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André Crochetière,
Jean-Claude Boulanger
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SEGMENTS, CONTOURS AND CLUSTERS

Donca Steriade

UCLA

1. THE QUESTION

I would like to present here some ongoing research centered on a problem of significant interest to phonologists: how do we define a segment? There are several aspects to this question. The one I am interested in here is the distinction between one segment and a cluster of segments.

In order to formulate the question more precisely, let's assume that we can segment any speech event into a sequence of articulatory units. There may be analytical difficulties involved in this task as well, but let us assume that articulatory phoneticians can resolve them. Suppose now that we are analyzing a speech event in which we have isolated of sequence of three articulatory units [ABC] where A, B and C are distributionally independent of each other in the language under study - in the sense that each can occur independently of the others. Given this segmentation into articulatory units and these distributional facts, how many *phonological* segments do we have in this string? One, two or three? How do we decide the issue?

To use a concrete example: suppose that the string being analyzed is [mba], where [m] represents the gesture of oral bilabial closure accompanied by nasal airflow, [b] represents oral bilabial closure and [a] is some vowel gesture. In the language being analyzed, neither [m] nor [b] nor [a] are contextually predictable transitions from one sound to another. Does this mean we have three segments? Under what circumstances would we decide that we have fewer than three: more concretely, how would we decide that [mb] is one phonological unit?

This is the question I would like to address here. I will have some suggestions about what sort of answer we want, though not a complete solution.

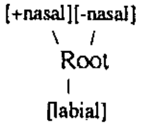
1.1 How we came to ask the question

The problem of segmentation is being addressed here because recent developments in the theory of feature and segment structure have revealed that it is not only an unresolved issue but also that the range of empirical questions falling in its scope is significantly richer than previously assumed.

The recent history of this issue begins with Anderson's (1976) demonstration that a single segment may contain two distinct phases of nasality. Anderson showed that partially nasal ostnasals like [b^m] - must be phonologically analyzed as being part oral and art nasal. He showed that any phonological description based on the ssumption that the entire segment is phonologically homogeneous for nasality ill fail to explain the cross-linguistic patterning of these sounds, as well as etails of their behavior in individual languages. The significance of this finding or the problem of segmentation is this: there exist languages where a phonetic equence [^{m}b] must be analyzed as containing one phonological segment. owever, internally to this one segment, there must exist two distinct values for asality. The most obvious questions raised by Anderson's work on nasality are: nder what circumstances do we get this type of segment-internal sequencing; nd what are the principles in virtue of which such articulatory sequences as ^{n}b] are analyzed by native speakers as being mono- rather than bisegmental?

In the later literature, the class of configuations we discuss here - onosegmental sequences containing two values for a given feature - were alled *contour segments*. In figure (1), which reflects currently standard ssumptions about the make-up of segments[1], the node labelled *root* designates e abstract notion *one phonological segment.*

1) [^{m}b] =



The notation employed in (1) allows us to express both aspects of nderson's discovery: that items like [^{m}b] are single segments - as indicated by e fact that they possess a single root node - and that, nonetheless, they contain vo sequenced values for the feature [nasal]. The same formalism can be xtended to other varieties of contour segments: affricates, for instance, were epresented by Sagey (1986) as single root nodes to which a sequence of continuant] [+continuant] feature values are associated.

But the fact that we can now point to an item in our representations which ands for the intuitive notion of one segment doesn't mean that we understand hy certain phonetic sequences count as one segment, while others don't. This uestion has been taken up in a number of studies[2], but the proposed answers are in my view - overly technical, in the sense that they legislate an observed state f affairs rather than explain why it obtains. There is substantial agreement that re and postnasal consonants, affricates, pre- and postglottalized, as well as ostaspirated segments frequently function as single segments. Recently, uckley (1992) has added to this class clusters such as [ht], [^{h}t^h], [ˀk], [ˀk'] which unction as monosegmental units in Kashaya, a Pomo dialect. On the other hand, here is also substantial agreement that consonant sequences such as /rk/, /sp/, l/, /ys/ do not, in the vast majority of cases, function as single segments. The teresting task for the phonologist is not to restate such observations in technical nguage but rather to understand why articulatory contours like [p^h], [^{h}p], [^{h}p^h], ^{m}b], [ˀb], [ts] display this systematic difference in patterning from other nceivable contours, such as [sm], [kr], [rkr], [ys].

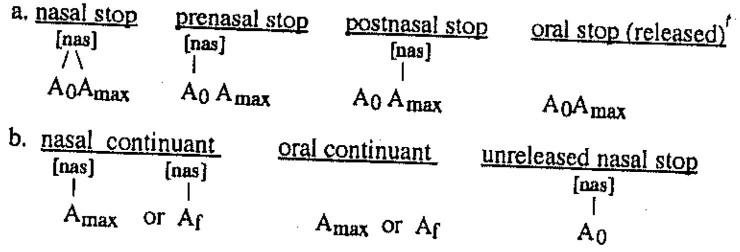
.2. Three generalizations and a proposal

Some progress in this direction can be made by taking a new look at the ircumstances under which distinctive intrasegmental contours occur. Several

general observations can be made in this respect. First, only plosives - stops and affricates - can be contour segments: the most obvious fact illustrating this is that the pre- and postnasal segments are always plosives, never vowels, approximants or fricatives. Second, the plosives can display intrasegmental contours *only if they are released*: pre- and postnasalized consonants, for instance, are absent in contexts where stop releases may not occur. I will suggest here that this second generalization holds for a substantial subset of the contour segments enumerated previously - postaspirated stops, postglottalized stops, affricates - but not for all. The exceptions will be noted and explained. Third, distinctive intrasegmental contours *never exceed two* articulatory phases: we get, for instance, distinctive pre- or postnasalized consonants, but not distinctive medio-nasals (e.g. [bmb][3]) or medio-orals (e.g. [mbm]). Ternary contours don't exist[4].

Let's assume then that, as a general rule, contour segments involve a subset of the class of released plosives. Why should this be? The suggestion made here will be that released plosives are inherently bipositional, in that they consist of a closure and a release slot. Wherever these two positions - the closure and the release - can occur, the intrasegmental contours can appear as well. This can be seen in the following schematic representations of nasal, oral and partially nasal segments, where A_0 stands for closure (Aperture zero), A_{max} (maximal aperture) represents an approximant segment or release and A_f (intermediate aperture generating turbulent airflow) represents fricative segments or the fricated releases of affricates. Note the representation of released stops: a closure (A_0) followed by an approximant release (A_{max}).

(2) Patterns of [nasal] association within a segment:



If we assume further that the feature [nasal] is privative[5], then we can begin to understand why the presence of release is critical for the segmental contour to surface: if [-nasal] is not a phonological entity, orality can manifest itself only as a position unattached to a [nasal] value. To represent partially nasal segments, we therefore need two such positions: this is what we see in (2), where only the released plosives appear as partially nasal.

Fundamental to the representations suggested in (2) is the idea that the slots to which features attach - units comparable in function to the root node in (1) - are defined in terms of *degrees of oral aperture*. For our purposes, we need to distinguish three such degrees: full closure (A_0), fricative (A_f) and approximant (A_{max})[6]. The proposal to view released stops as sequences of a closure followed by approximant release (A_0A_{max}) can be extended to provide a representation for affricates: these can be seen as sequences of closure followed by a fricated release (A_0A_f).

The positions thus defined can all anchor features. And we may reasonably hypothesize that *all features associated to a given aperture position are interpreted as phonologically simultaneous*[7]. If we assume this, we will have come very close to explaining the observations made at the beginning of this section. We anticipated the descriptive result that contour consonants always belong to the category of released plosives: this is so because any featural sequence defining a contour - [αF][-αF] - will, under the convention sketched here, require two distinct positions in order to be realized. The only bipositional segments are released plosives. Therefore the only contour segments will be released plosives. QED. The observation that distinctive contours do not exceed two distinct articulatory states - recall the absence of ternary nasality contours like [mbm], or [bmb] - is also explained: a segment may have at most two aperture positions. It cannot support a tripartite contour.

2. THE EVIDENCE

2.1. Which contours are distinctive

I would like to sketch now the evidence supporting one generalization proposed in the last section: that contour segments are released plosives. First, however, we need to clarify the relation between the observable data and this claim. Consider the following pattern of association between /h/ - i.e. aspiration - and supralaryngeally articulated oral consonants: this pattern is encountered in a Mazateco dialect studied by Kirk (1966:14-25), Mazatlán de Flores. One must bear in mind that Mazateco is a language in which consonant clusters are exclusively onsets and thus pattern as single C's. Further evidence for their monosegmental status is discussed elsewhere (Steriade 1992b).

(3)

oral plosive + h	continuant + h
th, tsh, ʧh, kh, kʷh	sh, ʃh,
h + oral plosive	**h + continuant**
ht, hts, hʧ, hk, hkʷ	hy, hw, hwy [hɥ]

Both oral plosives and continuants are transcribed by Kirk as sometimes preceding and sometimes following /h/. But only the plosives are *distinctively* ordered relative to /h/: /th/ contrasts with /ht/ while no comparable contrast exists among the continuants. The relative order between /h/ and the continuants can be predicted: /h/ follows a voiceless (or fricated continuant) and precedes a voiced one. Because the sequencing can be predicted, there is no reason to encode it in the phonological representations. By this reasoning, we reach the conclusion that the *phonological* contours involving aspiration in Mazatlán de Flores occur among the plosives only. The Mazatlán plosives are necessarily released since they occur sylable-initially. This is then a first illustration of our claim, outside the domain of nasal contours: only the plosives, the released plosives, yield distinctive contours. Note that Kirk's transcriptions indicate quite clearly that some phonetic sequencing or temporal misalignment exists between /h/ and *any* oral constriction, whether it involves a plosive or a continuant. But phonetic sequencing is not what we're interested in. We're looking at the distinctive aspiration contours, and these are found among the plosives only.

Some explicit representations of the Mazatlán contours presented in (3) can now be proposed. Note the close parallel between these structures and the representations of nasal contours in (2). ([spread] = [spread glottis], i.e. /h/)

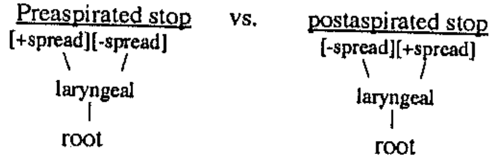
(4)

postaspirated stop	postaspirated affricate	aspirated fricative
[spread] | A_0A_{max}	[spread] | A_0A_f	[spread] | A_f
preaspirated stop	**preaspirated affricate**	**aspirated glide**
[spread] | A_0A_{max}	[spread] | A_0A_f	[spread] | A_{max}

These structures help answer several questions. First, why do the hC an Ch clusters of Mazatlán pattern as single C's? The answer is that they *are* singl C's: aspiration does not occupy in the representations of (4) an aperture position i.e. a segmental slot - distinct from those projected by the basic consonant. I resides *on* the consonant, rather than next to it. Second, why do the distinctiv contours occur only among the plosives? Because only the plosives ar bipositional and, hence, only they can display a contrast between association t the first vs. last position.

Stepping back from our hypothesis, we should ask how the sounds in (3 could be represented in the absence of a closure/release distinction. The onl possibility sems that of adopting representations comparable to (1), inspired b Sagey (1986):

(5) Preaspirated stop vs. postaspirated stop ?



The difficulty with these representations is that we are left without ar explanation for the asymmetry observed between plosives and continuants. Th contours in (5) could reside inside a continuant's matrix, as well as inside plosive's. The fact that they are distinctively present only on plosives remain unaccounted for[8]. We may, alternatively, claim that the phonetic sequences in (3) are all bisegmental: but if we do, we fail to understand why these particula phonetic sequences act as single segments, not only in Mazatlán but also i numerous other languages, while phonetic sequences like /ys/, /rk/, /kr/, /km do not.

The Mazatlán pattern of pre- vs. postaspiration is encountered in number of other American Indian languages (cf. Buckley (1992) and Steriad (1992b). The same possibilities are attested with the feature of glottalization: w observe minimal contrasts between pre- and postglottalized segments, but onl within the plosive class. A contrast between pre- and postglottalized stops - representable as association of /ʔ/ to closure vs. release - is present in languages like Maidu (Shipley 1956), which oppose an ejective to an implosive series[9]. Both series are limited to stops; neither is attested in contexts where Maidu plosives are unreleased.

(6) Ejective stop vs. Implosive

A_0A_{max} | A_0A_{max}

Cases of contrast between ejectives and implosives have been examined by Greenberg (1970), who claims that the linguistically relevant difference is that between glottalized voiceless (ejectives) vs. glottalized voiced (implosives) segments. This may or may not be true for some languages in Greenberg's survey but it is clearly untrue of the entire class: in Maidu, for instance, the contrast between the ejectives /p'/, /t'/ and the implosives /ˀb/, /ˀd/ cannot be represented as voiceless glottalized vs. voiced glottalized, because the language has no independent series of voiced *unglottalized* obstruents. Voicing *per se* plays no role in the sound system of Maidu; rather, it is the automatic consequence of the implosive realization of preglottalized C's. Maidu therefore represents a clear example of distinctive glottalization contours limited to the released plosive class[10].

2.2. Released vs. unreleased plosives

The proposal made here predicts that *unreleased* plosives should pattern ike continuants: they have a single aperture position - A_0 - on which only one value for any given feature can be realized. Distinctive contours should be impossible on such consonants[11]: for instance, in the absence of the stop release, a contrast like that depicted in (6) cannot be realized. We examine now the evidence supporting this aspect of our proposal. Illustrated first is the global effect loss of release has for the phonotactics of a language. We turn then to a more careful consideration of the link between unrelease and the loss of glottalization contours.

2.2.1. Loss of contours in coda

The global loss of segmental contours in unreleased codas can be observed in a language like Tlahuica (Muntzel 1982), which contrasts postaspirated and postglottalized plosives with plain voiceless ones; prenasalized plosives with full nasals; and the affricates [ʦ], [ʧ] with the plain stop [t]. Tlahuica thus has practically all widespread types of contour segments. Significantly, all are missing from coda position. Tlahuica codas are limited to plain stops (/p/, /m/, /t/, /n/, /k/), fricatives (/s/, /ʃ/) or approximants (/l/, /h/, /ʔ/). Since coda /h/ is attested in examples like /lih.t'ʌ/ 'el/ella', /lih.thim.pi.ya/ usted', it is clear that what excludes the postaspirates /p^h/, /t^h/, /$ʦ^h$/, /$ʧ^h$/, /k^h/ from coda position is not the presence of aspiration but rather the fact that aspiration is realized, in these consonants, on the release. Similarly, since coda ʃ/ and /s/ are attested in examples like /ʃaʃ.k^Wa.li/ 'estropajo', /ki.ʦis.ntankwe] bautizaste a los dos', we cannot explain the absence of coda /ʦ/ or /ʧ/ by ocussing on the point of articulation or stricture type of these segments: the affricates are absent in coda because their release is absent.

Phonotactic paradigms similar to that of Tlahuica are encountered in Slave (Rice 1989), Kiowa (Crowell 1949), Tolowa (Bright 1964), Tututni Golla 1976), Zuni (Walker 1972), Navajo (Sapir and Hoijer 1967) and others.

The converse of the generalization proposed here - that unreleased losives do not support contours - can also be documented: in languages where odas are systematically released, postaspiration, postglottalization, affrication nd nasal contours are permissible coda features. Languages illustrating this ption are: Wikchamni (coda affrication, postaspiration, postglottalization: amble 1978), Tunen (coda prenasalization: Degast 1971), Tzutujil (coda jectives contrast with implosives; coda affricates: Dayley 1985); Hupa (coda jectives, postaspirates and affricates: Woodward 1964).

2.2.2. Deglottalization in coda: which instances come from unrelease?

Taking now the specific case of glottalization, we can outline as follows the predicted developments of glottalized consonants in positions where stop releases are absent. Plosives which surface as postglottalized when released may turn, when unreleased, into plain closures lacking glottalization:

$$(7)\quad \underset{\substack{|\\ \text{[constricted]}}}{A_0A_{max}} \;\text{->}\; A_0$$

This is what happens in Kiowa (Crowell 1949), Tolowa (Bright 1964), Maidu (Shipley 1956), Slave (Rice 1989), Tututni (Golla 1976), Zuni (Walker 1972), Tonkawa (Hoijer 1946), Navaho (Sapir and Hoijer 1967) as well as other, better known languages, such as Cambodian, Korean and Klamath.

In order to better appreciate the connection between loss of release and deglottalization, we must draw a number of distinctions. It is frequently the case that coda consonants lose certain components of their matrix, *regardless of where these components are located.* In the case of the laryngeal features - voicing, aspiration, glottalization - these are frequently excluded from the coda, independently of whether they are linked to stop releases or not. I will cite here only one immediately relevant example: Maidu (Shipley 1956) disallows coda ejectives, implosives as well as coda /ʔ/. The representations of implosives and ejectives were given in (6); /ʔ/ is an approximant (A_{max} position) associated to [constricted glottis] . Note that the loss of stop release in coda may explain the deglottalization of the ejectives, but not that of the implosives, or the loss of /ʔ/. We must invoke in such cases a condition like (8).

(8) [constricted glottis] is disallowed in coda.

Thus the absence of postglottalization from the codas of Maidu, although consistent with our representations, is not a direct effect of unrelease. To observe the unmediated consequences of unrelease, we must consider cases in which loss of glottalization cannot be attributed to (8). Indeed a significant number of languages in our sample disallow ejectives but not /ʔ/ in coda: to this class belong, among others, Zuni (Walker 1972), Navajo (Sapir and Hoijer 1967), Kiowa (Crowell 1949), Tolowa (Bright 1964). Even more directly relevant patterns are attested in languages that disallow the coda ejectives but not coda glottalized sonorants - realized with preglottalization - or fricatives. In Tolowa, for instance, where all coda affricates, ejectives and postaspirated plosives are disallowed, the glottalized sonorants [m'] and [n'] - as well as /ʔ/ - occur at the end of syllables. As Bright (1964) points out, the phonetic realization of Tolowa syllable-final glottalized nasals is transcribable as [mʔm], [nʔn] respectively, with the glottal gesture occuring during the period of oral closure: these sounds are not postglottalized nasals, but rather nasals with glottalized closures[12]. They can be given representations consistent with the idea that Tolowa plosives are unreleased in coda:

(9) <u>Tolowa coda [n']</u> (place features omitted)

[nasal]
|
A_0
|

Tolowa represents therefore a language in which condition (8) is inactive: the absence of coda ejectives - as opposed to plain /ʔ/ or preglottalized nasals can be traced unambiguosly to the loss of release.

A distinct prediction of our analysis is that in languages where coda plosives are unreleased and the constraint in (8) is inactive, ejectives will lose postglottalization but glottalized continuants, along with preglottalized segments, will maintain their feature of glottalization. Consider the following data from Tonkawa (Hoijer 1946): all consonants may be glottalized syllable initially - stops, affricates, nasals, fricatives and glides - but only the continuants are allowed to be glottalized in syllable-final position: word-final /s'/, /l'/, /y'/ occur[13]. The representational difference between /ts'/ and /s'/ is shown below:

(10) <u>(Post)glottalized plosive</u> (ts') vs. <u>glottalized fricative</u> (s')

A_0A_f | [constricted] A_f | [constricted]

Given these structures, we understand that coda unrelease will affect the realization of the glottal feature in /ts'/ but not in /s'/.

A much more interesting development is attested in the languages where glottalized plosives are maintained in coda but with altered timing between the oral and the laryngeal gestures. Several American Indian languages display a shift from postglottalized onset ejectives to preglottalized codas: Chitimacha (Swadesh 1934) is perhaps the most revealing in this class. All Chitimacha consonants can be glottalized: there are ejective stops and affricates, postglottalized nasals and postglottalized glides in onsets. In coda position, however, the articulation of the glottalized stops changes. Swadesh distinguishes three realizations of the ejectives and postglottalized nasal stops (1934:358): a syllable-initial allophone with "synchronous glottalization", a distinct syllable-initial allophone with "strong, slightly retarded glottal gesture" ; and a syllable-final allophone "with glottal stricture slightly preceding the oral closure". We suggest the following representations for these three variants:

(11) a. A_0A_{max} \ / [constricted] "synchronous glottalization"

b. A_0A_{max} | [constricted] "retarded glottal gesture"

c. A_0 | [constricted] "glottal stricture slightly preceding oral closure"

The syllable-final allophone appears in (11.c): note that the loss of release renders inevitable some change in the glottal gesture. In the case of Chitimacha this modification is the realignment of glottalization with closure, a timing change which obviates the loss of the feature. To show that the changes described here involve the phonological representations of these sounds rather than just their phonetic realization, we must show that the glottalized continuants are not similarly affected by their syllabic position. Indeed, glottalized glides are attested in Chitimacha, in syllable-initial as well as syllable-final position: syllable-finally they are, if anything, *postglottalized* (Swadesh (1934:361). Our phonological representation for [y'], [w'] - syllable initial or final - is that of an approximant (A_{max}) linked to [constricted]. Swadesh's observations indicate

that the shift towards syllable-final preglottalization involves only the plosiv
We claim that this is so because only the plosives are affected by unrelease.

A further prediction is that ejectives and implosives - represented as (6) - will be differently affected by unrelease: ejectives will lose glottalizati altogether, or become preglottalized, while implosives may well just turn in unreleased implosives, with no significant change in the timing or nature of t laryngeal gesture. My data is very limited on this point, but suggests that th prediction is not far off the mark. In Adamawa Fulani (Stennes 1967) syllabl final stops are unreleased (p.7) ; as a consequence, the prenasalized stops a affricates of the language are excluded from coda position (p.10). But t implosives and the voiced stops are allowed syllable-finally: their larynge features are associated to closure and therefore immune to loss through unreleas

3. CONCLUSION: WHAT ARE SINGLE SEGMENTS?

We have seen here that the designation *contour segment* is appropriate f certain classes of glottalized and aspirated segments: in particular, t distinctively pre- and postaspirated plosives of Mazatlán, the distinctively pr and postglottalized plosives of Maidu. The results obtained for nasality Anderson (1976) can thus be legitimately extended to laryngeal features as we Wherever such distinctive contours occur, they are realized on released plosiv This too is a property that holds of the nasal contours studied by Anderson.

We have also noted that postaspirated and postglottalized plosives a affected by the loss of release, along with all other categories of conto segments: unrelease trigers either the loss of the relevant laryngeal feature else it induces a significant realignment of this feature inside the consonan matrix. Not all instances of laryngeal loss can be directly attributed to unreleas but a significant number can.

These considerations suggest that *the most widely attested conto segments are simply varieties of released plosives in which the association of particular feature to closure or release is phonetically unpredictable.* But whe does this conclusion leave us in our search for solutions to the problem segmentation?

Let's approach this problem indirectly by asking a narrower questio what is the sense in which a postaspirate like /t^h/ is a single segment - albeit o involving a distinctive contour - instead of a /t+h/ cluster? My suggestion is th /t^h/ is identified as a single segment because it contains no more than one of eac featural components of a segment: it has one oral constriction and one larynge component (aspiration and voicelessness). These features happen to be realiz in sequence - the oral constriction precedes at least the perceptible portion the laryngeal gesture - but they are, in principle, articulatorily compatible wi each other. Similarly, a prenasalized postglottalized stop like /$^{n}t'$/ - functionin as a single segment in many Mazateco dialects - is, despite the distinctiv contours of nasality and glottalization, a composite of mutually compatib features drawn from complementary sets: one oral constriction, one nasal gestur one laryngeal gesture. This property of featural coherence is, in part, wh makes it one segment. A contributing factor to the monosegmental analysis /t^h/ and /$^{n}t'$/ is the fact that the timing of the laryngeal features relative to th oral constriction is such that they can be phonologically analyzed as residing o the stop's release. Thus not only are the featural contents of the sequence /th monosegmental representation of the sequence can be given, one in which the stop's closure carries the point of articulation features, while the stop's release carries the laryngeal values. The analysis is sequential - insofar as we distinguish closure from release - but monosegmental nonetheless, since the release is a predictable by-product of closure.

The answer suggested here is influenced by Trubetzkoy's second principle governing the distinction between single segments and clusters: " a phonetic cluster can be analyzed as one phoneme only if it is produced by a single articulatory movement or *through the gradual dissolution of an articulatory complex*" (1939:58). Trubetzkoy makes it clear that he views postglottalized and postaspirated stops - instances of what he calls "an articulatory complex" - as representing always stops in which the oral and laryngeal gestures are simultaneously initiated: only the timing of their release differs. Thus he requires that a monosegmental unit involve some moment of *actual* rather than potential simultaneity between the articulations composing it. In this respect, his position is even stricter than the one suggested here: it appears that a phonetic sequence such as that involved in the Chitimacha postglottalized stops with "strong, slightly retarded glottal gesture" (11.b above) might not qualify as monosegmental if the glottal gesture involves no significant temporal overlap with the oral constriction. But, aside from this difference, the idea of articulatory (i.e. featural) coherence as a prerequisite for monosegmental status is clearly present in Trubetzkoy's second principle.

It is useful to compare, in closing, Trubetzkoy's view of monosegmental sequences - a view from which ours derives - with the conception of contour segments implicit in representations like (1), repeated below. The reader will recall that such structures became, after Sagey (1986), the standard means of representing intrasegmental contours.

```
(1)  [mb] =    [+nasal][-nasal]
                    \    /
                    Root
                     |
                  [labial]
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The prenasal depicted in (1) contains two incompatible values for [nasal]: thus, the notion that a segment is defined at least in part by the coherence of its featural components cannot be maintained within a theory employing (1). What then identifies [^{m}b] as one segment, under the theory instantiated by (1)? The presence of the unique root node? But the root node is a simple diacritic, a concise way of stating *All this is one segment*, rather than a testable principle that could shed light on the observed behavior of contour segments.

I hope to have shown that, whether or not the proposals made here are on the right track, there is interesting work to be done in discovering such a principle.

NOTES

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(1) See in particular Clements 1985 and Sagey 1986.

(2) Sagey 1986 , Rosenthall 1989, Buckley 1992 and references there.

(3) For the term and exemplification, see Anderson 1976.

(4) The Kashaya contours transcribed as [hkh] are not ternary sequences of [h-k-h] but rat and postaspirated stops. Their phonological representation is discussed in Steriade 1992b.

(5) On privativity in general , see Trubetzkoy 1939, who classifies the nasal/oral oppo privative. On specific arguments to this effect, see Steriade 1992a, b.

(6) Because vowels will not be discussed, the necessary distinction between vow approximants is left undefined.

(7) The results derived from this assumption - which essentially denies the cohere representations like (1) - can be equivalently obtained by assuming that all features, [nasal], are privative. I believe there is support for this view, but cannot defend it here.

(8) Worse still, we could not even stipulate the correct restrictions. We cannot st continuancy is incompatible with the presence of feature contours, since affricates - sta analyzed as containing a [+continuant] value in their matrix - do display contours of n aspiration and glottalization. (On the latter see below.) And we cannot state the r restriction in positive terms - something like *Intrasegmental contours must coexist w feature value [-continuant]* - since unreleased plosives, which are clearly non-con sounds, do not display contours, as will be observed in a later section.

(9) Additional instances of contrast between pre- and postglottalization are discussed in I (1992) and Steriade (1992b).

(10) Kingston (1985) discusses other reasons to reject Greenberg's claim that implosives always be represented phonologically as [glottalized, +voiced].

(11) I cannot discuss in any detail here the contexts where releases tend to be absent. Th common such locus is in the syllable coda. We should note however that there is consi variation on this point: not all languages have unreleased plosives in their codas, nor do al behave identically on this score in any given language.

(12) Bright states that the glottalized nasals are restricted to the coda position. She is p referring to the phones transcribed as [mʔm], [nʔn], which are indeed coda-bound. There ap exist postglottalized nasals in the onset, as indicated by the example /nʔée/ 'land'.

(13) Word medial codas are subject to the constraint in (8) in Tonkawa, since no glo segments are allowed there. However, word-final codas are subject to a distinct treatmen they disallow ejectives, though not glottalized continuants: (8) is not in force, only the release in plosives. Interestingly, the phonetic realization of glottalized continuants i postglottalization, since Hoijer transcribes them as sequences of continuant followed by /ʔ/.

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NATURALIZING FORMAL SEMANTICS

Barbara H. Partee

University of Massachusetts, Amherst

1. APPROACHES TO SEMANTICS.

Semantics has been a lively and controversial field of research for centuries, and radically different approaches to it can be found within various disciplines and interdisciplinary combinations, involving such fields as linguistics, philosophy, logic, cognitive science, artificial intelligence, theoretical computer science, informatics, semiotics, and literary criticism It is not surprising that there are a lot of competing approaches, rapidly evolving theories, and a mixture of mutual influence and mutual ignorance among contemporary semanticists; cannot pretend to be familiar with all the important contemporar approaches nor is it my aim to provide a representative survey, but I do want to set my central concerns within a slightly broader perspective.

One source of deep differences is the initial selection of the object of study: the central questions of semantics may come out quite differently if one focusses on language and thought, o on language and communication, or on language and truth. A more accidental but no less profound source of differences is the research methodology prevalent in the field within which one approaches questions of semantics: early linguists tended to see features and many linguists still see another level of tree structures; logicians see formal systems and model structures; psychologists see concept discrimination and principles for scaling semantic fields; artificial intelligence researchers see data bases and symbol manipulation. After an interdisciplinary conference fifteen years ago, the philosopher David Kaplan remarked to friends that philosophers are like black holes and linguists are like vacuum cleaners: philosophers will take any approach and show that it suffers from probably fatal foundational problems, while linguists will take any approach and absorb it into their arsenal.

I want to begin by very briefly characterizing certain broad classes of semantic theories; then I will turn my attention to the issue of how model-theoretic semantics has been evolving in the hands of linguists to meet more of the demands posed by the