In the syllable structure adn markedness approach outlined above, the assimilation for voice is forced without positing a language particular rule. Since the plural morpheme alternates for the feature voice, it must be represented as unmarked for that feature. Since it turns up voiced in isolation in coda position after vowels as in *bees*, it must be [m voice] in lexical representation. Principle (5a) requires that every segment be syllabified. Thus in cases like *dog+plural* and *cat+plural*, the plural *Z* (marked for voice) must be syllabified together with *g* and *t* in the complements of the respective syllables. Since unmarked or marked values of features are nondistinct from plus or minus values of the same features at dominating categories (7), and since every category must have an interpretation under (5d), we get the analysis in (10a) for *cats* and (10b) for *dogs*.

(10) *Voicing assimilation in English*

a. C {-voice, m voice} = [-voice]

[- voice] [m voice]

b. C {+voice, m voice} = [+voice]

[+voice] [m voice]

Notice that no language particular rules are necessary to get the assimilations for voice. Instead they follow automatically from the lexical representations of alternating features with u/m values, principles of syllable structure and markedness theory.

Pro-segments in Phonology

I turn now to somewhat more complicated phonological alternations, alternations involving abstract, or pro-segments. In English, there are alternations between single consonants in (11a) and geminate clusters in (11b). The alternating consonants at issue are italicized in the examples.

(11) *English Gemination and Degemination*

a.		b.		c.	
a*pp*ly		a*pp*lication		aC+ply	
a*tt*est		a*tt*estation		aC+test	
su*pp*ly		su*pp*lication		suC+ply	
su*pp*ose		su*pp*osition		suC+pose	

If representations like those in (11c) are assumed, then Pro-C must delete in the cases in (11a), but copy the features of the consonant to the right in (11b). Gemination appears to hold after a stressed vowel in (11b), degemination after a stressless vowel in (11a). That syllabification of codas in English falls together with stress in such cases can be seen more clearly in examples such as those in (12), where the dot represents syllable boundary.

(12) *Codas and Stress in English*

a.		b.	
a. spíre		às.pirátion	

de.spáir	dès.pirátion
de.cláire	dèc.larátion
a.cróstic	àc.rostícian
re.stóre	rès.torátion

In the cases in (12a), the unstressed first syllable has no coda. In (12b), where stress falls on the first syllable it appears to pull the first consonant of a following cluster to its coda position. Representing the cases in (11) in a similar way brings out the geminating (13b) and degeminating (13a) contexts.

(13) *Stress and Syllabification in English*

a.		b.	
	a.pplý		àp.plicátion
	a.ttést		àt.testátion
	su.pplý		sùp.plicátion
	su.ppóse		sùp.posítion

Thus, it appears that in English a stressed syllable attracts the pro-segment copy of a following consonant to its coda position, resulting in a geminate cluster of consonants. Where the preceding syllable is unstressed, the prosegment does not emerge phonetically.

A similar phenomena can be seen in Italian in what is called syntactic doubling (*raddoppiamento sintattico*) (Bertinetto & Loporcaro, 1988; Loporcaro, 1988). In Italian, a final stressed short vowel triggers gemination of the initial consonant of the following word as in (14a).

(14) *Syntactic Doubling in Italian*

a.			b.
	mangió(p) poco	'(He) ate little'.	mangioC#poco
	dá(t) tutto	'(He) gives everything'.	daC#tutto

If these cases are given representations with final Pro-C as in (14b) (following Bertinetto and Loporcaro, 1988), then the parallel with English is clear. In both England and Italian a stressed syllable attracts the Pro-C copy of a following consonant to its coda position. Note that in Italian, a stressed vowel in an open syllable will normally be long. The final stressed syllables that trigger syntactic doubling are all short. This follows from interpreting them as stressed vowels in syllables closed by Pro-C.

There is a Calabrian dialect of Italian, Senigalliese, described by Mancini (1986, cited in Vincent (1988)), in which the pattern of geminated consonants after a stressed vowel, single consonants after an unstressed vowel is extended broadly throughout the vocabulary as illustrated in (15) from Mancini

(1986).

(15) *Senigalliese*

Standard Italian	*Senigalliese*	*Gloss*
stúpido	stúppido	stupid
médiko	méddiko	doctor
fégato	féggato	liver
pennéllo	penéllo	brush
fattsoléttо	fatsuléttо	handkerchief

As Vincent (1988) points out, the pattern of geminate/nongeminate clusters shows up in morphophonemic alternations such as [ríkke] 'rich', [rikéttsa] 'richness' and [bálla] 'he dances', [balé] 'to dance'. This pattern of alternation is quite similar to the one illustrated in (13) for English.

Still another case, one which has received an explicit analysis along these lines, is gemination and degemination in Southern Paiute. Sapir (1933) describes as automatic, in Southern Paiute, processes that turn lexical *p, t, k* and k^w into geminates. He attributes gemination to the inherent property of the morpheme which precedes these morpheme initial consonants. Chomsky and Halle (1968) give Sapir's inherent geminating force a segmental interpretation. They represent the morphemes which trigger gemination in the initial consonant of the following morpheme with an abstract final consonant, similar to what I have been calling Pro-C. This consonant copies the place of articulation features of a following consonant. In other contexts it deletes. Thus they represent Sapir's /ma+pa/ as /maC+pa/ and posit the following rule to get the geminating effect.

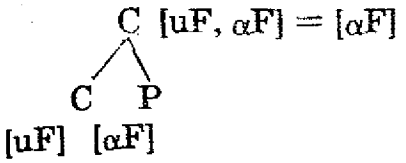
(16) *Gemination*

$$C \dashrightarrow \begin{bmatrix} \alpha\text{ant} \\ \beta\text{cor} \\ \dots \end{bmatrix} \; / __ + \; \begin{bmatrix} +\text{cons} \\ \alpha\text{ant} \\ \beta\text{cor} \\ \dots \end{bmatrix}$$

Notice that the effect of the gemination rule falls out automatically if Pro-C is structured together with the following specified consonant in a single syllable structure position, much in the way that the voicing assimilations were shown to fall out for English. Since Pro-C alternates for its place of articulation features with the following consonant, it must be represented with u/m values for these features. If it is structured together under a dominating C-category with the following consonant, specified +/- for the same features, we

get the result in (17).

(17) *Gemination*



Thus, where α equals +/-, the unmarked features of Pro-C are nondistinct from its sister consonant under the dominating C-category in (17). Let us say that the dominating category is the onset position of the second syllable of *mappa* (that is, /ma.Cpa/). Then it remains to show how Pro-C gets into the onset position of the second syllable at initial syllable structure, and then how it gets into the coda position of the first syllable for phonetic interpretation.

Something like the onset first principle of Kahn (1976), Clements and Keyser (1983) or Selkirk (1982) could force Pro-C to structure together with the following consonant in onset position of the second syllable. However, all versions of this principle are quite stipulative, and it obviously fails to work for cases like *aspiration* in (12), where the *sp* cluster is a possible onset (compare *aspire*) and yet is split between two syllables. Instead, I assume (following Ishii and Michaels (1988)) that pro-segments must be bound to another segment for interpretation. Thus, if Pro-C were to be structured initially in coda position of the first syllable, it would not be bound and would violate a condition on pro-segments. The binding condition on pro-segments is then simply as stated in (18).

(18) Pro-segments must be bound.

I assume that binding in phonology is strictly local. That is, if a pro-segment is adjacent to a specified segment of the same category, and is immediately dominated by the same category that dominates the adjacent segment, it is bound by that segment. I formulate binding in (19).

(19) *Binding*
α binds β, if α and β are of the same category (that is, C or V), and the category Γ that immediately dominates α, immediately dominates β.

Now, pro-segment binding (18-19) will insure that Pro-C is structured together with a following consonant in onset position, since onsets are obligatory categories and pro-segments must be bound. It remains to move Pro-C to co-

da position.

As mentioned earlier, given a constituent structure theory of phonology, it is possible to severely restrict the rules that apply to constituents in a way that is similar to rules in syntax. We can, for example, require that rules be structure preserving. Thus rules cannot create or destroy syllables (see Lapointe and Feinstein (1982) for a similar proposal in a framework with context sensitive rules). In fact, rules can be limited to the single operation "move α", if we assume that movement can only be to an empty category of the appropriate type. Furthermore, it appears that movement in phonology can only be between adjacent positions. For the case under consideration in Southern Paiute, Pro-C, bound (and interpreted) in onset position of the second syllable, moves to an empty coda position in the first syllable as illustrated in (20).

(20) pa_.Cka
└┘ (by "Move α")

It still remains to motivate the empty coda position to which Pro-C moves. As noted above for English and Italian, it appears that a coda position is licensed in a stressed syllable. Following Majdi and Michaels (1987), I will assume that stress assigns a coda licensing property to vowels (call it [+L] for "licensing"). Furthermore, a vowel marked [+L] must assign this property to a complement, and the complement position of a [+L] vowel cannot be empty. I summarize coda licensing under stress in (21).

(21) *Coda licensing under stress*
a. Stress assigns a licensing feature [+L] to the syllable head.
b. [+L] must be transmitted to a complement of the syllable head.
c. A licensed [+L] coda position must have phonetic content.

Thus, I assume that each vowel in a lexical representation is [u L]. Stress maps the [+L] feature to any vowel that can satisfy its conditions as spelled out in (21), interpreting [u L] as [+L]. If a vowel cannot satisfy the coda licensing conditions, [u L] is interpreted as [-L] by default. If the syllable preceding Pro-C in the example in (20) is stressed, that is marked [+L], then the movement of Pro-C to the empty coda position is forced. "Move α" is, therefore, optional in phonology. If it fails to apply in (20), when the first syllable is stressed, the structure will violate the coda licensing principles in (21) and be ruled out for that reason.

In Southern Paiute, stress is governed by an alternating stress rule which stresses even numbered vowels counting from the beginning of the word (Sapir (1933), Chomsky and Halle (1968)). Where the syllable preceding Pro-C is

unstressed under the alternating stress rule, there is no coda position for Pro-C to move to. In this case it deletes. Chomsky and Halle (1968) posit a degemination rule which deletes a consonant after another consonant before a stressed vowel (22).

(22) *Degemination*
C_i --> ø / C_i __ [V, +stress]

Thus, *ma.Cpá* will become *ma.pá* by (22). Notice that there are at least three other ways to get the same effect as the Degemination Rule (22). These are illustrated in (23).

(23) *Alternative Degemination Rules*
a. C_i --> ø / __ C_i [V, +stress]
b. C_i --> ø / [V, -stress] C_i __
c. C_i --> ø / [V, -stress] __ C_i

That is, delete the first consonant in the cluster, rather than the second, before a stressed vowel (23a), or delete either of the consonants in a cluster after an unstressed vowel (23b,c). Since the cluster is a geminate cluster, it doesn't seem to matter which consonant is deleted. Since Southern Paiute has an alternating stress pattern, the context "before a stressed vowel" is equivalent to the context "after an unstressed vowel". Chomsky and Halle (1968) choose one way to degeminate (22). Sapir (1933) chooses a way more like the rules in (23b,c). Since he represents geminates as "long" consonants, it could either be the first or second member of the cluster that deletes. However, he says that degemination occurs after an unvoiced vowel, and since a necessary condition for unvoicing a vowel in Southern Paiute is that it has no stress, it is clear that the contexts (23b,c) are what he had in mind. In any event, in a rule based framework, there are several ways to describe degemination and no nonarbitrary way to choose among them. This is not so in the syllable structure framework.

In the case where the preceding syllable is unstressed and does not license a coda position, Pro-C cannot move. Where Pro-C cannot move, it remains in onset position with its specified adjacent consonant. At the dominating C-category (onset), Pro-C is nondistinct from the specified consonant, and they are interpreted as a single segment in a single syllable structure position. Thus, degemination follows automatically when the preceding syllable is unstressed. This is close to Sapir's informal description. The degemination rule (22) in Chomsky and Halle (1968), though correct in their framework, seems to make the wrong generalization when viewed from this framework, since the stres-

sed vowel following the cluster can have no effect on the geminate status of the preceding cluster. Since the rule based account does not force a particular solution in any event, it is not explanatory.

The similarity between the Southern Paiute gemination and degemination pattern and that in English, illustrated in the examples in (13), is striking. The contexts for gemination an degemination in English are identical to those in Southern Paiute. Thus, following an unstressed vowel, Pro-C in English is nondistinct from its sister in the onset of the following syllable and must remain there, where a single segment interpretation results in a single syllable structure position. Following a stressed vowel, however, Pro-C moves to the licensed coda position and the geminate interpretation results. Similarly, at least for gemination, syntactic doubling in Italian (14) follows in the same way as gemination in Southern Paiute and English, if we assume that the stressed final vowel is followed by Pro-C. Once again, the pro-segment is bound in onset position with the following specified consonant. Since the stressed vowel which precedes licenses a coda position, the bound pro-segment can move to that position giving the doubling effect. No language particular rules are required to force these patterns. Rather they result from the interaction of representations with a pro-segment, principles of syllabification, markedness, move α, binding of a pro-segments and coda licensing under stress. The lexical representations with Pro-C are not unlike those proposed for Southern Paiute by Chomsky and Halle (1968) and for Italian by Bertinetto and Loporcaro (1988). The principles which yield the patterns of gemination and degemination are presumably part of Universal Grammar.

The fact that several languages share quite specific conditions on the interaction of stress and syllabification suggests that these conditions might follow from a general parameter governing codas. I turn now to a consideration of the nature of such a parameter.

A Coda Parameter

In the study of comparative grammar, the one place where language differences are usually expressed in syllable structure is the complement position (or coda) of the rhyme. Typically, languages are characterized as having CVC or CV syllable structures. If we assume that [-coda] is an unmarked parameter setting, that CV languages are the unmarked case, then the marked [+coda] setting is arrived at on the basis of readily available data, such as words ending in consonants or word internal geminate clusters of consonants, as those discussed for English, Italian and Southern Paiute. In the [+coda] case, there may be further parameter settings. For example, a stressed coda para-

meter, which is set as plus, just in case codas are only licensed in stressed syllables, and minus if they are freely licensed. In the discussion of gemination and degemination, coda licensing under stress was assumed. If [+L] is set parametrically in [+coda] languages, then the analyses given above would follow from this setting. Thus, in English, Italian and Southern Paiute, the coda parameter would be set as [+coda] on the evidence of internal geminate clusters, and the stressed coda parameter would be set as [+L] on the evidence of geminates following a stressed vowel.
Setting the parameters in this way would predict that degemination would follow an unstressed vowel, that is, a vowel which does not license a coda position.

The positive setting, in English, of the coda parameter and stressed coda parameter also predicts contrasts between words like the noun *can* with *n* in coda position in a stressed syllable, and the auxiliary *can*, which is typically unstressed, and in which *n* is realized as nasalization on the vowel rather than as consonantal *n* in a licensed coda position (Malécot, 1960).
This contrast is also evident in pairs of words such as those in (24).

(24) a. *Verb*	b. *Noun*
conténT	cóntent
convért	cónvert
convíct	cónvict
combíne	cómbine

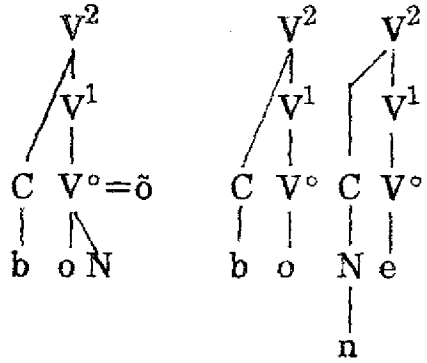
I assume that the nasal consonant in such cases is Pro-N, since it alternates between consonantal and vocalic realizations, and for place of articulation features with the following stop consonant. In (24a), the initial syllable is unstressed, the vowel reduced and the nasal consonant realized as nasalization on the vowel. In (24b), the initial syllable is stressed, the vowel is not reduced and the nasal is realized as coda to the stressed vowel. Since English is a [+coda, +L] language, these consequences follow automatically.

It might be expected that nasalization of vowels would be more pervasive in a language with a negative setting of the coda parameter. In such a case, a postvocalic nasal consonant which cannot be licensed as onset to a following vowel, would necessarily have to adjoin to the preceding vowel, since there would be no coda position for it to occupy. Nasalization and related processes in French can be analyzed in this way as illustrated in the next section.

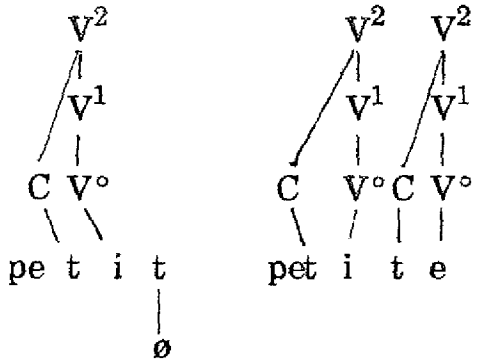
Nasalization, Deletion and Liaison in French

As an example of the consequences of a [-coda] parameter setting, consider the facts of postvocalic consonants in French. In French, a syllable final nasal nasalizes the preceding vowel and deletes as in *bon* [bõ]. If the nasal is onset to a following vowel, nasalization does not occur, as in *bonne*. Though, the feminine ending *e* may be pronounced in citation forms or "careful" speech, it normally is reduced or deleted. Alternatively, the feminine ending could be represented by an abstract vowel. This vowel would be sufficient to license the preceding consonant. Since the vowel itself has no phonetic content, it cannot have a phonetic interpretation. The syllable which it heads, however, could adjoin to the preceding vowel. Thus, adjunction of an obstruent to a vowel would only be possible through a syllable headed by a vowel with no phonetic properties. Such a vowel would be the lexical representation of the feminine in French. Its presence at initial structure is what is at issue here. Syllable final obstruents, as opposed to nasals, delete in French. In *petit garçon*, word final *t* deletes (compare *petite fille*, where *t* is onset to a vowel, the feminine ending, and does not delete). The facts of nasalization and consonant deletion follow automatically, if in French the coda parameter is set [-coda], as illustrated in (25).

(25) a. Nasalization



b. C-deletion



In (25a), *N* is taken to be a maximally unmarked nasal (that is, specified only [+nasal] and unmarked for all other features). The vowel o, which alternates for nasality, is [u nasal], and by default [-nasal]. Since there is no coda position under the [-coda] parameter setting in which *N* can be licensed, it adjoins to V°. Since *N* is unmarked for all features except [+nasal], and the vowel is [u nasal] and specified for all other features, the two segments are nondistinct at V°, and yield a [+nasal] vowel with the features of *o*, that is, [õ]. Where *N* is followed by a vowel, it will be licensed in onset position to that vowel. Here, since it is alone in onset position, no structural interpretation of

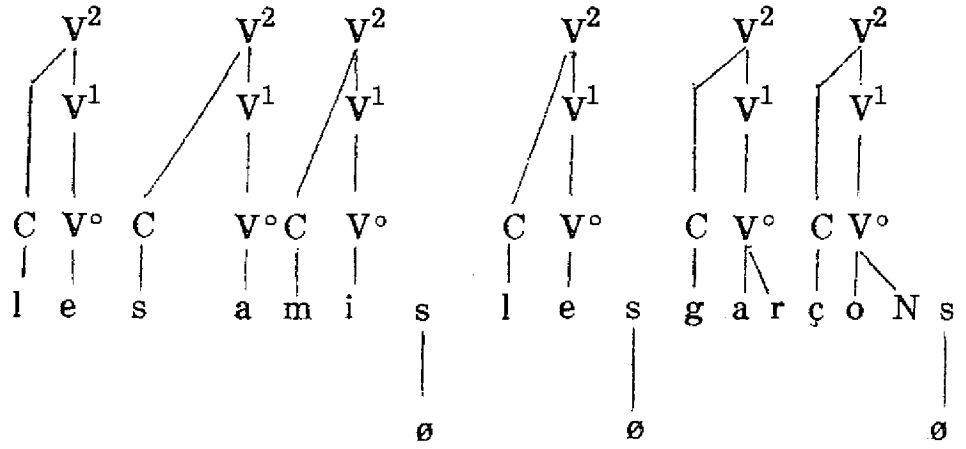
its unmarked features is possible. Instead it receives a default interpretation under universal markedness conventions, yielding *n*.

In the case of *petit* in (25b), the obstruent *t* (unlike the sonorant *N*) cannot adjoin to a vowel position. That is, sonorants are compatible with vocalic positions either because they are [+voc] or [u voc]. The latter is the case for *N* which alternates for vocalic in French. In postvocalic position, as sister to a vowel under V°, [u voc] is interpreted as [+voc]. In isolation in onset position, a [-voc] position, [u voc] is interpreted as [-voc]. Obstruents, such as *t*, must be specified [-voc], so they cannot adjoin to a V° category. Since there is no syllable structure position in which *t* can be licensed, it has no phonetic interpretation. In *petite*, on the other hand, *t* is licensed as onset to the following vowel.

I assume that *r* in *garçon* is treated similarly to *N*. That is, *r*, a sonorant segment, is adjoined to the preceding vowel under V° when the following onset position is filled. Phonetically, liquids are typically analyzed differently in onset position, where they are consonantal, than in postvocalic position where they may be vocalic (as in the case of light and dark *l* or *r*-coloring, for example). In this account, the different properties of liquids are determined by the syllabic categories which dominate them.

The syllable structure analysis, under the [-coda] parameter setting, extends to liaison phenomena in French in obvious ways. For example, consider the syllable structure diagrams of *les amis* and *les garçons* in (26).

(26) a. Liaison



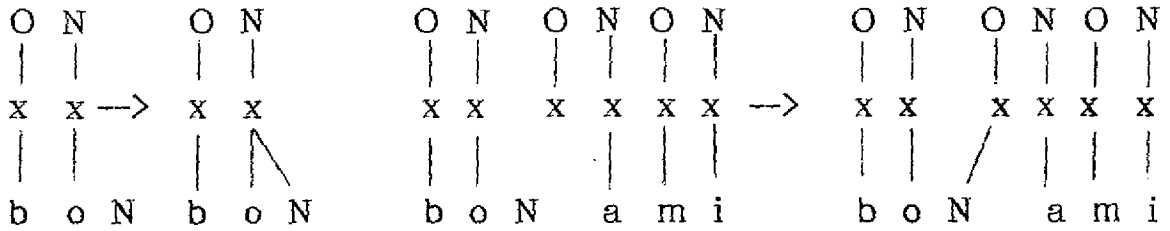
b. Deletion

In *les amis*, *s* (of *les*) cannot be licensed as coda under the [- coda] parameter setting, but can be licensed as onset to the following vowel, giving the liai-

son effect. Where *les* is followed by a consonant initial word, as in *les garçons*, *s* can neither be licensed as coda under the [- coda] parameter setting, nor as onset, since that position is filled. Since it is not syllabified in this case, it is not phonetically realized. The plural *s* has a similar fate. Thus, nasalization, C-deletion and liaison fall out automatically for French, given a negative setting of the coda parameter. See Michaels (1989) and Girelli (1988) for an extension of this analysis to nasalization and diphtongization in Brazilian Portuguese.

The analysis of nasalization and liaison presented above bears some resemblance to Vergnaud's (1982) insightful analysis in an autosegmental framework of these same phenomena. Vergnaud treats the liaison segments as "floating", that is as not associated to the skeletal tier, thus allowing them to be associated to a free onset or C-position in the skeleton or deleted when there is no free position. Prunet (1986, cited in Kaye (1988)) treats the nasal in *bon* as "floating", following Vergnaud's analysis. Thus, in isolation, the floating *n* is associated to the skeletal slot which is already associated to the vowel. When followed by an accessible onset, it links to that position via a skeletal slot. This is illustrated in (27), where O = onset, N = nucleus and x = skeletal slot.

(27) a. *bon* b. *bon ami*



Prunet (1986) contrasts this analysis with the analysis of *son ami*, where the *o* of *son* is always nasalized. Prunet gives syntactic arguments to show that *son ami* is bracketed differently from *bon ami*, such that there is no internal cycle with respect to *bon ami*, but there is one with respect to *son ami*. Thus, the analysis for *son ami* is identical to that for *bon* (27a) in isolation on the first cycle. On the second cycle it is identical to that for *bon ami* (27b). Thus, the single linking of *N* in *bon*, or the multiple linking of *N* in *son* follows from the syntactic bracketing of the strings in which they appear. The analysis is quite elegant. As Kaye (1988) points out, no level ordering is required to get these results.. Linking takes place whenever its conditions are met.

In the syllable structure and markedness approach I have outlined in this paper, the invariable nasalization of the vowel of *son* requires that its vowel be specified [+ nasal]. Thus, it will be nasalized in isolation and in the liaison context. The *N* of *son* is analyzed in the same way as that of *bon*. Where it is adjoined to *son*, it is nondistinct from the lexical [+ nasal] feature of the vowel. Where it is followed by a vowel, it is interpreted in onset position. Hence, no cyclic analysis of syllabification is required here. If there are different cyclic bracketings for *bon ami* and *son ami*, they are irrelevant to the nasalization contrast in this framework, since it is built into the lexical representations of *bon* and *son*. Whether these different treatments have empirical consequences or are simply notational variants remains to be seen.

Conclusion

I have outlined an approach to phonology that restricts rules to the form "move α". Structure preservation, locality conditions on movement and the licensing of coda positions under stress to which movement can take place constrain the application of this rule. Crucial to the elimination of context sensitive rules is the analysis of phonological strings into constituents under syllable theory and the extension of markedness theory to the structural interpretation of unmarked and marked values of features. Notice that within this account the reduction in the expressive power of rules is not accompanied by a complication in other components of the phonology. Lexical representations, though different under this account, are not more complicated. The decision to represent alternating features with marked and unmarked values rather than with plus and minus values results in a simplification or, at least, a limitation on the abstractness of such representations. Most approaches to phonology since Chomsky and Halle (1968) assume a theory of markedness. Nothing more is assumed here. The extension of markedness theory to structural interpretations replaces the linking function of markedness conventions, since there are no rules, and hence no outputs of rules to link the conventions to. Similarly, most accounts of phonology assume a level of syllable structure representations. Usually, this is in the form of syllable structure templates to which analyzed strings of segments are associated. Here the syllable structure is taken to be a projection of the vowels. The central difference here is that phonetic interpretation is the result of percolating the lexical properties of segments to the dominating categories of syllable structures. However, any system with hierarchical syllable structures must have some mechanism for interpreting the categories of such structures. I have proposed a theory of pro-segments and conditions of interpretation (binding) on their phonetic interpretation. The specific proposals for the interpretation of abstract segments simplify, rather than complicate, phonological theory. Pho-

nological accounts with abstract segments need rules to interpret him. Typically, these rules copy properties of neighboring segments onto the abstract segment. The binding of pro-segments, in the account presented here, makes such rules unnecessary. Instead, it captures the function of such rules in a general and principled way.

NOTES

1. A version of this paper was presented at the Incontro of Grammatica Generativa on February 24, 1989 in Bologna. I am grateful to Pier Marco Bertinetto and Gaberell Drachman for discussions on many of the analyses in the paper. I am also indebted to Roberto Bolognesi for comments on the relation between syntactic doubling and vowel length in Italian and to Leo Wetzels for comments on nasalization in French.

2. A notable exception in phonology is the work of Kaye, Lowenstamm and Vergnaud (1985) Their work is similar in spirit to generative syntax. It differs in detail from the proposals I discuss in this paper, since it relies on autosegmental representations in phonology.

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