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Linguistic Nature of Prenasalization

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THE LINGUISTIC NATURE OF PRENASALIZATION

by

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ABSTRACT

The linguistic nature of the class of sounds which are traditionally called "prenasalized consonants" (PNCs) has never been adequately explored. The purpose of this work is to provide a descriptively adequate framework in which to characterize PNCs, and to express their behavior most generally. This is done within the theory of generative phonology (essentially the Standard Theory of Chomsky and Halle 1968), incorporating a theory of markedness and syllabification. It is argued that PNCs cannot be described adequately as monosegmental entities in linguistic theory. Rather, PNCs in all languages are claimed to be sequences of homorganic nasal and oral consonant in underlying phonological representations, which surface in systematic phonetic representation as (tautosyllabic) syllable onsets. For a language to exhibit such onsets, it must contain a costly (language-specific) syllabification rule which converts the unmarked syllabified string XN$CY (whose syllabification is given by universal convention) into the marked structure X$NCY, where $ represents the syllable boundary. There is no linguistic level, nor any stage in phonological derivations, where PNCs must be represented monosegmentally, nor at which the characteristically brief nasal onset period must be referred to as an internal component of an oral consonant. Such properties as are necessary to fully characterize PNCs as physical-phonetic events are assigned to systematic phonetic $NC sequences by mechanisms within a phonetic performance theory.

One of the very few languages where PNCs appear to contrast directly with ordinary heterosyllabic clusters of homorganic nasal and oral consonants is Sinhalese, an Indoeuropean language of Sri Lanka (Ceylon). An analysis of this language, and a similar case in the West African language Fula, are presented, and strong evidence is provided for the adequacy of a sequential analysis of prenasalization, in spite of the apparent contrast. The analysis of Sinhalese also reveals a rich interaction between the behavior of PNCs and the general syllable structure of the language. This relationship can be revealingly expressed only if the notion of the syllable is formally available in phonological theory.

Adviser: Prof. Charles Cairns

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CHAPTER I: THE SEQUENTIAL ANALYSIS OF PRENASALIZATION

1.0. General Introduction

The purpose of this dissertation is to investigate the linguistic nature of prenasalization: to provide a descriptively adequate framework in which to characterize those sounds which are traditionally called "prenasalized consonants" (henceforth, PNCs). It will be shown that such an account is possible within the theory of generative phonology, incorporating the notions of markedness and syllabification; in particular, that the notion of the syllable is crucial to a description of PNCs.

Prenasalization is a general term applied to a number of phonetic events. In some languages, sounds which are called PNCs are virtually identical to ordinary (nonprenasalized) consonants, except for a characteristically brief period of nasality at the onset of the PNC; the overall impression is of a unitary event. In other languages, the nasal period is appreciably longer, and the overall impression is of a sequence of segments. In all cases, the nasal and oral periods of sounds traditionally described as PNCs are homorganic, and tautosyllabic.

Although PNCs are often regarded as "exotic" sounds, prenasalization is not a very rare phenomenon. It is however a marked phenomenon, in the sense that languages which contain PNCs always contain nonprenasalized consonants, though the inverse is not true.

Prenasalization is sometimes regarded as a restricted "areal" phenomenon; Chomsky and Halle (1968:316), for example, appear to assume that it is restricted to Africa. While it is true that languages with PNCs cluster in certain geographical regions, these areas are rather widespread. In addition to Africa, languages exhibiting prenasalization are found in Australia, New Guinea, the South Pacific, South Asia, China and South America. Only Europe, North America and Central Asia lack languages with PNCs.

The physical-phonetic properties of PNCs in some languages have often led phonologists to regard them as unitary events at some level of physical reality; many have further assumed that PNCs should be represented linguistically as a distinct class of unitary segments. We do not believe that an examination of the physical properties of PNCs should necessarily inform the linguistic representation of these sounds; "hugging the phonetic ground" is not appropriate to the enterprise of generative phonology, whose primary task is the determination of linguistically significant generalizations.

We will argue here that PNCs should not, and indeed cannot, be represented monosegmentally. It will be shown that no phonological feature currently available in the Standard Theory (essentially that of Chomsky and Halle (1968)) is adequate to this task; nor are proposals for new features.

Feature-based monosegmental analyses fail at the level of observational adequacy (they cannot distinctively characterize all observed types of PNCs), and at the level of descriptive adequacy (they unduly complicate the expression of linguistically significant generalizations). Several attempts have been made to characterize prenasalization monosegmentally by revising the notion of the segment in the Standard Theory. We will examine the "internally-structured segment" proposal of Anderson (1975), and the autosegmental approach of Goldsmith (1976), and show that both innovative analyses are problematical as devices for describing PNCs.

Our thesis is that PNCs arise from sequences of ordinary nasal and oral consonants which come to constitute syllable onsets in systematic phonetic representation. Three kinds of arguments have been raised against such a Sequential Analysis of PNCs:

(i) The <u>phonotactic objection</u>, in which it is argued that PNCs exhibit the distribution typical of single segments

(ii) The <u>contrast objection</u>, in which it is argued that PNCs contrast in some languages with (heterosyllabic) NC sequences, and cannot be distinguished from the latter in a principled manner under the Sequential Analysis

(iii) The <u>monosegmental behavior</u> objection, in which it is suggested that there are languages containing rules which must refer to PNCs as single segments.

In our presentation of relevant analyses in the sequential approach, we will confront each of these objections, and show why they must be rejected.

The contrast objection is perhaps the most difficult of the three. PNCs appear to contrast directly with heterosyllabic NC clusters in very few languages; the clearest example is Sinhalese, an Indoeuropean language of Sri Lanka (Ceylon). Our research into the phonology of this language provides strong evidence for the Sequential Analysis, in spite of the apparent PNC/N$C contrast. It also reveals a rich interaction between the behavior of PNCs and the general syllable structure of the language. We will show that this relationship can be revealingly expressed only if the notion of the syllable (specifically, the notion of "tautosyllabicity") is formally available in linguistic theory. We maintain that this must be the case, and propose a universal syllabification mechanism in the spirit of the theory of markedness, as suggested by Chomsky and Halle (1968) in the framework of generative phonology, and elaborated by Cairns (1969) and Kean (1975). We will also show why, in the light of markedness theory, the phonotactic objection to the Sequential Analysis of PNCs cannot be maintained.

The contrast objection (among others) also arises in the case of Fula, a West African language. It will be shown that this language can also be described satisfactorily within the Sequential Analysis.

1.1. A Statement of the Hypothesis

The Sequential Analysis of prenasalization can be summarized as follows:

> "Prenasalized consonants" in all languages are represented linguistically as sequences of homorganic nasal and oral consonant which are syllabified as syllable onsets. For a language to exhibit such tautosyllabic sequences, its grammar must contain a costly (language-specific) syllabification rule which converts the unmarked (universally-determined) syllabified string XN$CY into the marked sequence X$NCY. There is no linguistic level or stage in phonological derivations where PNCs must be represented monosegmentally, nor at which such properties as the brief nasal onset exhibited by some languages must be referred to as such by phonological rules, or where the nasal period must be referred to by rules as an internal component of an oral consonant. Such properties are assigned to systematic phonetic $NC sequences by mechanisms within a phonetic performance theory.

The general organization of grammar which we are assuming here is the following: the phonological component consists (among other mechanisms which we will discuss shortly) of a set of phonological rules, which are operations over a set of binarily-specified features. These P-rules can change feature-values, insert and/or delete whole segments. In addition, the grammar contains phonetic (detail) rules which map binary values onto _n_-ary values (cf. Chomsky and Halle (1968) and Postal (1968)). While these rules are not organized into strictly segregated components, the phonetic rules will in general follow most or all P-rules, thus applying at a very low level in derivations. The precise nature of phonetic rules has rarely been discussed, nor have many relevant analyses been presented. In fact, the very notion of "(systematic) phonetic representation" is often used ambiguously: sometimes to refer to the ultimate output of all rules, phonological and phonetic, sometimes to the final derivation of strictly phonological rules. Anderson (1974b) and others, have shown that phonetic rules may precede phonological rules. We assume here that systematic phonetic representation is the level at which all and only language-specific rules of competence have applied. We use the term _phonetic_ (or linguistic-phonetic) to refer to this and only this level of representation. As Chomsky and Halle (1968:295) remark:

> ... phonetic transcriptions consistently disregard many overt physical properties of speech. Among these are phonetic effects that are not locatable in specific segments, but rather extend over entire utterances, such as voice quality and pitch of the speaker, and also such socially determined aspects of speech as the normal rate

> of utterance... In addition, phonetic transcriptions omit properties of the signal that are supplied by universal rules.

Phonetic representation is thus highly abstract, and its feature specifications on segments, whether binary or _n_-ary, are far too gross to call them "instructions to the vocal tract," as some phonologists have done (cf. Postal (1968)). Systematic phonetic representation (the output of a grammar of linguistic competence) must itself constitute part of the input to a distinct performance theory, a phonetic theory which translates linguistic representations into much less abstract structures which are directly interpretable by the neuromuscular mechanisms which govern actual speech. In general these translations are universal, as they are largely functions of human neurophysiology. But some, for example those which govern the articulatory "base", or musculature-set that characterizes different languages (cf. Chomsky and Halle (1968:395)) may yet be language-specific. Others may be informed by socially-determined parameters, or individual emotional or physiological states.

Our claim is that the apparent monosegmentality and the brief duration of nasality that may be exhibited by the speech events we call PNCs are governed by performance mechanisms of this sort, taking systematic phonetic _$NC_ sequences as input. These properties, which we will call <u>physical</u> (or physical-phonetic), may differ somewhat from language to language, or even in the same language when variables such as rate of speech are introduced. They are not, however, properties with any linguistic significance. We therefore take the notion "prenasalized consonant" to be a physical and not a linguistic notion. In this respect it is somewhat misleading to continue to refer to the term "PNC", as though it denoted some distinct linguistic entity. But the traditional term still has great currency, so we will continue to use it in this work, understanding that in the Sequential Analysis, PNCs have no independent linguistic status whatsoever. Whenever it appears, "PNC" is to be understood as representing the sequence <u>$NC</u>, i.e., a tautosyllabic NC cluster syllable onset.

In addition to the phonological mechanisms described above, we assume that the metatheory of phonology contains a set of markedness conventions. These convert the binary <u>m/u</u> (marked/unmarked) specifications of lexical representations into +/- values (cf. Chomsky and Halle (1968), Cairns (1969), Kean (1975)). On the assumption that only <u>m</u> markings are costly, it is possible to characterize the relative naturalness, or likelihood, of particular segments, classes of segments and sequences of segments. We further assume that markedness conventions and ordinary

P-rules are related by the notion of <u>linking</u>: when a P-rule operating over +/- values yields a segment whose specifications meet the structural description of a markedness convention for a feature not directly mentioned to the right of the arrow in the P-rule, that convention automatically "links" to the rule and reapplies, assigning a new +/- value. In the following subsection, we will suggest an extension of the notion of markedness and linking to syllabification. In Sec. <u>2.4</u>. we will examine the consequences of a sequential approach to prenasalization for the theory of sequential markedness.

<u>1.2</u>. Syllabification

In the Sequential Analysis, PNCs are distinguished from ordinary (heterosyllabic) NC clusters in phonetic representation solely by the position of the syllable boundary, $. PNCs are tautosyllabic sequences, [...$NC...], "ordinary" NC clusters are heterosyllabic sequences, [...N$C...]. Since both kinds of structures may occur in the same language (e.g., Sinhalese, which has a surface contrast between [ka$ndə] 'the trunk' and [kan$də] 'the hill'), it is incumbent on the Sequential Analysis to show how such differential syllabification could be accomplished in a principled manner.

Even before this is done, however, it is necessary to show why and how phonological theory should incorporate the direct representation of syllable structure that is essential to the Sequential Analysis.

1.2.1. Justification for the Syllable

There is no overt realization of what we will call syllable noundaries ($) in the physical speech event. Nor is there any generally-accepted articulatory or acoustic correlate of the syllable. Studdert-Kennedy (1976:11), echoing the sentiments of virtually all contemporary speech scientists, remarks that: "... the syllable has resisted acoustic definition only somewhat less than the phoneme-size phonetic segment."

But like the segment, the syllable has considerable intuitive force as a linguistic unit. Native speakers have a ready, untutored grasp of the basic concept; they can report consistently on the number of syllables in a form, and have generally clear and consistent intuitions about what constitutes appropriate syllabification in their language. Such intuitions may vary from speaker to speaker, or even for one speaker from time to time; this problem with introspective evidence should be familiar to linguists from syntactic research. But, as in syntax, clear cases abound: for example, the differential syllabification of NC sequences noted in 1.2 for Sinhalese.

In addition, like the segment, the syllable is the basis of orthographic systems; like the segment, it is fairly certain that the syllable is a unit of speech perception and production (cf. Ohmann (1966), Liberman et al. (1967), Studdert-Kennedy (1976)). Cairns (1971:41) poses a relevant question in this regard:

> If the syllable is to be a construct of the phonetician's model of speech production and perception, where does it come from? Let us make the natural assumption that the systematic phonetic level of grammar ... serves as input to the language user's speech perception and production devices. It is possible that syllable boundaries are not explicit features of systematic phonetic representation, but are instead assigned by the perception and production devices. Alternatively, it is conceivable that the phonological component of a grammar must contain rules that assign syllable boundaries. The burden of proof is on the proponent of the latter view, who would have to show that there are linguistic generalizations that could be captured only be explicit reference to syllable boundaries at preterminal stages of phonological derivations.

Other linguists (e.g., Anderson (1974:253) have argued that syllable structure must be incorporated into phonetic transcriptions simply on the grounds that languages may differ in the manner in which they syllabify the same strings of segments. But this argument is not sufficient. As we noted earlier, languages may differ in physical-phonetic properties that are determined nonlinguistically, but not necessarily universally.

What must be shown is that there are linguistic phenomena whose most adequate description requires the overt representation of syllable structure. It has long been tacitly assumed in generative phonology that the syllable is a derivative notion -- that any generalization to which syllable structure might be relevant could be expressed equally well by referring solely to sequences of segments. Thus a rule which linguists may informally characterize as reducing vowels before open syllables could be written in the form $[+\mathrm{syll}] \longrightarrow [\partial] \ / \left\{ \begin{matrix} \# \\ CV \end{matrix} \right\}$, where the notion of "open syllable" is expressed in terms of independently-required boundaries and segments. Hence there is purported to be no need to enrich phonological theory with the entity $ (or some comparable device), and the attendant mechanism needed to locate it appropriately.

A number of linguists (among them Hoard (1971), Hooper (1972), Anderson (1974), Vennemann (1974) and Kahn (1976)) offer strongly suggestive evidence that there are indeed linguistic generalizations that require specific reference to syllable structure for their most adequate expression. Our contention is that an adequate account of prenasalization in Sinhalese (and by extension universally) also demands that phonological theory be enriched in this way. We will see that Sinhalese PNCs must be represented as <u>$NC</u> sequences. By so doing, certain generalizations can only be expressed by direct reference to syllable boundaries. For example, a rule of Sinhalese much like the vowel reduction rule noted above cannot be formulated adequately by referring to sequences of segments alone. We therefore accept as a working hypothesis the premise that phonological theory must incorporate a direct representation of syllable structure.[1] Furthermore, this representation must function at all stages of phonological derivations.

1.2.2. Approaches to Syllabification Mechanisms

There are in the literature two general trends regarding phonological syllabification. The first we call the syllable markedness approach; the second, the maximal cluster approach. We will discuss each in turn, and then propose a framework, in the spirit of the former approach, in which to handle syllabification and prenasalization in the Sequential Analysis.

1.2.2.1. The Syllable Markedness Approach

Hooper (1972:534) argues that the task of a theory of syllabification is to "define the notion 'possible syllable' of a natural language." She claims that "... a few conditions on the structure of syllables are truly universal,

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[1] The assumption that PNCs are represented, and function linguistically, as $NC sequences requires of the general theory only that the notion of tautosyllabicity is expressible. So long as it is, nothing of consequence hinges on the particular theory of syllabification which is adopted, at least with respect to prenasalization. The Sequential Analysis simply demonstrates that some such theory is necessary.

and many conditions are widely applicable but not strictly universal. She proposes the following schema as a first approximation of a set of universal and near-universal conditions on syllabification:

(1) Hooper's Syllabification Schema

$$\emptyset \longrightarrow \$ \; / \; [+\text{syll}] \left\{ \begin{array}{l} \underline{\quad} \; [-\text{syll}]_0^1 \\ [-\text{syll}]_0 \; \underline{\quad} \left\{ \begin{array}{l} [-\text{son}] \begin{bmatrix} +\text{son} \\ -\text{nas} \end{bmatrix} \\ [+\text{cons}][-\text{cons}]_0 \end{array} \right\} \end{array} \right\} [+\text{syll}]$$

This schema is universal, and "operates ... in specific languages at no cost to the individual grammar." It applies first to lexical representations, and reapplies throughout phonological representations, readjusting syllable structure as phonological rules alter segmental sequences. Hooper claims, for example, that the underlying form of Spanish [pan] 'bread' is /pane/. This is first syllabified as /pa$ne/ in accordance with (1). A P-rule of Spanish then deletes the final /e/, yielding /pa$n∅/. The universal schema reapplies, adjusting this unexpected syllabification to /pan/. By convention, all earlier $ must be deleted when the universal schema reapplies. In addition, word-initial and word-final position automatically constitute syllable boundaries.

The essential notion underlying a schema like (1) is that certain syllable types are universal, or so close to universal that they may be regarded as optimal, or unmarked syllables, in much the sense that segments like /t/ and /a/, which are virtually universal, are maximally unmarked segments. These syllable types should arise without complicating the grammars of particular languages. One such syllable type is the CV syllable which, as Jakobson and Halle (1956:20) put it: "... is the only universal model of the syllable." Thus a /VCVCVCV/ string should be syllabified as /VCVCVCV$/ without cost. It is certainly true that, as Jakobson and Halle (1956:20) note, "there are languages where every syllable consists of a consonant and succeeding vowel." This is what we expect if CV is the maximally unmarked syllable. However, there is at least one language -- Oykangand, an Australian language cited by Sommer (1970) -- where a /VCVCVCV/ string is always syllabified as /VCVCVCV$/[2].

The universal mechanism, in this approach, rather than defining the set of "possible" syllables, is better viewed as defining the set of likely syllable types. The existence of languages like Oykangand, rare though they may be, also demonstrates that the costless universal mechanism should be supplanted by language-specific syllabification rules. These should operate at cost to grammars, reflect-

[2]CV syllables do occur in this language, but only in a few rare cases in phrase-initial position. See Darden (1970) for a more complete discussion.

ing the relative complexity (rarity) of syllable structure which they engender. The universal schema, together with all possible language-specific rules (on which there may be substantive constraints), define the set of possible syllable types. Since the universal schema itself defines only likely syllables, it is comparable in spirit to the universal interpretive conventions of markedness theory; these do not define possible segments (in general) but rather likely segments (and sequences of segments) (cf. Kean (1975:6ff) for discussion). We might then view the universal schema as defining a set of unmarked syllables, and the language-specific rules as defining a set of marked syllables.

1.2.2.2. The Maximal Cluster Approach

A second approach to phonological syllabification is reflected in the claim of Malsch and Fulcher (1975:308,fn.6) that "Hooper's rule ... is unnecessarily complex because it fails to formalize the generalization that syllable-initial clusters and initial clusters are governed by the same restrictions." Hoard (1971) and Kahn (1976)[3] have also proposed maximal cluster analyses.

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[3]Kahn's approach to syllabification has a rather different (and interesting) overall perspective. Instead of inserting syllable boundaries intersegmentally in strings, Kahn postulates a suprasegmental parallel string of syllable units (comparable to the autosegmental approach of Goldsmith (1976)); These are associated with segments by a set of well-formedness conditions. Kahn's theory, for which he brings to bear some very convincing evidence from low-level rules in English, allows for certain segments under some conditions to

Before discussing this approach further, two remarks are called for. First, the "complexity" of Hooper's schema is irrelevant. The schema is assumed to be part of universal grammar, hence not subject to the evaluation metric which chooses among potential individual grammars. Second, there is a fundamental circularity in the claim that syllable-onsets and initial clusters are "governed" by the same principle. Since initial clusters are virtually always syllable-onsets, a (trivial) relationship is guaranteed.

This circularity is taken even further by proponents of the maximal cluster approach, especially within taxonomic-structuralist phonological theories. Kuryłowicz (1948), O'Connor and Trim (1953), Haugen (1956) and Pulgram (1965, 1967) all espouse the position that, as Bell (1971:44) puts it, "... the initial and final clusters of medial syllables conform to the same constraints as initial and final syllables."

Bell further claims that "this condition has astonishing generality. I know of only one exception." The exception, Huichol, allows only VC$CV syllabification medially, even though the same medial clusters which are split

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be associated with more than one "autosegmental" syllable unit. Thus certain segments may be ambisyllabic. The notion of ambisyllabicity corresponds correctly to many native speaker intuitions about words in English like hammer, as Kahn observes. But there is no obvious formalization of the notion in a theory utilizing discrete intersegmental syllable boundaries (such as we propose here). In this respect Kahn's theory demands attention. For present purposes we note that Kahn's approach is perfectly consistent with the Sequential Analysis of PNCs, since the notion of tautosyllabicity is of course expressible in Kahn's framework.

syllabically may occur as initial clusters, and in spite of the fact that no word-final consonants are permitted.

But the generality of the maximal cluster approach is not as astonishing as Bell suggests. There are in fact numerous languages where permissible initial clusters do not serve as (medial) syllable onsets. In Russian, for example, initial [kn] and [dn] clusters are permitted: [kniga] 'book', [dni] 'day, gen.' But native speakers of Russian uniformly syllabify [okno] 'window' as [ok$no], and [odno] 'only' as [od$no].

We also find languages where medial clusters are syllabified as onsets, but are not permissible initially. In certain varieties of English (cf. Abercrombie (1967)), words like _Atlantic_ are syllabified as _A$tlan$tic_, even though [tl] is prohibited initially. Similarly, words like _handler_ may be syllabified as _han$dler_ despite the absence of initial [dl]. In certain dialects of German, words like [ra:dlə] are syllabified as [ra:$dlə],[4] although initial [dl] clusters are not permitted in German. Nielsen (1974) reports, in an experimental study, that many English speakers syllabify words like _exclaim_ as [ek$skleym] in spite of the general prohibition against initial [skl].

[4] This observation is from Vennemann (1968), who observes as well that this form can also occur as [ra:t$lə]. The devoicing of /d/ in the latter form can be accounted for only by assuming the differential placement of the syllable boundary, and by assuming that P-rules may refer to the boundary.

Cairns (1971:42), in a review of Pulgram (1967), points out another serious deficiency of the maximal cluster approach:

> Even if it is true that no other constraints are required to account for syllable boundaries beyond those that apply at word boundaries, it does not follow that all word-boundary constraints apply to medial syllables. Indeed, as Pulgram himself notes, examples of medial sequences that cannot be divided into a permissible final cluster followed by a permissible initial cluster are not hard to find among languages of the world. Thus, for example, Finnish permits only single consonants word-initially and word-finally, but some consonant clusters consisting of three members are permitted in medial position.

A similar situation obtains in Kannada, according to Bell (1971:41). For Pulgram, cases of this type are "resolved" by an ad hoc heuristic principle by which it is the coda of the preceding syllable which carries the burden of irregularity, i.e., which does not conform to a permissible final cluster. Cairns (1971) provides cogent arguments against this artificial, empirically-unfounded procedure.

It should be clear that there is no empirical basis for assuming that the maximal cluster approach underlies any putative universal syllabification mechanism. In the markedness approach, on the other hand, the precise nature of the universal syllabification mechanism can be determined by empirical means, under the same assumptions by which segmental and sequential markedness interpretive conventions are determined. We will adopt here a version of the markedness approach, incorporating a universal syllabification mechanism (to be given as (3) below) which is essentially that of Hooper (1972), with some minor revisions. We recognize that there may be aspects of the schema that are inadequate or empirically unfounded as they stand. It is to the credit of this approach, however, that the universal mechanism is subject to empirical validation; its best formulation is certainly a matter for much more extensive empirical investigation. For our present purposes it is necessary to adopt some coherent means of establishing and defining syllable structure; we opt for the markedness approach because it is amenable to empirical validation, and because it has potential as part of a larger, powerful theory of universal grammar.

1.2.2.3. The Universal Syllabification Convention and Other Matters

We take the syllable boundary, \$, like other boundaries in phonology (cf. Chomsky and Halle (1968:364) to be a complex symbol characterized by a set of features. We will distinguish the syllable boundary from other boundaries by the feature [syllable boundary] ([+/-SB]:

$$(2)\quad \$ = \begin{bmatrix} \text{-seg} \\ \text{-FB} \\ \text{+SB} \end{bmatrix}$$

\$ may be either [+WB] or [-WB]. The convention we give below guarantees that the unmarked value of [SB] for [+WB] is [+SB].

We assume that all segments in lexical representations are automatically bounded by the feature complex [u seg, u SB]; we regard this complex as a <u>segment boundary</u>. (The unmarked specification of [seg] is of course [-seg].) Segment boundaries may or may not become syllable boundaries; this is determined by the operation of the following markedness interpretive convention for the feature [SB]:

(3) UNIVERSAL SYLLABIFICATION CONVENTION (USC)

$$[\text{u SB}] \longrightarrow [\text{+SB}]$$

$$/ \left\{ \begin{array}{l} \begin{bmatrix} \_\_\_ \\ \text{+WB} \end{bmatrix} \\ [\text{+WB}]\ [\text{+nas}]\ \_\_\_\ [\text{-son}] \\ [\text{+syll}] \left\{ \begin{array}{l} \_\_\_\ [\text{-syll}]_0^1 \\ [\text{-syll}]_0\ \_\_\_ \left\{ \begin{array}{l} [\text{-son}] \begin{bmatrix} \text{+son} \\ \text{-nas} \end{bmatrix} \\ [\text{+cons}][\text{-cons}]_0 \end{array} \right\} \\ \qquad / \begin{bmatrix} \_\_\_ \\ \text{-seg} \end{bmatrix} \end{array} \right\} [\text{+syll}] \end{array} \right\}$$

By convention any [u SB] entity not specified as [+SB] by (3) is automatically [-SB]. Thus the only [+SB] entities -- syllable boundaries -- which occur in underlying representations are unmarked. A language with optimal syllable structure, a costless language with respect to syllable structure, is one in which underlying syllabification (as determined by (3)) is identical to systematic phonetic syllabification. But this optimality will not, of course, always be achieved by languages. Particular grammars may contain language-specific syllabification rules (LSRs) which yield non-optimal (marked) syllable structure. We take LSRs to be ordinary P-rules, distinguished only by the fact that they insert $, specified as [-seg, +SB], in environments which are not within the scope of the USC. Since P-rules are costly, a language whose grammar contains LSRs will necessarily be less highly valued than one without LSRs.

The USC is related to the operation of phonological rules (except LSR; see further) by a mechanism essentially like linking (cf. Chomsky and Halle (1968) and Kean (1975)). When a P-rule changes the segmental structure of a string such that unmarked syllable structure is lost -- for example, when <u>CVCV$</u> is converted by rule to $CV<u>$</u>CØ$ -- the USC links to the rule and reapplies: the underscored $ is automatically specified [-SB]. As an entity specified [-seg] and minus for all other boundary features, it has no phonetic interpretation, and in effect is deleted.

The USC simultaneously readjusts to unmarked syllable structure, re-evaluating the string and specifying new [+SB] entities where required.

In the theory of markedness proposed by Chomsky and Halle (1968:419ff.), the linking of rules and conventions is blocked when a rule mentions the feature interpreted by the convention in its (the rule's) structural change. A rule which blocks linking in this way is thus more complex than an otherwise identical rule which does not mention the feature interpreted by the convention, and which induces linking. A P-rule which changes syllable structure but does not insert a new [+SB] boundary will link back to the USC. LSRs, on the other hand, specify the feature [SB] in their structural change; hence LSRs do not induce linking. Thus when a <u>VCCV$</u> string is converted by an LSR to <u>VCCV$</u> (by deleting an unmarked $ and inserting a marked [+SB] entity), the USC is blocked from reconverting the string to its original form.

<u>1.2.2.4</u>. Supporting Evidence

The general model of syllabification proposed here is supported by the (sequential) analysis of prenasalization in Luganda advanced by Herbert (1976). This East African language exhibits PNCs medially (<u>$NC</u> sequences) but <u>#N$C</u> sequences in initial position. Assuming that PNCs are simply NC sequences in lexical representation, the USC claims that the underlying syllabification of a string

/mbutanda/ will be /\$m\$bu\$tan\$da\$/. The syllabification of initial NC clusters is already given by the USC; but the grammar of Luganda must contain an LSR which coverts intervocalic <u>N\$C</u> sequences to <u>\$NC</u>, at cost.

We have as yet seen no direct evidence, however, that Luganda <u>\$NC</u> sequences have an <u>N\$C</u> source; this assumption simply follows automatically from the operation of the USC. In fact, there is a phonological process in Luganda which provides such direct evidence. Herbert (1976:115) cites the form [kuta:\$nda][5] 'to betray'. He observes that Luganda has a general process of vowel-lengthening which applies to vowels in closed syllables. The long vowel in [kuta:\$nda] is inexplicable if the PNC is monosegmental; assuming that the PNC is sequential, the facts of vowel lengthening can be explained only if the nasal of the underlying NC cluster functions as the coda of the syllable in which the vowel that is to lengthen occurs. That is, the intermediate representation of this form must be /kutan\$da/ at the stage in the derivation when vowel lengthening applies. This is precisely what is predicted by the USC, by which the underlying syllabification of NCV is always <u>N\$CV</u>.

Since the surface form [kuta:\$nda] contains a PNC (native speakers uniformly report this syllabification, and the nasal in this language has quite brief duration), the grammar of Luganda must contain an LSR which converts

[5]In citing surface forms with PNCs, we will often omit \$s which are not relevant to the discussion, using \$ only to characterize tautosyllabic versus heterosyllabic clusters.

VN$CV to V$NCV. This rule must follow the rule of vowel lengthening.

Luganda therefore provides clear evidence that:

(i) phonological syllabification can be distinct from systematic phonetic syllabification; the syllabification mechanism must operate at levels deeper than systematic phonetic, hence cannot simply be part of a performance theory.

(ii) the USC, which takes N$C to be the unmarked underlying syllable structure, makes the correct prediction about the behavior of NC sequences in Luganda.

(iii) LSRs, which we take to be ordinary P-rules, may -- as expected -- be ordered with respect to other P-rules.

1.3. Summary

The Sequential Analysis of prenasalization involves the following theoretical assumptions and mechanisms:

1. The "prenasalized consonant" is not a distinct unitary linguistic entity. Languages which exhibit prenasalization as a physical phenomenon contain NC sequences at all levels of linguistic representation.

2. The metatheory contains a universal syllabification mechanism, with the status of a markedness interpretive convention. This convention assigns an unmarked syllable boundary to NCV sequences in underlying representation, namely N$CV.

3. Languages with underlying NC sequences will normally and typically treat them heterosyllabically, unless

a costly language-specific syllabification rule converts N$C to $NC.

4. Languages which exhibit prenasalization (physically) contain $NC sequences in systematic phonetic representation. These are interpreted by performance mechanisms (phonetic theory) as having the physical properties which may characterize prenasalization.

5. The physical properties commonly associated with many PNCs -- very brief duration of nasality, and the apparent monosegmentality of the overall event -- are never linguistically significant, i.e., need never be referred to by phonological rules.

1.4. General Outline of the Dissertation

Having described and motivated the Sequential Analysis, we will devote Chapter II to a discussion of the universal properties of PNCs: on the one hand, the physical-phonetic characteristics of prenasalization, and on the other, universal phonological properties of (tautosyllabic) NC sequences in terms of the theory of markedness. We will also present a typology of languages exhibiting prenasalization. Chapter III will consist of two parts: (a) part of a phonological analysis of Sinhalese, including a defense of the Sequential Analysis in terms of Sinhalese PNCs; and (b) a discussion of prenasalization phenomena in Fula, another language that has been described as problematical for the Sequential Analysis. In Chapter IV, we will review a number of proposals for dealing with PNCs monosegmentally, both within the Standard Theory and by extensions of the Standard Theory.

CHAPTER II: UNIVERSAL PROPERTIES OF PNCs

2.1. The Physical Nature of Prenasalization

2.1.1. Duration and Tautosyllabicity

The traditional term "prenasalized consonant" attests to the strongly monosegmental picture that these sounds usually present to the linguist. In all cases, PNCs are observed to contain an oral period which is essentially identical to an ordinary oral consonant; the nasal onset period may be so brief that the PNC appears to take no more time to produce than an ordinary consonant. In the one published instrumental study (of Luganda PNCs by Herbert (1976)), it is claimed that PNCs "exhibit only slightly more surface length than is characteristic of underlying single consonants.[6] Daniel Jones (1950:78), describing Sinhalese PNCs in a more impressionistic vein, remarks that "the nasal element is so short that the word [kaⁿdə] (trunk) has the same rhythmic pattern as [kadə] (shoulder pole carrying weights at each end)..." In other languages, the nasal period may be so brief as to be barely perceptible; initial PNCs in Fijian may have this property (cf. Scott (1948)). Brief duration of nasality coupled with the fact that PNCs are always tautosyl-

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[6] Herbert also reports that the duration of the nasal period when the oral period is voiced (i.e., a prenasalized voiced stop) may be appreciably longer (by 30 msecs. in one comparison) than the duration of nasality when the oral period is voiceless. This may well follow from general phonetic principles; Lehiste has shown, for example, that in contrasting pairs of English nasal/oral stop clusters with voiced and voiceless oral members, the nasal is shorter before the voiceless stop than the voiced.

labic (syllable onsets) contribute to the overall impression of monosegmentality that is often conveyed by speech events called PNCs. At the same time it has always been clear to linguistic observers that PNCs are complex entities. Trubetskoy (1969:169) describes PNCs as giving "the impression acoustically of being combinations of a very short nasal and an occlusive." Ladefoged (1971:33) describes them as having "a short nasal section in the first part of the articulation."

It is not at all clear, however, that brief nasal duration is either a necessary or sufficient criterial factor in the linguist's decision to call a complex nasal-oral event a PNC. Consider an English form like [æŋ$gwIs] 'anguish' where the nasal may be so brief that is surfaces simply as nasalization on the preceding vowel. In such a case, where the medial nasal-oral event is heterosyllabic, it is never suggested that a PNC is in evidence. The term seems always to be restricted to cases where the nasal and oral periods are judged as tautosyllabic by native speakers and linguistic observers. Brief duration of nasality, then, is not a sufficient condition in the characterization of such an event as a PNC.

That it is not a necessary condition either is demonstrated by the fact that there are languages described as containing PNCs where the nasal period is not markedly brief. Javanese is a clear example of this sort. We also commonly find in the literature descriptions of languages that are claimed to have PNCs, but no mention whatsoever is made of nasal duration. Again, tautosyllabicity is the necessary characteristic.

2.1.2. Homorganicity

Chomsky and Halle (1968:317) characterize PNCs as follows:

> Prenasalized consonants differ from the more usual type of nasal consonant in that the velum, which is lowered during the period of oral occlusion, is raised prior to the release of the oral occlusion, whereas in the more common type of nasal consonant, the velum is raised simultaneously with or after the release of the oral occlusion.

Although Chomsky and Halle assume uncritically the monosegmentality of PNCs, their description is correct in that it suggests that homorganicity (with respect to place of articulation) is a necessary characteristic of PNCs. Observe, however, that monosegmentality is not necessary to Chomsky and Halle's description, since it holds equally well for a sequence of ordinary homorganic nasal and oral consonants.

No language has ever been described as containing heterorganic PNCs, i.e., heterorganic tautosyllabic NC syllable onsets. This universal <u>homorganicity condition</u> can be captured in an interesting way in the theory of syllabification we have proposed here, namely by imposing the following substantive constraint on possible language-specific syllabification rules (LSRs):

(4) Homorganicity Condition

> No language may contain an LSR such that the underlying syllabified string XM$CY (where M is a nasal heterorganic to C) is converted to X$MCY.

Given (4) we can formally simplify LSRs which yield $NC sequences in languages which have both NC and MC underlyingly (and where MC does not surface as a syllable onset, but NC does; Fula is a case of this sort). The rule need not specify that N and C are homorganic, since rules where they are not homorganic are universally precluded by (4).

2.1.3. Nasalization

PNCs have sometimes been characterized as "nasalized" consonants (cf. Trubetskoy (1969:169) and Skousen (1971:83)). But this characterization is inconsistent with the usual usages of the term. Ladefoged (1971:33) observes that "a common practice ... is to use the term ... nasalized for a sound where the velum is lowered but there is no oral stop closure, so that some of the air passes out through the nose and some through the mouth." In this sense there may be nasalized vowels, nasalized glides, nasalized liquids, nasalized fricatives, nasalized glottal stops. Nasalized stops (with complete oral closure), however, are precluded by definition. Even if we relax the definition, and simply call nasalization the situation which obtains when part of the airstream escapes through the oral cavity while, simultaneously, part escapes through the nasal cavity, PNCs cannot be so characterized. There is no significant simultaneous nasal-oral air release in the case of PNCs, even prenasalized continuants (which could not be distinguished from nasalized continuants if both involved simultaneous nasal-oral air release).

Ohala (1975:300) reports on a phonetic study which suggests that some residual nasal-oral air release may occur in the production of ordinary voiced stops. He cites Yanagihara and Hyde (1966) to the effect that

> there are reliable reports ... of voiced stops allowing some velic leakage at the very beginning of the stop closure, attaining a completely airtight oral cavity only immediately before the stop release.

It is obvious that the velic leakage in such cases cannot be sufficient to produce any perceptually salient nasalization; since some leakage apparently continues throughout the stop, the voiced stops in question would be indistinguishable from true nasals. We assume that this kind of nonsalient velic leakage must occur in PNCs as well, since the velum is already lowered at the onset of the PNC. But residual velic leakage is not a sufficent basis for characterizing PNCs as nasalized in linguistic-phonetic terms.

2.2. Types of PNCs

A typology of prenasalized consonants is most usefully cast in terms of the oral period of the PNC, whose phonetic properties are essentially those of ordinary oral consonants. In the following subsections we will discuss the kinds of PNCs which are described in the literature, commenting where appropriate on the distribution and phonological behavior of these types.

2.2.1. Voiced Stop PNCs

These are overwhelmingly the most frequent of all PNC types. It is often incorrectly assumed (cf. Ferguson (1963:56)) that only this type of PNC exists. It is certainly the case, however, that many languages contain only voiced stop PNCs and no other type. Sinhalese, Fula, Fijian and Javanese are examples of this sort.

The set of voiced stop PNCs in a given language almost always corresponds exactly to the set of ordinary voiced stops. Kikongo, cited by Welmers (1973), is a rare example of a language which exhibits [ᵑg] but not [g] phonetically.

Voiced stop PNCs are observed to occur at all points of articulation except uvular.[7] The most common PNCs are labial, alveolar or dental and velar. The voiced palatal stop PNC [ᶮj] is cited by Hoffman (1963) for Margi; this language also exhibits doubly-articulated voiced stop PNCs.

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[7] Purnell (1972) describes a voiceless uvular stop PNC in some dialects of the Miao languages of southern China which do not otherwise contain voiced uvular stops.

Herbert (personal communication) reports the existence of prenasalized voiced imploded stops in the Karanga dialect of Shona, though in the related Zezevu dialect, the corresponding voiced stops are de-imploded in PNCs.

Voiced stop PNCs never occur contrastively with voiceless nasal periods; in the Sequential Analysis this follows from the extreme rarity (if not total absence) of voiceless nasal/voiced stop clusters. Gudschinsky, Popvich and Popovich (1970:85), however, report that the derived PNC [$^{\eta}$g] in Maxakali, an Amazon language, may occur with a voiceless nasal onset in free variation with a voiced onset, following a nasal consonant.

<u>2.2.2</u>. Voiceless Stop PNCs

Languages which contain only voiceless ordinary stops may contain only voiceless stop PNCs. Iatmul, a New Guinea language described by Staalsen (1966), exemplifies this situation. There are virtually no languages[8] which contain ordinary voiced stops but only voiceless stop PNCs. As noted above, however, the inverse case (only voiced stop PNCs in languages with both voiced and voiceless ordinary stops) is quite common.

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[8] Tairora, a New Guinea language cited by Vincent (1973) is a marginal counterexample to this claim. Tairora exhibits the voiceless stops [p t k], the voiceless stop PNCs [^{m}p ^{n}t $^{\eta}$k] and the lenis voiced stop [b], which alternates with the voiced bilabial fricative [β] intervocalically. Since the language has no other voiced stops, and underlying systems with /b/ only are bizarre, it is likely that the lenis stop is a fricative underlyingly. In any case, we can state with assurance that no language with a full series of voiced stops contains only voiceless stop PNCs.

When voiceless stop PNCs occur in a particular language, they appear always to have corresponding ordinary voiceless stops. Voiceless stop PNCs are found at all points of articulation, from labial to uvular (see fn. 7). As for voiced stop PNCs, labial, dental or alveolar and velar voiceless stop PNCs are most frequent. Doubly-articulated voiceless stop PNCs are found in Margi, and glottalized aspirated voiceless stop PNCs in the Shui Wei dialect of Miao.

The one voiceless stop which never occurs prenasalized is the glottal stop [ʔ], even in languages with voiceless stop PNCs corresponding to all other voiceless stops. Thus Margi exhibits [p t c k ʔ] as well as the PNCs [ᵐp ⁿt ᶮc ᵑk] but not "prenasalized" [ʔ]. The phonetic basis for this asymmetry is quite transparent, however. The state of the velum is obviously irrelevant when the airflow is completely blocked at points in the vocal tract below the velar port. Thus there can be no nasal consonant homorganic to [ʔ], hence no homorganic nasal-glottal stop sequence. The same holds true for pharyngeal consonants and [h].

2.2.3. Voiced and Voiceless Stop PNCs in Phonological Alternations

It is commonly the case that voiced and voiceless stop PNCs will behave differently in phonological alternations. Stevens (personal communication) reports that in Javanese PNCs may arise when a nasal prefix precedes a voiced stop-initial verbal stem; the prefix is /ŋ/, which surfaces as such before vowel-initial stems. The nasal assimilates to the place of articulation of the following stop. Thus /ŋ+dələŋ/ 'see' surfaces as [\$ndələŋ], with an initial PNC. When a voiceless stop follows the nasal, however, it is deleted: /ŋ+potoŋ/ 'cut' surfaces as [motoŋ]. Thus Javanese permits derived voiced stop PNCs, but not derived voiceless stop PNCs. In many Eastern Bantu languages, Herbert (n.d.) reports, voiced stop PNCs--but not voiceless--are simplified to ordinary nasals when the following syllable begins with a voiced stop PNC.[9]

2.2.4. Fricative PNCs

Fricative PNCs are quite rare in the languages of the world. They are frequently absent even in systems with a wide variety of other PNCs. Margi, for example, exhibits [f f^{w} s s^{w} s c x v v^{w} z z ɣ] and an extensive range of prenasalized voiced and voiceless stops, but no prenasalized fricatives.

Labio-dental and dental and alveolar fricative PNCs are attested in Luganda (Herbert (1976)) and Kikongo (Welmers (1973)); in both cases the fricative PNCs correspond to the ordinary fricatives: [^{m}f ^{m}v ^{n}s ^{n}z] are found along with [f v s z]. Swahili, however, contains only [^{m}v and ^{n}z], although it has ordinary voiceless fric-

[9] This rule is known as Meinhof's Law, or the Ganda Law. Fricative PNCs are also exempt from the law.

atives as well. There are no cases in the literature of bilabial, alveolpalatal, palatal, velar or uvular prenasalized fricatives.

<u>2.2.5</u>. Affricate PNCs

Prenasalized affricates, unlike fricative PNCs, are relatively common. They are cited, for example, by Hoffman (1963) for Margi; Trubetskoy (1969) for Chichewa; and Armstrong (1940) for Kikuyu. Margi exhibits [^{n}¢ ^{n}dz ^{ɲ}č ^{ɲ}ǰ] as well as the doubly-articulated prenasalized affricates which Ladefoged (1968) writes as [m͡nb͜dz] and [m͡nb͜dʒ]. There are no cases cited in the literature of prenasalized labial or velar affricates. Affricate PNCs are always accompanied by ordinary stop PNCs; languages with stop PNCs and ordinary affricates, however, do not always exhibit affricate PNCs. Sinhalese, with [ǰ] but not [^{ɲ}ǰ], is a case of this sort.

<u>2.2.6</u>. On "Sonorant PNCs"

There is only one language that is explicitly described traditionally as containing a prenasalized sonorant. This is Fijian, which Hockett (1955:124), for example, claims has a "mixed nasal/non-nasal pure sonorant," [^{n}r]. Anderson (1975:7) takes this case as evidence for a class of prenasalized liquids.

The physical event in Fijian, however, does not consist of a nasal period followed immediately by a sonorant, trilled [r]. In fact, it always occurs as [^{n}dr], with a voiced stop-like transition (cf. Scott (1949:741)). This transition is so apparent that the current standard orthography of Fijian represents the sound as dr.[10] Schutz (1972:15) remarks that: "D is excrescent, the result of the motions required to move from the position of the nasal to that of the trill." Such a transition is not "required" universally; Russian, for example, exhibits initial /nr/ sequences which surface simply as non-syllabic nasal plus trilled [r], as in [nraf] 'disposition.' Similarly, Ladefoged (1976) reports that Kele, an Austronesian language of Papua New Guinea, exhibits initial [nr] sequences, as in [nruwin] 'bone'; whereas the Titan language contains the Fijian-like sequence [ndr], as in [ndruli] 'sandpiper'.

Welmers (1973:71-72) presents data from Kikongo in which it appears that tautosyllabic initial [nl] and [mm] sequences occur. These always arise from underlying structures containing a nasal prefix (which assimilates in place to the following consonant), and a sonorant-initial stem: [nlaambi] 'cook' from /N+laambi/; [mmoni] 'one who sees' from /N+moni/. These parallel forms like [nti] 'tree' from /N+ti/ and [mbu] 'ocean' from /N+bu/.

Under the assumptions we have made in the Sequential Analysis, all of these initial nasal-sonorant sequences

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[10] Prenasalization itself is never represented in Fijian orthography: b = [^{m}b], d = [^{n}d], etc.

(being tautosyllabic and homorganic) might well be characterized as sonorant PNCs. In none of these cases, however (and to our knowledge in no language), do we find medial nasal-sonorant sequences as syllable onsets. Only Fijian is described as containing medial sonorant PNCs but, as we have noted, intrusive stops are always found between the nasal and the sonorant, in initial as well as medial position. In languages where PNCs are derived by rules sensitive to the nasal context in which a consonant occurs (cf. sec. 2.3.3.), it is never the case that sonorants are "prenasalized" by the process which inserts nasal segments. Where /...ṼCV.../ surfaces as [...Ṽ$NCV...], /...ṼRV.../ (where R is a sonorant) does not surface as *[...Ṽ$NRV...].

As we have formulated the Universal Syllabification Convention, (3), initial #NC sequences (where C is an obstruent) are syllabified NC; but initial #NR sequences are syllabified $NR. Medial NC and NR, in their unmarked state, are syllabified between the nasal and the following consonant. In order to account for the fact that no languages appear to permit medial sonorant PNCs (V$NRV sequences, for example) we propose the following substantive universal constraint on LSRs:

(5) The Obstruence Condition

> No language may contain an LSR such that the underlying syllabified string XN$RY (where R is a sonorant consonant) is converted to X$NRY.

Note that the adequacy of the Sequential Analysis as a means of describing prenasalization in linguistic theory depends neither on the Obstruence Condition, (5), nor on the Homorganicity Condition, (4). If languages are discovered with heterorganic PNCs (<u>$MC</u> sequences) or medial sonorant PNCs (<u>$NR</u> sequences medially), they will constitute evidence against the substantive constraints on LSRs that we have proposed, not against the Sequential Analysis per se.

<u>2.3</u>. A Classification of Languages With PNCs

In this section we will examine the kinds of surface contrasts into which PNCs can enter in different languages, and the kinds of phonological processes (other than marked syllabification rules) which contribute to the derivation of PNCs (surface <u>$NC</u> sequences). The classification rests primarily on the distribution of PNCs with respect to:

(i) ordinary oral consonants = C
(ii) ordinary nasal consonants = N
(iii) heterosyllabic NC sequences = N$C

The typology which is outlined in subsequent subsections is based on an examination of phonetic descriptions and phonological analyses of several dozen languages; where typological distinctions are based on phonological evidence, only morphologically transparent and noncontroversial cases are used. It is an extensive, though perhaps not exhaustive, characterization of the kinds of surface relationships that PNCs can exhibit, cast in terms of such traditional but heuristically useful notions as "contrast" (defined by the minimal pair test) and "complementary distribution" in its usual sense. For each type of language we will present a grid of the form:

	N	C	N$C
PNC			

When PNCs contrast (in surface forms) with a particular phone-type, we will mark the relevant cell Ct; when PNCs are in complementary distribution with a phone-type, we will mark the relevant cell CD; when a phone-type does not occur, we will mark the relevant cell Ø.

2.3.1. Type I

	N	C	N$C
PNC	Ct	Ct	Ct

Type I languages exhibit minimal contrast sets among all four phone-types. As we suggested earlier, the existence of Type I languages, with surface contrasts between PNCs and heterosyllabic N$C sequences will require some considerable explanation on the part of the Sequential Analysis. A critic will quickly point out that the differential syllabification of PNCs and N$C clusters in Type I languages could only be accomplished -- without string phonological evidence to the contrary -- by the ad hoc marking of individual lexical items, to which some language-specific principle of syllabification might be sensitive. The burden of proof is on the proponent of a sequential approach to show how PNCs and N$C sequences can be distinguished in underlying representation (if indeed they must), and how the necessary differential syllabification can be accomplished in a principled manner.

To our knowledge there are only two languages of Type I, which provide rare but crucial testing grounds for the Sequential Analysis. One is Sinhalese, where we find in systematic phonetic representation contrasting sets like the following:

(6)	i.	ka$ndə	'the trunk'
	ii.	kan$də	'the hill'
	iii.	kadə	'the carrying pole'
	iv.	kanə	'the ear'

The other language is Fula. In both cases, only voiced stop PNCs occur (Fula but not Sinhalese contains a voiced affricate stop PNC). In neither case is it possible to account for PNCs by reference to the nasality or non-nasality of neighboring segments. Thus under the Sequential Analysis, PNCs in Fula and Sinhalese must be represented as simple NC sequences in lexical representation (though some PNCs in Fula are derived by essentially morphological rules; see sec. 3.2.).

2.3.2. Type II (a and b)

		N	C	N$C
a.	PNC	Ct	Ct	Ø
b.	PNC	Ct	Ct	CD

Languages of Type IIa are the most common among languages of the world which contain PNCs. These languages contrast PNCs with ordinary oral and nasal consonants, and do not exhibit heterosyllabic N$C clusters at all. Examples include Margi and Kikongo in West Africa; Waffa, Tairora, Gadsup, Binumarien and Iatmul in New Guinea; Gugu-Yulanji in Australia; and Javanese in Indonesia. In all of these cases, and the many more cases like them, PNCs are represented lexically simply as NC sequences which are syllabified <u>$NC</u> in all positions where they occur, by means of an LSR.

Since no heterosyllabic <u>N$C</u> sequences occur phonetically, there is no potential descriptive indeterminacy between PNCs and other nasal-oral sequences.

In languages of Type IIb, <u>N$C</u> sequences do occur phonetically, but always in complementary distribution with PNCs. Thus in Luganda, <u>$NC</u> syllabification (PNCs) occurs only intervocalically; in initial position, the nasal of underlying NC sequences is always syllabic. Since the latter syllabification is given by the USC, the Luganda LSR yielding <u>$NC</u> onsets must be formulated so as to apply intervocalically only. In Swahili, PNCs and not <u>N$C</u> sequences occur intervocalically; in initial position, PNCs occur only when a nasal morpheme is prefixed to a bisyllabic (or longer) stem. <u>N$C</u> sequences occur initially when the stem is monosyllabic. Thus /m+buzi/ 'goat' surfaces as [$mbuzi]; but /m+bwa/ 'dog' surfaces as [$m$bwa].

One occasionally finds in the literature a language which appears to be a Type II case in general, but where PNCs and N$C sequences are apparently in free variation. Thus one finds reports like the following by Oates (1967) on Gugu-Yulanji, an Australian language which otherwise contains no heterosyllabic sequences phonetically: "..in a word like wanguriga 'to ask' there is doubt whether the syllables are wa-ngu-ri-ga or wan-gu-ri-ga." In such cases there is doubt whether it is the native speaker or the linguist who is in doubt. Hence we take cases of this type as marginal at best, and do not treat them as a separate class.

2.3.3. Type III

	N	C	N$C
PNC	CD	CD	Ø

In Type III languages, PNCs are always in complementary distribution with ordinary single nasal and oral consonants. The occurrence of PNCs is usually predictable on the basis of the nasality or non-nasality of neighboring segments, both consonants and vowels. Many Type III languages are "nasal-prosodic", in the sense that entire morphemes may be characterized as nasal or non-nasal. In Guarani, for example, (cf. Gregores and Suares (1967)) the prosodic nasality of a formative is essentially determined by the lexical nasality of stressed vowels. Thus a form like /nereme/ 'your lips', consists only of non-nasal formatives. Underlying intervocalic nasals in non-nasal spans surface as PNCs. Hence /nereme/ surfaces as [nere$mbe]. /menã/ 'husband', on the other hand, is a nasal formative, and surfaces as [m̃ẽnã]. In Maxakali, an Amazon language described by Gudschinsky, Popovich and Popovich (1970), PNCs are derived from underlying simple nasals in syllable-initial position before oral vowels. The same phenomenon is found in the Chinese dialects cited by Chen (1975).

This general phenomenon is characterized by Hyman (1975) as "partial denasalization," assuming the monosegmentality of PNCs. Hyman has observed that the phenomenon appears to occur only in languages which contrast nasal and non-nasal vowels, and suggests that it has a "perceptual" basis. Given syllables like [mã] and [ma], there is a tendency for the underlying oral vowel to nasalize when preceded by a nasal consonant, neutralizing the nasality distinction in vowels. The "partial denasalization" of nasals before oral vowels, then, serves to block this incipient neutralization. There is at least one language which we may classify as Type III for which this explanation is inadequate. According to Chen and Clumeck (1975) the Seoul dialect of Korean exhibits "partial denasalization" -- PNCs -- in initial position; but nasality is not contrastive in vowels. For all these cases, whatever their ultimate explanation, we can account for the "denasalization" process in the Sequential Analysis by postulating rules which insert whole oral segments appropriately; the resultant NC sequence undergoes syllabification to *\$NC* by an LSR.

2.3.4. Type IV

	N	C	N\$C
PNC	Ct	∅	∅

The most striking property of Type IV languages is that voiced stop PNCs occur phonetically but corresponding ordinary voiced stops do not. Nor do *N\$C* sequences. Voiceless stops, however, are always in evidence. There are very few languages of this type; only Fijian and related languages (cf. Scott (1949) and Schutz (1971)) and the Lo p'o River dialect of Miao (cf. Purnell 1972) are described in the literature.

It is most plausible to assume that these languages have ordinary voiced stops underlyingly, and that surface PNCs are derived by a context-free rule which, in the Sequential Analysis, inserts a homorganic nasal before all voiced stops.

There are no languages where voiceless stop PNCs occur, but not ordinary voiceless stops.

2.3.5. Further Remarks and Summary

The four general types of languages exhibiting PNCs fall into two subclasses: in Types I and II, NC sequences occur in lexical representations; in Types III and IV, NC sequences arise by rule. In all cases, a costly rule yielding *\$NC* syllabification is required in the Sequential Analysis. It is of interest to note that grammars of Type

III and IV languages are, all other things being equal, more costly than grammars of Type I and II languages. Type III and IV require both a rule yielding NC sequences and an LSR yielding $NC syllabification; Types I and II require only the LSR. Types III and IV are certainly less widespread among the languages of the world than Type II; this is predicted by the Sequential Analysis. The relative rarity of Type I languages, however, is another matter -- one to be explained, we believe, by the opacity which a NC/NC surface contrast engenders with respect to the rule of $NC syllabification. Both known Type I languages, Sinhalese and Fula, reveal considerable morphological complexity underlying the surface contrast (See Chapter III for relevant details).

In (7) below, we schematize the results of this section:

(7)

	Type	Example	Surface Relation of PNC to:		
			N	C	N$C
NC IN LEXICON	Type I	Sinhalese	Ct	Ct	Ct
	Type IIa	Javanese	Ct	Ct	∅
	Type IIb	Luganda	Ct	Ct	CD
DERIVED NC	Type III	Maxakali	CD	CD	∅
	Type IV	Fijian	Ct	∅	∅

Ct = contrast
CD = complementary distribution
∅ = does not occur in surface forms

2.4. Universal Implicational Laws and Markedness of PNCs

2.4.1. General Considerations

The theory of markedness in generative grammar first proposed by Chomsky and Halle (1968), and elaborated by Kean (1975), attempts to provide a formal account of the naturalness, or likelihood, of particular phonological systems. The set of universal markedness interpretive conventions constitutes a "cost-book" by which the complexity of a given grammar can be evaluated. In addition, the theory can be construed so as to account formally for universal laws of implication between segments and classes of segments: for example, the implication that "If a language has voiced stops, it also has voiceless stops." Cairns (1969:871) suggests that these universals follow from conditions on the assignments of *m*s in the lexicon, and proposes the following heuristic principle:

> (8) If the presence in any language of a set of segments, S, is implied by the presence of another set of segments, T, in the same language, and the converse is not true, then the segments in S are unmarked for at least one feature for which the segments in T are marked.

Cairns writes further that "It is evident that, since implicational universals partially dictate the assignment of *m*s in the lexicon, these universals may serve as evidence for a proposed set of universal conventions in a way somewhat different from that suggested previously. Any proposed set of universal interpretive conventions must at least meet the requirement that _m_-_u_ matrices which conform to the condition on _m_-assignment, based on an empirical study of implicational universals, must be converted into the appropriate plus-minus feature matrices."

Although considerably more attention has been paid to the naturalness of individual segments and segment-classes, the theory of markedness has equal relevance for the notion of "sequential" markedness, or the naturalness of certain constellations of features in context. Cairns (1969) proposes that his heuristic principle (8) be extended, so that sequential as well as segmental universals can inform the formulation of interpretive conventions. In (9) we give a somewhat simplified version (limited to two-segment sequences) of Cairns' condition on _m_-assignment with respect to segmental sequences:

(9) If the presence in any language of the segment sequence $S_\alpha S_\beta$ is implied by the presence of another segment sequence $T_\alpha T_\beta$, in the same language, and the converse is not true, then either S_α is unmarked for at least one feature for which T_α is marked, or S_β is unmarked for at least one feature for which T_β is marked.

In the following subsections, we will discuss a variety of problems arising from a consideration of universal (and near-universal) implicational properties of PNCs, and propose a set of sequential markedness interpretive conventions which are consistent with the empirically-based implicational laws that we have observed.

2.4.2. On the Markedness of NC Sequences in General

Certain phonologists have objected to analyzing PNCs sequentially on the grounds that, as Anderson (1975:6) puts it, they "have the distribution of single segments (that is, they occur in positions where clusters are impossible.)" We have referred to this position as the "phonotactic objection."

It is certainly true that there are languages in which PNCs occur in positions where no (other) consonant sequences are permitted. There are two situations where this arises: (i) in languages like Fijian, which exhibit PNCs but no consonant clusters of any other type; (ii) in languages like Fula, which exhibit PNCs in certain positions where other sequences (permitted elsewhere) are prohibited.

The fact that a language allows PNCs and no (other) consonant clusters cannot be taken a priori to mean that PNCs are not properly analyzed as clusters themselves. Such an argument is circular. If we find empirical and theoretical reason to believe that PNCs are sequential, we must acknowledge that there are languages which contain NC sequences, but no other type. The question is then perhaps best posed in terms of markedness theory: is a system which permits only N and C to cluster a like-system? Are there universal implicational laws which might inform markedness theory as to the complexity of NC sequences?

Consider the fact that there are clearly languages which exhibit unimpeachable NC clusters (heterosyllabic, hence necessarily sequences); but no other clusters are permitted. Japanese is a well-known example, allowing NC only, in medial position. Similarly, Sapir (1965) reports that Diola-Fogny, a language of Senegal, permits only NC clusters lexically, in initial, medial and final position. Initially, N is syllabic, as the USC predicts. PNCs do not occur in any position (i.e., there is no resyllabificationf N$C to $NC). When other clusters arise across morpheme boundaries, this "invariably leads to consonant reduction or separation." But NC clusters, whether inter- or intra-morphemic, remain intact.

Ferguson (1975:178) remarks that "homorganic nasal-stop clusters are among the commonest types of consonant clusters in human language (cf. Greenberg 1965), and clusters of this kind are also among the first consonant clusters to be acquired by the child learning his mother tongue." We know of no case where a language permits fully-oral CC clusters generally, but disallows NC clusters. This implication, and the other kinds of evidence noted above, suggest that the following markedness interpretive convention for the feature [nasal] in consonant sequences should be incorporated in the theory:

(10) $[u\ nas] \rightarrow [+nas] \ / \ \begin{bmatrix} \_\_\_ \\ +cons \end{bmatrix} \ [+cons]$

Since (10) has the effect of valuing NC sequences in general highly, it follows that systems exhibiting only this sequence type are likely. Hence, given the Sequential Analysis, it follows that a language is likely to exhibit PNCs but no other clusters. Since such a language's grammar must still contain a costly LSR, however, the general evaluation metric will treat a language with PNCs as more complex than one with (unmarked) N$C sequences.

It might appear, in isolation, that (10) is too strong, since it values NC sequences highly in all positions, and there is reason to believe that NC is not the maximally unmarked cluster in initial position. It is commonly the case that a language will prohibit NC sequences initially while permitting clusters of other kinds (and while allowing NC clusters and other sequences in other positions). English is a clear example.

The following universal implication, (U-1), provides another reason to believe that initial NC sequences are marked, now with respect to medial NC sequences. (U-1) holds for both PNCs and NC sequences in general.

(U-1) IF A LANGUAGE HAS PNCs (NC SEQUENCES) INITIALLY, IT ALSO HAS THEM MEDIALLY.

There are no languages with PNCs (or N$C sequences) initially, but no NC sequences at all medially.[11] Nor are there any languages with PNCs in initial position, but only N$C sequences medially.[12]

We can capture (U-1), and characterize the relative complexity of initial NC sequences, with the aid of the markedness interpretive convention proposed by Chomsky and Halle (1968:406) for the feature [continuant]:

$$(12) \qquad [\text{u cont}] \longrightarrow \left\{ \begin{array}{l} [\text{+cont}] \;/\; + \_\_ \; [\text{+cons}] \\ [\text{-cont}] \end{array} \right\}$$

Under this convention the unmarked value of [continuant] is minus everywhere but in morpheme-initial (hence word-initial) position before a consonant. We believe that (12) is essentially correct, though it requires some modification to account for the relative naturalness of initial stop-liquid clusters as opposed to stop-stop clusters. It has the desirable effect, for our purposes, of adding a mark to [-cont] nasals in initial position before another consonant. Initial NC sequences are thus marked for one more

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[11] We exclude here, of course, languages where all noncompound words are monosyllabic, since medial clusters are impossible on independent grounds. The Miao languages, and the Chinese dialects with PNCs cited by Chen (1975) are of this sort.

[12] The fact that there are no languages with [#$NC...N$C...] syllabification suggests another substantive universal constraint on LSRs:

(11) Word-Initial Condition

No language may contain an LSR such that the underlying syllabified string #N$CX is syllabified #$NCX, but the underlying syllabified string YN$CZ (where Y does not contain #) is not syllabified Y$NCZ.

feature, [continuant], than medial NC sequences. (U-1) thus follows from the assignment of ms by conventions (10) and (12) in concert.

Observe that these conventions value systems with NC clusters in general highly, though languages with initial as well as medial NC sequences are valued less highly. The latter kind of case cannot, of course, be ruled out; otherwise a language like Diola-Fogny, with initial, medial and final NC clusters, would be impossible. The assumption that marking conventions constitute a cost-book -- not absolute constraints on representations -- says that Diola-Fogny is somewhat complex, not illegal. The same is true of languages with initial PNCs but no other clusters (for example, Fula). Since languages like Diola-Fogny exist, it would be surprising if languages like Fula did not. Thus the "phonotactic objection" to the Sequential Analysis is groundless; it is simply an observation about the complexity of systems with initial NC.

A more convincing phonotactic argument against the Sequential Analysis might involve a language which freely permits consonant sequences in a position where it prohibits PNCs. We are not aware of any such case.

2.4.3. Other Implicational Universals and Related Conventions

(U-2) IF A LANGUAGE HAS PNCs, IT ALSO HAS NON-PRENASALIZED CONSONANTS.

Although Type IV languages like Fijian may exhibit only voiced stop PNCs without corresponding ordinary voiced stops (phonetically), these languages always contain ordinary voiceless stops and ordinary nasals. There is no language which contains only PNCs, and no ordinary stops of some sort. In the Sequential Analysis, this universal implication is an automatic consequence of a much more general implicational law: namely that languages with CCV sequences must also have CV sequences. No language permits clusters without also permitting single consonants. The relevant interpretive convention, as formulated by Cairns (1969:869) is as follows:

$$\text{(13)} \qquad [\text{u cons}] \longrightarrow \left\{ \begin{array}{l} [\text{+cons}] / \left\{ \begin{array}{l} + \underline{\quad} \; [\text{u cons}] \\ [\text{m seg}][\text{u cons}] \; \underline{\quad} \end{array} \right\} \\ [\text{-cons}] / \left\{ \begin{array}{l} + \underline{\quad} \; [\text{m cons}] \\ [\text{m seg}][\text{m cons}] \; \underline{\quad} \\ [\text{m seg}] \; \underline{\quad} \end{array} \right\} \end{array} \right\}$$

Observe that in a monosegmental analysis of PNCs (utilizing some phonological feature to characterize unitary PNCs), this implicational law would require a separate interpretive convention, whereby the unmarked value of whatever feature [F] characterized PNCs would be [-F] (with [+F] PNCs being marked). Although the monosegmental analysis with a separate convention would be no more costly in purely formal terms (since the universal marking conventions do not contribute to the cost of particular grammars), the Sequential Analysis nonetheless accounts for two superficially different phenomena in a unified way, and provides a more general explanation of (U-2).

(U-3) IF A LANGUAGE HAS FRICATIVE PNCs, IT ALSO HAS STOP PNCs.

Many languages have only prenasalized stops, and no prenasalized fricatives. No language has only fricative PNCs. This is expected whether PNCs are analyzed sequentially or monosegmentally. The unmarked value of [continuant] for single consonants is minus (cf. (12); thus monosegmentally-represented fricative PNCs would contain one more m lexically than stop PNCs, and (U-3) would follow from principle (8). In the Sequential Analysis, (U-3) is a function of the general fact that nasal-fricative sequences in all languages presuppose nasal-stop sequences, and not vice versa. The interpretive convention (12) renders fricatives anywhere but in initial position before a consonant relatively complex with respect to stops: in NS sequences (where S is a fricative), S is marked for the feature [continuant]; in NT sequences (where T is a stop), T is unmarked for that feature. Hence (U-3) follows from principle (9).

(U-4) IF A LANGUAGE WITH ORDINARY VOICED STOPS HAS VOICELESS STOP PNCs (NC SEQUENCES) IT ALSO HAS VOICED STOP PNCs (NC SEQUENCES).

Evidence for (U-4) was presented in 2.2. Note that for ordinary stops, the unmarked value of [voice] is clearly minus. Many languages have only voiceless stops, but no language has only voiced stops. In a monosegmental analysis of PNCs, a separate convention would be required in order that the unmarked value of [voice] for PNCs is plus. In the Sequential Analysis, the likelihood of voiced stop PNCs falls out directly from the following general interpretive convention over consonant sequences:[13]

$$\text{(14)} \quad [\text{u voi}] \rightarrow [\alpha \text{voi}] \ / \ \begin{bmatrix} +\text{cons} \\ -\text{syll} \\ \alpha \text{voi} \end{bmatrix} \ \underline{\quad}$$

(14) holds for fricative PNCs (NS sequences) as well as for stop PNCs and other sequence types. We expect that languages with voiceless fricative PNCs will exhibit voiced, and not vice versa. As noted in <u>2.2.4</u>., Luganda contains both voiced and voiceless fricative PNCs; Swahili, as predicted, contains only voiced. Ladefoged (1968) refers to one case, Sherbro, where it appears that only the highly unlikely fricative PNC [$^{n}\theta$] occurs, although the language contains voiced fricatives. Such a system should clearly be costly; (14) has this effect (in part).

We noted in <u>2.2.2</u>. that a few languages (at least two, Tairora and Binumarien, New Guinea highlands languages, are cited by McKaughan (1973)) with only voiceless stop PNCs. These languages do not, however, contain a normal series of voiced stops. (14) claims that such languages are costly, and they are indeed extremely rare.

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[13] This convention holds that clusters agreeing in [voice] are the norm. Fully voiceless PNCs (NC sequences) are thus less marked than PNCs with a voiceless nasal onset but a voiced oral period. No language is claimed to have the latter type of sequence underlyingly. Both types are more marked than voiced-nasal onset PNCs by virtue of the assumption that voiceless nasals are marked in all positions.

(U-5) IF A LANGUAGE HAS AFFRICATE PNCs (NC SEQUENCES) IT ALSO HAS NON-DELAYED RELEASE STOP PNCs (NC SEQUENCES)

Languages with affricate PNCs always contain non-delayed release stop PNCs as well, but the converse is not true (cf. <u>2.2.5</u>.). Convention (15) accounts for this implication:

(15) $[\text{u del rel}] \rightarrow [\text{-del rel}] \; / \begin{bmatrix} \text{+nas} \\ \text{+cons} \end{bmatrix} \begin{bmatrix} \rule{1em}{0.4pt} \\ \text{+cons} \end{bmatrix}$

<u>2.4.4.</u> Syllable and Word-final NC Clusters

In our discussion so far we have consistently treated prenasalized consonants as tautosyllabic NC cluster syllable onsets, ignoring the question of whether tautosyllabic NC cluster offsets are also, in some sense, PNCs. This apparent oversight was not, however, accidental. There is an overwhelming tendency among languages which exhibit PNCs (<u>$NC</u> onsets) to disallow NC sequences in syllable-final (hence word-final) position. While it is certainly true that there are many languages with syllable-final and word-final NC clusters, these languages virtually never resyllabify <u>N$C</u> in other positions to <u>$NC</u>.[14] Diola-Fogny, English, Hindi and Hungarian are examples of this type.

We are aware of only one case in the literature in which it is suggested that PNCs occur in syllable-final

[14] The Malgache language, an Austronesian language of Malagasy -- which this writer is familiar with only from tapes by the University of California, Berkeley Language Laboratory-- appears to exhibit initial and medial PNCs, and NC clusters in word-final position, at least phonetically. It is the only case of this type of which we are aware.

position; this is Maxakali, in which Gudschinsky, Popovich and Popovich (1970) claim that underlying nasals in syllable-final position before a non-homorganic oral consonant develop "a transition ... that is both denasalized and devoiced." Thus (the intermediate representation) /mim$koy/ 'canoe' surfaces as [mimp$koy]. Maxakali, a Type III language, exhibits PNC (onsets) in initial and medial position.

(A similar phenomenon is found in English (and many other languages), where a form like /warm+θ/ 'warmth' surfaces as [warmpθ], /sʌm+θiŋ/ 'something' as [sʌmp$θiŋ], etc.)

Maxakali does not contain NC clusters in syllable-final or word-final position underlyingly, nor does it exhibit word-final NC sequences phonetically.

From a monosegmental perspective, the absence of final PNCs in the vast majority of languages with initial and medial PNCs is a complete mystery. There is no imaginable reason (nor any precedent) for a particular class of unitary segments to fail to occur in final position in virtually all languages. Within the Sequential Analysis, this phenomenon is more coherent. Word-final and syllable-final clusters in general are undoubtedly more marked than initial or medial clusters (we will not however propose a formal interpretive mechanism to account for this claim, lacking extensive data on final clustering). There are many languages with only medial clusters (e.g., Finnish and Kannada), and only initial and medial clusters (e.g., Spanish). Some monosyllabic languages (e.g., Miao-Yao and other Mon-Khmer languages; cf. Purnell (1972) have only initial and no final clusters. There are certainly no languages with final clusters only.

In fact, virtually no language with PNCs (Malgache being the only possible exception) allow consonant clusters of any sort whatsoever in final position phonetically. In 3.1. we will see that Sinhalese, with medial PNCs, allows final NC clusters in lexical representations, but these are reduced by general rule to N in word-final position.

These facts may be summarized by the following (near-) universal:

(16) IF A LANGUAGE PERMITS CONSONANT SEQUENCES IN WORD-FINAL POSITION IN SYSTEMATIC PHONETIC REPRESENTATION, IT WILL NOT SYLLABIFY INITIAL OR MEDIAL NC SEQUENCES AS SYLLABLE ONSETS (I.E., WILL NOT EXHIBIT PNCs).

Since (16) is in part a function of the operation of independent P-rules, hence a non-local property of grammars, it is difficult to see how it could be expressed formally, either within markedness theory, or as a substantive constraint on LSRs. It suggests, however, that there is a strong relationship between a language's general syllable structure, and the fact that it does or does not have a language-specific mechanism yielding $NC syllable onsets. Herbert (1976b) has observed that languages with PNCs show a strong general tendency toward open syllable structure in phonetic representation. In many cases, only $\$C_0V\$$ syllables may occur. In others (e.g., Sinhalese; see 3.1.) only $\$C_0VC_0^1\$$ syllables may occur. Maxakali, which permits medial $\$C_0VC_0^2\$$ syllables, does not permit them in word-final position.

The exact nature of the relationship between $NC onsets and general syllable structure remains to be explored, but (16) clearly indicates that some kind of relationship exists.

2.4.5. Summary

We have observed the following implicational universals involving PNCs; to our knowledge all of them hold for heterosyllabic N$C sequences as well as tautosyllabic $NC sequences (PNCs):

(U-1) IF A LANGUAGE HAS PNCs INITIALLY, IT ALSO HAS THEM MEDIALLY.

(U-2) IF A LANGUAGE HAS PNCs, IT ALSO HAS NON-PRENASALIZED CONSONANTS.

(U-3) IF A LANGUAGE HAS FRICATIVE PNCs, IT ALSO HAS STOP PNCs.

(U-4) IF A LANGUAGE WITH ORDINARY VOICED STOPS HAS VOICELESS STOP PNCs, IT ALSO HAS VOICED STOP PNCs.

(U-5) IF A LANGUAGE HAS AFFRICATE PNCs, IT ALSO HAS NON-DELAYED RELEASE STOP PNCs.

In addition to (U-1) through (U-5), which appear to be true for all languages, we also observed in (16) that languages which exhibit PNCs (\$NC onsets) in initial and/or medial position virtually never exhibit NC sequences in syllable-final position, or, for that matter, syllable-final CC sequences of any sort. This suggests a relationship between \$NC syllabification (by marked, costly LSR) and other general constraints on syllable structure in particular languages which future research should make a point of exploring.

Following Cairns' heuristic principle (9), we propose a set of sequential markedness interpretive conventions which reflect the universal implicational laws discussed above. These conventions are restated below:

(10) $$[\text{u nas}] \rightarrow [\text{+nas}] \;/\; \begin{bmatrix} \_\_\_ \\ \text{+cons} \end{bmatrix} \; [\text{+cons}]$$

(12) $$[\text{u cont}] \rightarrow \left\{ \begin{array}{l} [\text{+cont}] \;/\; + \_\_\_ \; [\text{+cons}] \\ [\text{-cont}] \end{array} \right\}$$

(13) $$[\text{u cons}] \rightarrow \left\{ \begin{array}{ll} [\text{+cons}] \;/ & \left\{ \begin{array}{l} + \_\_\_ \; [\text{u cons}] \\ [\text{m seg}][\text{u cons}] \_\_\_ \end{array} \right\} \\ [\text{-cons}] \;/ & \left\{ \begin{array}{l} + \_\_\_ \; [\text{m cons}] \\ [\text{m seg}][\text{m cons}] \_\_\_ \\ [\text{m seg}] \_\_\_ \end{array} \right\} \end{array} \right\}$$

(14) $$[\text{u voi}] \rightarrow [\alpha\text{voi}] \;/\; \begin{bmatrix} \text{+cons} \\ \text{-syll} \\ \alpha\text{voi} \end{bmatrix} \; \_\_\_$$

(15) $$[\text{u del rel}] \rightarrow [\text{-del rel}] \;/\; \begin{bmatrix} \text{+nas} \\ \text{+cons} \end{bmatrix} \begin{bmatrix} \_\_\_ \\ \text{+cons} \end{bmatrix}$$

Given the above conventions, the lexical complexity of NC sequences is expressed in the matrices in (17); N = voiced homorganic nasal (voiceless nasals are marked by a separate segmental convention; for each type below, the complexity of its voiceless nasal-onset counterpart is one m greater); D = voiced oral stops; T = voiceless oral stops; Z = voiced fricatives; S = voiceless fricatives; J̌ = voiced affricates; Č = voiceless affricates. Each sequence type is given in both initial (marked) position, and medial (unmarked) position:

(17) Complexity of NC Sequences

	#ND	#NT	#NZ	#NS	#NJ̌	#NČ	ND	NT	NZ	NS	NJ̌	NČ
Nasal	uu	uu	uu	uu	uu	uu	uu	uu	uu	uu	uu	uu
Voice	uu	um	uu	um	uu	um	uu	um	uu	um	uu	um
Cont	mu	mu	mm	mm	mu	mu	uu	uu	um	um	uu	uu
Del Rel	uu	uu	um	um	um	um	uu	uu	um	um	um	um
Complexity	1	2	3	4	2	3	0	1	2	3	1	2

Note that the overall systemic complexity of prenasalization is a function not only of the m/u specifications of NC sequences in the lexicon, but also of the additional cost accrued by language-specific resyllabification rules which take unmarked N\$C to \$NC. In light of empirical evidence presented in this section, we have proposed three substantive constraints on such LSRs:

(i) Homorganicity Condition

No language may contain an LSR such that the underlying syllabified string XM$CY (where M is a nasal heterorganic to C) is converted to X$MCY.

(ii) Obstruence Condition

No language may contain an LSR such that the underlying syllabified string XN$RY (where R is a sonorant consonant) is converted to X$NRY.

(iii) Word-Initial Condition

No language may contain an LSR such that the underlying syllabified string #N$CX is converted to #$NCX, but the underlying syllabified string YN$CZ (where Y does not contain #) is not converted to Y$NCZ.

CHAPTER III: TWO ACCOUNTS OF PRENASALIZATION IN THE SEQUENTIAL ANALYSIS

3.1. Sinhalese

In this section we will present part of a general phonological analysis of Sinhalese, an Indoeuropean language of Sri Lanka (Ceylon) with Type I characteristics; PNCs contrast on the surface with N$C sequences, as well as ordinary nasal and oral consonants. We will show that the Sequential Analysis, including a formal representation of the syllable, provides a simple, revealing and unified account of prenasalization and other phenomena in Sinhalese.

3.1.1. Some Background About the Language

Sinhalese (or Sinhala) is the main, and official, language of the island of Ceylon, now called Sri Lanka. It is a member of the southern Indic group of languages, related to the main Indoeuropean languages of northern India. Sri Lanka is separated from Indoeuropean-speaking northern India by a large Dravidian-speaking region; about 20% of the population of Sri Lanka (cf. Fairbanks, Gair and de Silva (1968)) speaks Tamil, a Dravidian language which has had considerable influence on Sinhalese, particularly lexical. Sinhalese is characterized by a rather complex form of diglossia (cf. Gair (1968)); the Colloquial and Literary varieties of the language are quite distinct, both phonologically and syntactically. The Colloquial variety is the only form used in normal spoken discourse; it is the only variety we will be dealing with in this work. Our informant, Mr. Wimal de Silva, is a native of Galle, on the southwestern coast; he speaks the Colloquial dialect of that region (which includes the capital city of Colombo).

The main phonological property which distinguishes Sinhalese from related Indic languages is the fact that it exhibits contrastive prenasalized consonants; in fact, it is the only Indoeuropean language to do so.[15] Sinhalese also exhibits extensive distinctive consonant gemination, common in Dravidian languages but rarer among Indic languages. Like so many languages in the area, Sinhalese contains retroflex stops (voiced and voiceless); these are represented here as /D/ and /T/. They are articulated with the tongue-tip curled backward, making contact near the middle of the alveolar ridge; they are considerably fronter than comparable retroflex stops in Tamil, for example (cf. Perera and Jones (1919)). The ordinary coronal stops /t/ and /d/ are dental.

Sinhalese exhibits the ordinary nasals [m n N (ñ) ŋ] in systematic phonetic representation. The retroflex [N] occurs only in clusters with homorganic [D] and [T]; [ñ] is extremely limited in its distribution; and [ŋ] occurs

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[15] The closely related Maldivian language, spoken on the Maldive Islands, in the Indian Ocean to the west of Sri Lanka, also appear to have PNCs; but information on the language is extremely sketchy, limited essentially to some brief word-lists (for example, Geiger (1902)).

only by neutralization of /m/ and /n/ in final position, and in homorganic clusters with velar stops. Sinhalese exhibits the following vowels phonetically:

(18)

	Front		Back
High	i,ii		u,uu
Mid	e,ee	ə,əə	o,oo
Low	æ,ææ		a,aa

Doubled vowel letters indicate long vowels ([əə] occurs only in a few English loans: e.g., [səəwis] 'service'). Underlying long vowels are characterized as [+long], though identical-vowel sequences may also occur in surface representations: the two kinds of vowels are physically identical, but only underlying [+long] vowels can be shortened by rule (cf. Feinstein (1976)). Vowels are nasalized both when they precede and when they follow nasal consonants; nasalization is strongest among [-high] vowels, and in vowels following nasals. Sinhalese also exhibits a "nasal-spreading" phenomenon, whereby nasality is spread rightward from a nasal consonant until blocked by a [-nas, +cons] segment: e.g., [ædũna͠awẽ] 'pull, passive past permissive'; [mẽh̃e͠e] 'here'; [ma͠ase] 'month,sg.def.'; [ña͠ya͠a] 'cobra,sg.def.'; [ta͠ana͠ayə̃mə̃] 'rest house,sg.def.'; [m̃ah͠attea] 'gentleman,sg.def.'

The stress pattern of Sinhalese is somewhat fluid. Perera and Jones (1919:13) remark:

> If a word of more than one syllable requires to be stressed in the sentence, the speaker may put the stress on any syllable he likes. There are no strict rules regarding the position of the stress in words of two or more syllables.

The same form may be elicited from an informant, in isolation and on separate occasions, with a different stress pattern each time. This is especially true of polysyllabic words of the form CVCVCV. As Perera and Jones (1919:14) observe, "If there is no long syllable in a word of three or more syllables, the tendency is to stress either the first syllable of the word, or the second syllable, or to distribute the stress equally over the first two syllables."[16]

By "long syllable" Perera and Jones mean one which contains a long vowel, a diphthong or is closed. When such a syllable occurs, "there is a tendency to put the stress on that long syllable." If two long syllables occur, the tendency is to stress the first. In bisyllabic words with two short syllables, "the tendency is to stress the first syllable."

In (19), we present a feature characterization of the surface phonetic segments of Sinhalese ; all but [N ŋ] in (19a) and [ə] in (19b] may be lexically distinctive; observe that prenasalized consonants, which we take to be surface <u>$NC</u> sequences, are not characterized here. We are also ignoring a few marginal surface segments, such as the nasalized unrounded bilabial glide [ṽ], which is derived from intervocalic /m/ in rapid speech.

[16] This observation does not, however, apply to verbs. A form such as [adinəwa] 'pulls' or [kapənəwa]'cuts' can be stressed on the second syllable only.

(19) Systematic Phonetic Segments of Sinhalese

a. [-syll] segments

	p	t	T	č	k	b	d	D	ǰ	g	s	m	n	N	ñ	ŋ	l	r	w	y	ĥ
Cons	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	-	-
Son	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
High	-	-	-	+	+	-	-	-	+	+	-	-	-	-	+	+	-	-	+	+	-
Back	-	-	-	-	+	-	-	-	-	+	-	-	-	-	-	+	-	-	+	-	-
Ant	+	+	-	-	-	+	+	-	-	-	+	+	+	-	-	-	+	+	-	-	-
Cor	-	+	+	+	-	-	+	+	+	-	+	-	+	+	+	-	+	+	-	-	-
Voi	-	-	-	-	-	+	+	+	+	+	-	+	+	+	+	+	+	+	+	+	+
Cont	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	+	+	+	+	+
Nas	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+	-	-	-	-	-
D.R.	-	-	-	+	-	-	-	-	+	-	+	-	-	-	-	-	-	-	+	+	+
Dist	+	+	-	+	+	+	+	-	+	+	+	+	+	-	+	+	+	+	+	+	+

b. [+syll] segments

	i	ii	e	ee	æ	ææ	u	uu	o	oo	a	aa	ə	əə
High	+	+	-	-	-	-	+	+	-	-	-	-	-	-
Low	-	-	-	-	+	+	-	-	-	-	+	+	-	-
Back	-	-	-	-	-	-	+	+	+	+	+	+	+	+
Round	-	-	-	-	-	-	+	+	+	+	-	-	-	-
Long	-	+	-	+	-	+	-	+	-	+	-	+	-	+

[All vowels may also occur [+nasal] phonetically.]

3.1.2. Some Phonological Rules

The data in (20) exemplify a [ə]-[a] alternation which is pervasive in Sinhalese:

(20)	a. i.	matak	'remembered'(prenominal)
	ii.	matəkə	'remembered'(postnominal)
	iii.	amətak	'unremembered'(prenominal)
	iv.	amətəkə	'unremembered'(postnominal)
	b. i.	kapə kapə	'cut' (reduplicative)
	ii.	kapənəwa	'cut' (non-past indicative)
	iii.	kapannə	'cut' (infinitive)

Observe that [a] in these cases occurs only in the first syllable of a word, before two consonants, or a single consonant and ##. [ə] occurs before a CV sequence, and immediately before ##.[17] To account for these facts, we postulate rule (21):

(21) REDUCTION

$$\begin{bmatrix} +\text{low} \\ +\text{back} \\ -\text{long} \end{bmatrix} \rightarrow [-\text{low}] \;/\; V\, C_0 \;\_\_\_ \begin{Bmatrix} CV \\ \#\# \end{Bmatrix}$$

Rule (21), since it involves an "open syllable" condition, is a likely candidate for revision in terms of $; we will discuss this question in later sections. Stress is not a factor in this rule, though vowel reduction rules in other languages commonly depend on stress: compare [kapə́nəwa], (20bii), with [kapánnə], (20biii).

We have assumed here that /a/ and not /ə/ is basic. If /ə/ were basic, Sinhalese would lack an underlying low back short vowel; but this vowel is clearly the unmarked vowel (whereas /ə/ is quite marked), and appears to function as such phonologically in virtually all languages. Underlying /ə/ would make Sinhalese a rare language indeed. In addition, we have observed that Sinhalese contains distinctive long and short vowels. /aa/ occurs underlyingly, but /əə/ does not (except for a very few marginal loan words). If

[17] [ə] may occur in word-initial syllables under three conditions: (i) in rare loan-words like [səəwis] 'service';(ii) in Sanskrit loans with initial stop-liquid clusters: e.g., [prəsiddə] 'famous'; and (iii) in the verb [kərənəwa] 'to make, do' and related forms. In the case of (iii) there is evidence that the stem contains a midvowel underlyingly, and that /kora-/ is converted to /kəra-/ by a minor rule. The loans may be accounted for by minor morphological rules.

/ə/ were underlying, the lack of a normal corresponding long vowel would be anomalous, as would the lack of a short vowel corresponding to underlying /aa/.

We will now propose a number of additional rules which follow from an examination of the morphophonemic behavior of nouns. The general morphological structure of Sinhalese nouns is given in (22):

(22) $\#\#\ \text{ROOT} + \text{DETERMINER}\ \#\ \text{CASE}\ \#\#]_N$

Roots are marked lexically as either [+Animate] or [-Animate]; this is a fundamental distinction in Sinhalese morphology. Singulars are marked by the presence of a Determiner, either [+Definite] or [-Definite]:

(23) Surface Determiners

	[+Definite]	[-Definite]
[+Animate]	aa, a	ek
[-Animate]	ə	ak, ək

We will comment shortly on the underlying representation of the Animate Definite Determiner; the Inanimate Definite Determiner is underlyingly /a/ by the assumptions which give us rule (21).

Plurals are marked by the presence of a plural formative which is <u>not</u> marked for definiteness; no such distinction occurs in the plural of Sinhalese nouns. A variety of plural formatives occur for both Animates and Inanimates; for the moment, it suffices to observe that the most common Inanimate plural formative is simply zero.

Colloquial Sinhalese has five cases: Nominative, Accusative, Dative, Genitive and Instrumental. Unless otherwise noted, all cited forms are in the Nominative case, which is not overtly marked; the underlying Nominative formative is /∅/, and in general we will not indicate it in underlying representations. We will discuss the form of other case suffixes in later sections.

In (22) we assume that the ROOT and DETERMINER are concatenated by the simple morpheme boundary, +; together, these constitute the <u>stem</u>. We also assume in (22) that the case formatives are suffixed to the stem with the internal word-boundary, #, rather than +. There are a number of strong arguments in favor of this assumption. Consider the rule (which we will motivate shortly) which neutralizes nasal consonants to [ŋ] in word-final position. This rule will apply to the form /gam/ 'village, pl.', converting it to [gaŋ]; it will not apply to /gam+a/ 'village, sg. def.', since the nasal precedes +. The underlying form of the plural instrumental of the root /gam-/ is /gam-wal+in/: we leave the boundary between the root and the case suffix tentatively unspecified, as - . (/wal/ is the case pluralizer, which always accompanies case suffixes like /in/ 'instrumental' in the plural). If the boundary between the stem and the case elements were +, we would not expect the final nasal of the root to neutralize; thus we expect *[gamwəliŋ] to be the surface form. But it is not: [gaŋwəliŋ] is the correct form.

The simplest explanation of these facts entails the assumption that case suffix elements are bounded by #.

Now consider the rule (which we will motivate shortly) which shortens vowels in final position when either a long vowel, a closed consonant, or two or more syllables precede in the word. Thus the intermediate representation /iskoolee/[18] 'school, sg.def.' surfaces as [iskoole]. But /baasaa+a/ 'language, sg.def. surfaces as [baasaawə] (after glide insertion; see further), not * [baasawə]. Shortening does not apply before the simple + boundary which we have assumed to inhere between the root and the determiner. Consider now the dative form of [iskoole]; its intermediate representation is /iskoolee-Ta/, where - is the controversial boundary between stem and case suffix, and /Ta/ is the dative case suffix. If the boundary were +, we would predict that shortening would not apply, and [iskooleeTə] would be derived. If the boundary is #, shortening should apply, and we expect [iskooleTə]. In fact, this latter form is correct, hence our assumption that case endings are bounded by # is correct as well. More evidence for this assumption is found in the case of inflected verb forms which take nominal case endings: for example, /ya+na+waa/ 'go, nonpast indic.' may take the dative suffix /Ta/; the resultant form has the meaning of 'for going.' If /Ta/ were bounded by +, we would

[18]This form has the basic underlying structure /iskoola+a/; /a+a/ is converted to /aya/, then /əyə/, then /eə/, then /ee/ by a series of independently motivated rules which are not relevant to the present discussion.

expect surface *[yanəwaaTə]. But the correct surface form is [yanəwaTə]. Again the simplest explanation is that the case suffix is bounded by the internal word-boundary, #.[19]

These morphological preliminaries having been established, we are now in a position to examine some data which constitute evidence for several more P-rules of Sinhalese. The Sg.Def. forms in (24) are all in the Nominative, and have the general structure /ROOT + a # ∅ /, where /a/ is the Definite Determiner, and /∅/ is the Nominative case marker. (We will not indicate this formative in underlying representations). The Pl. forms in (24) are also Nominative, and have the general form /ROOT + ∅ # ∅ /, where the stem-internal ∅ is the Plural marker (the normal plural for a very large class of Inanimate Nouns); we will ignore this /∅/ in underlying representations as well.

---

[19]The case boundary cannot be the absolute word-final boundary ##. The vowel in /#Ta/ is reduced to [ə], but REDUCTION is normally blocked in word-initial syllables, in the environment /##C_o___.../. REDUCTION must be reformulated such that its environment is roughly /V (#) C_o ___$\left\{\begin{matrix}CV\\ \#\#\end{matrix}\right\}$, where (#) must be interpreted to mean that an internal word-boundary, but not ##, may be present, and ## must be interpreted to mean that either # or ## must be present. Such an interpretation follows from a theory which takes boundaries to be complex symbols specified for a class of boundary features. Assume the features [Word Boundary] and [Internal Boundary]: both # and ## are specified [+WB]; # is specified further as [+IB], whereas ## is [-IB]. In this framework, the environment of REDUCTION is / V$\left(\begin{bmatrix}+WB\\ +IB\end{bmatrix}\right)$ C_o ___$\left\{\begin{matrix}CV\\ [+WB]\end{matrix}\right\}$ and the rule applies correctly in all cases. For the present, pending a reformulation of REDUCTION in terms of \$, we assume the latter formulation.

(24) Inanimate Nouns

	Root	Sg.Def.	Pl.	Gloss
a.	mal-	malə	mal	flower
b.	pot-	potə	pot	book
c.	maenik-	mænikə	mænik	gem
d.	gas-	gasə	gas	tree
e.	olu-	oluwə	olu	head
f.	kaasi-	kaasiyə	kaasi	coin
g.	putu-	putuwə	putu	chair
h.	maalu-	maaluwə	maalu	fish curry
i.	toppi-	toppiyə	toppi	hat
j.	gam-	gamə	gaŋ	village
k.	kan-	kanə	kaŋ	ear
l.	gaman-	gamənə	gamaŋ	journey
m.	paalam-	paaləmə	paalaŋ	bridge
n.	bim-	bimə	biŋ	ground

The alternations in (24e-i) provide evidence for the rule of GLIDE INSERTION, (25):

(25) GLIDE INSERTION

$$\emptyset \rightarrow \begin{bmatrix} -\text{syll} \\ -\text{cons} \\ \alpha\text{rd} \end{bmatrix} \;/\; \begin{bmatrix} +\text{syll} \\ \alpha\text{rd} \end{bmatrix} \;\_\_\_\; [+\text{syll}]$$

We assume that the basic root form in such cases is vowel-final and not glide-final, since the quality of the glide is always predictable from the roundness of the preceding vowel.[20] Final glides following vowels of iden-

[20]GLIDE INSERTION must also insert a /w/ following the long low back vowel /aa/, as in [baasaawə], from /baasaa+a/ 'the language, sg.def.' Either (25) must be complicated to account for this fact, or /aa/ must be specified underlyingly as [+round]. We know of no independent evidence for this assumption, which would entail a minor late rule readjusting the roundness of [aa]. For present purposes, we accept the latter analysis, and leave (25) as it stands.

tical roundness occur in the language (e.g., [lamay] 'children') so a general rule deleting final glides is suspect.

The forms in (24j-n) provide evidence for a rule which neutralizes nasal consonants in final position to [ŋ]. Only /n/ and /m/ occur lexically in final position:

(26) NASAL NEUTRALIZATION

$$[+\text{nas}] \rightarrow [+\text{back}] \;/\; \_\_\_ \;\#\#$$ [21]

Now consider the form (24h), [maaluwə] 'fish curry, Inan. Sg. Def.' We assume that its underlying representation is /maalu+a/. GLIDE INSERTION and REDUCTION both apply. But compare this form to the Animate singular definite noun [maaluwa] 'fish'. The two constitute a "minimal pair" and traditional taxonomic-phonemic strictures would require us to postulate two phonemes, /ə/ and /a/, contrary to the assumptions underlying rule (21). The data in (27), however, reveal that the nature of the Animate Definite Determiner is more complex:

(27) <u>Animate Definite Singular Nouns</u>

a.	maaluwa	'the fish'
b.	putaa	'the son'
c.	miniha	'the man'
d.	gonaa	'the bull'

---

[21] The full specification of the segment yielded by (26) is determined by the linking of appropriate markedness interpretive conventions to the P-rule. The final term ## refers to the class of [+WB] boundaries, # and ##.

e. æ taa	'the elephant'
f. siiya	'the grandfather'
g. noona	'the woman'
h. gemba	'the frog'
i. lamea[22]	'the child'
j. balla	'the dog'
k. eluwa	'the goat'
l. sataa	'the animal'

The determiner in each of these cases is a low back vowel; it is [aa] only in bisyllabic words where the first syllable is open (i.e., a consonant cluster does not precede [aa]) and contains a short vowel. In polysyllabic words, and in bisyllabic words where the first syllable is closed or contains a long vowel, the determiner is [a].

Rather than assume an underlying contrast between /a/ and /ə/, which occurs in this and only a very few other grammatical formatives, plus a rule lengthening /a/ under certain conditions, we assume that the Animate Determiner is /aa/ (as opposed to the Inanimate Determiner /a/). There must then be a rule of SHORTENING in the grammar.

In the Standard Theory, this rule would have to be formulated as in (28):

(28)

$$[+\text{syll}] \rightarrow [-\text{long}] \ / \ \left\{ \begin{matrix} [+\text{long}] \\ [-\text{syll}] \\ VC_0\ V \end{matrix} \right\} \ C \ \_\_ \ \#\#$$

[22]The form [lamea] appears superficially to be a counter-example to GLIDE INSERTION; we expect *[lameya]. The root, however, is /lamay/ (the form takes a Ø plural, hence [lamay] is its surface plural form); In the Sg. Def., /ay/ becomes /əy/, and then /e/ by an independently motivated rule.

(where ##, again, refers to the class of [+WB] boundaries). The formulation of (28) is extremely complex, and suggests that the three conflated environments have nothing in common. But the complexity of (28) obscures an important kind of generalization, one which can be captured neither in the Standard Theory, nor a theory utilizing $. This generalization follows from the notion of the <u>mora</u>, an abstract unit of phonological length which has rarely been discussed (and virtually never formalized) in generative phonology, though its significance has been made clear by such phonologists as Trubetskoy (1969:173ff.). Trubetskoy (1969:174) observes:

> Classical Latin may be cited as a generally known example, where the accent delimiting words could not fall on the word-final syllable. It always occurred on the penultimate "mora" before the last syllable, that is, either on the penultimate syllable, if the latter was long, or on the antepenultimate if the penultimate was short. A long vowel was thus comparable to two short vowels, or to a "short vowel + consonant."
>
> Similar rules also exist for Middle Indic ... the final syllable of a word is always unstressed, and the accent falls on the "long" syllable closest to the end of the word. Not only syllables with long nuclei but also syllables with the combination "(short) vowel + consonant" are regarded as long. In Colloquial Arabic the accent only occurs on the final syllable if the syllable ends in a long vowel + consonant or a short vowel + two consonants. It follows that the long vowel is prosodically equivalent to the combination or a short vowel plus a consonant.

Sinhalese is clearly an example of such a "mora-counting language." But without a formal means of "counting moras", a transparently mora-based generalization like

(28) would have to retain its inelegant and unrevealing form . We propose that such generalizations be captured by incorporating in universal grammar a costless Mora Counting Device which assigns a "mora quantity", or weight, to certain syllable configurations: $\underline{\$C_oV\$}$ is assigned a mora quantity of 1, $\underline{M}^1$; $\underline{\$C_oVC_1\$}$ is assigned a mora quantity of 2, $\underline{M}^2$; syllables containing long vowels are assigned $\underline{M}^2$; etcetera. The Mora Counting Device -- which is called into play, at any stage of derivations, when a rule refers to $\underline{M}^n$ in its structural description -- can also additively determine the mora weight of a string of syllables.

Now consider the mora weights of Sinhalese forms in which SHORTENING applies. In /noon+aa/, the underlying form of (27g), syllabified by the USC as /\$noo\$n+aa\$/, the mora quantity of the string preceding the final long vowel is $\underline{M}^2$. In a form like /\$gem\$b+aa\$/, (27h), the mora quantity of the string preceding the long vowel is also $\underline{M}^2$. In /\$e\$lu\$+aa\$/, the syllabified string underlying (27k), the mora weight is additively determined to be $\underline{M}^2$, the weight of two $\underline{\$C_oV\$}$ syllables; in /\$maa\$lu\$+aa/, which underlies (27a), the additive mora weight of the string preceding the final long vowel is $\underline{M}^3$. But in /\$pu\$t+aa\$/, which underlies (27b), the mora value of the string preceding the final long vowel is $\underline{M}^1$. The same value is assigned to the relevant substrings of (27d,e,l). In all those cases where the final long vowel shortens, it is preceded in the word by a substring whose mora quantity is $\underline{M}^2$ or greater. When the mora value of the substring preceding a final long vowel is $\underline{M}^1$, the vowel is not shortened. This is clearly the correct single generalization which underlies the complex environments of (28), which we will reformulate as (29):

(29) SHORTENING

$$[+\text{syll}] \rightarrow [-\text{long}] \;/\; X^{M^{n \geq 2}} \_\_\_ \;\#\#$$

The left-hand term in the structural description of (29) is to be read "when the mora quantity of the string preceding is greater than or equal to $\underline{M}^2$." The fact that $\underline{M}^n$ is mentioned by the rule triggers the Mora Counting Device, which analyzes the relevant string and determines the numerical exponent of $\underline{M}$ for that string.

Additional evidence for the rule of SHORTENING can be found throughout the language, in a wide variety of morphophonemic alternations. By ordering REDUCTION before SHORTENING (extrinsically)[23] we can account for pairs like [maaluwə]/[maaluwa] as follows:

---

[23]Observe that the rule ordering REDUCTION-SHORTENING is a counter-feeding order. If SHORTENING were ordered before REDUCTION, it would feed the latter rule. In various theories of intrinsic ordering (e.g., Koutsoudas, Sanders and Noll (1973)) counter-feeding orders are assumed to be marked; universal ordering conventions predict a feeding order. Note that in this case the feeding order, SHORTENING-REDUCTION, would yield [maaluwə] in both cases, leveling the Animate/Inanimate distinction. Thus the marked counter-feeding order, which must be stated extrinsically, serves to maintain paradigm distinctness.

(30)

	a. / maalu + a /	b. / maalu + aa /
USC	maa\$lu\$ a	maa\$lu\$ aa
GLIDE INSERT	maa\$lu\$wa[24]	maa\$lu\$waa
REDUCTION	maa\$lu\$wə	--
SHORTENING	--	maa\$lu\$wa
	[maa\$lu\$wə]	[maa\$lu\$wa]

When forms are cited in the text we will in general omit reference to their syllabification, unless (as in the case of PNCs) it is of some particular relevance.

3.1.3. Alternations Between Single and Geminate Consonants

By postulating the rules of GLIDE INSERTION, REDUCTION, SHORTENING and NASAL NEUTRALIZATION, we can thus far account for a wide range of data involving Animate and Inanimate Nouns in Sinhalese. Now consider the forms in (31), comparing them with those in (24):

(31) Inanimate Nouns

	Sg.Def.	Pl.	Gloss
a.	pottə	potu	core
b.	ginnə	gini	fire
c.	wattə	watu	estate
d.	wæssə	wæsi	rain
e.	kæaellə	kæaeli	piece
f.	reddə	redi	cloth

[24]GLIDE INSERTION is formulated in (25) without mention of \$, i.e., it does not specify whether the glide should be inserted in the environment VG\$V or V\$GV. GLIDE INSERTION, since it does not mention [SB], will link to the USC, which guarantees the syllabification V\$GV.

We noted earlier that the Inanimate plural marker is commonly Ø, and that the bare root surfaces (after the application of appropriate rules) as the plural. Other inanimates, which must be lexically marked, take the suffix /wal/ in the plural: [kadə] 'carrying pole, sg.def.', [kadəwal] 'carrying pole,pl.' (with an epenthetic [ə] irrelevant to the present discussion). The cases in (31) are clearly not of the "/wal/ class". But if they are of the "/Ø/ class" they are, at least superficially, quite problematical. The forms in (24) differ from those in (31) in two crucial respects: (i) the forms in (31) contain geminate consonants in the singular, but single consonants in the plural; (ii) the plural in (31) forms contains a vowel -- [u] or [i] -- which is not present in the singular.

If we were to assume that the forms in (31) are in fact of the /Ø/-plural class, we would assume that the root of a form like (31a) would be /potu-/. The plural -- the root with /Ø/ suffix -- would then surface correctly as [potu]. But the singular, whose underlying representation in the Definite would be / potu + a / , would surface incorrectly as *[potuwə].

There are a variety of possible morphological solutions to this problem. Each entails marking the forms in (31) as Inanimate Nouns of a class distinct from those in (24), as well as a morphologically-constrained gemination or degemination rule. Before resorting to such an unrevealing solution, we must determine whether there is any independent motivation in the grammar for a phonological gemination (or degemination) process.

There is no independent evidence for a degemination rule. But the verbal paradigm provides strong motivation for a general phonological rule yielding geminate consonants from underlying sequences of true consonant and glide. Before returning to see what relevance this may have for our analysis of the noun forms in (31), let us consider some verbal morphophonemic evidence in more detail.

The general morphological structure of Sinhalese verbs is roughly that in (32):

(32) $\#\#$ ROOT + TENSE + MOOD $\#\#]_V$

A full verbal paradigm involving all tenses and moods (in a rich variety of honorific forms) is quite large; see De Silva (1960:107-108) for an illustrative case. We will limit the present discussion to cases with nonpassive roots in the Indicative mood.[25] Thus we will examine forms like [kapənəwa] 'cut, nonpast indic.', and [kæpuwa] 'cut, past indic.' The underlying representations of these forms are, respectively, / kapa + na + waa / and / kapa + u + waa /. /na/ is the nonpast formative,

[25]See Gair (1970) for a detailed account of the passive/nonpassive distinction. Except where noted, the analysis of Sinhalese morphology and phonology presented here is the responsibility of the present writer.

/u/ the past formative, and /waa/ the indicative.

To account for the nonpast form, we need only the already-motivated rules of REDUCTION and SHORTENING:

(33)	/ kapa + na + waa /
USC	ka\$pa+\$na+ \$waa
REDUCTION	ka\$pə \$nə \$waa
SHORTENING	ka\$pə \$nə \$wa
	[ka\$pə\$nə\$wa]

To account for the past form, we must postulate two additional rules. The first will front root vowels in the past, as well as in a variety of other morphological circumstances; we assume that the root (hence all of its segments) is marked by the feature [+ROOT]. The rule is stated only in terms of the [+PAST] environment:

(34) VOWEL FRONTING

$$[+\text{syll}] \rightarrow [-\text{back}] \;/\; \begin{bmatrix} \underline{\quad\quad} \\ +\text{ROOT} \end{bmatrix} \quad X\,]_{\substack{V \\ [+\text{PAST}]}}$$

The second rule deletes the final vowel of a root when it precedes a non-root vowel(for the present), but not a true consonant. This rule cannot apply to the vowel of a monosyllabic root; the past tense form of the root /ka-/ 'eat', whose underlying representation is / ka + u + waa / is not *[kuwaa], but [kæuwa].

(35) ROOT VOWEL DELETION

$$[+\text{syll}] \rightarrow \emptyset \ / \ V \ C_o \left[\frac{\quad}{+\text{ROOT}}\right] \ V \ X \ ]_V$$

The past form [kæpuwa], then, is derived as follows:

(36) / kapa + u + waa /

USC	ka\$pa\$+u +\$waa
VOWEL FRONTING	kæ\$pæ\$+u+\$waa[26]
ROOT VOWEL DEL	kæ\$pø \$+u+\$waa
USC links	kæ\$p ø+u+\$waa
REDUCTION	--
SHORTENING	kæ\$p u \$wa
	[kae\$pu\$wa]

We will now turn our attention to the Causative form of verbs, which we will examine for present purposes in the nonpast only. Illustrative examples are given in (37):

(37)

Nonpast Indicative Verbs

	Root	NonCausative	Causative	Gloss
a.	kapa-	kapənəwa	kappənəwa	cut
b.	adi-	adinəwa	addənəwa	draw
c.	ani-	aninəwa	annənəwa	strike
d.	ka-	kanəwa	kawənəwa	eat
e.	e-	enəwa	ewənəwa	come
f.	bo-	bonəwa	bowənəwa	drink
g.	ya-	yanəwa	yawənəwa	go

---

[26] We assume that VOWEL FRONTING applies to all root vowels, including the root-final vowel that is destined to delete by ROOT VOWEL DELETION. There are rural dialects where the latter rule does not apply, and all root vowels are fronted. Hence / kapa + u + waa / surfaces as [kæpaeuwa].

Observe that bisyllabic roots (which undergo ROOT VOWEL DELETION) surface with geminate consonants in the surface Causative form; note that the final root vowel of bisyllabic roots is not present in the Causative. In monosyllabic roots, however, [wə] occurs between the root and the tense formative.

In order to account for the monosyllabic cases, we assume that there is a Causative formative, /wa/, which may be affixed to the root, preceding the tense marker. Hence the general morphological formula for verbs must be restated as (38):

(38) ## ROOT (+ CAUS) + TENSE + MOOD ##]$_V$

The derivation of a Causative form like (37d) 'make someone eat' would proceed as follows:

(39)

	/ ka + wa + na + waa /
USC	ka +$wa +$na +$waa
⋮	
REDUCTION	ka $wə $nə $waa
SHORTENING	ka $wə $nə $wa
	[ka$wə$nə$wa]

But the derivation of a form like (37b), [addənəwa] 'make s.o. draw (water)', from underlying / adi +wa +na +waa/ is problematical: the root vowel /i/ must delete, the /w/ of the Causative must fail to surface, and a geminate /dd/ must somehow result.

Our present formulation of ROOT VOWEL DELETION, (35) stipulates that a vowel must follow the final root vowel for deletion to occur. In the case at hand, a glide follows. By generalization the environment of ROOT VOWEL DELETION to [-cons], we can induce deletion before vowels and glides without complicating the rule. There is no counterevidence to this reformulation, so we will assume it here. The absence of /i/ in the Causative of (37b), then, is accounted for by the application of this rule.

Once it has applied, the intermediate representation / ad + wa + na + waa/ obtains. We can now account both for the absence of /w/ and the presence of a geminate consonant by postulating the following new rule:

(40) GLIDE ASSIMILATION

$$\begin{array}{cc} [+\text{cons}] & \begin{bmatrix} -\text{syll} \\ -\text{cons} \end{bmatrix} \\ 1 & 2 \\ 1 & 1 \end{array} \Rightarrow$$

Rule (40) converts sequences of true consonants and glides into geminate versions of the first consonant.[27] The full derivation of the Causative form like [addənəwa] then proceeds as follows:

[27] Certain clusters of C and [w] do occur phonetically in Sinhalese: e.g., [potwəliŋ] 'book, p. instr.', and [waalwenəwa] 'become a slave'. In both of these kinds of cases, however, a boundary (namely the internal word boundary #) intervenes between C and G which is not specified in (40) and blocks application of the rule. See 3.1.2 for a discussion of # in cases like [potwəl-iŋ]. [waalwenəwa] and similar cases are clearly compounds of Noun (/waal/ 'slave') and Verb (/we-/ 'become').

(41) / adi + wa + na + waa /

USC	a$di+$wa +$na +$waa
ROOT VOWEL DEL	a$dØ+$wa +$na +$waa
USC links	a$d +Øwa +$na +$waa
GLIDE ASSIMIL	a$d +da +$na +$waa
USC links	a d +$da +$na +$waa
REDUCTION	a d +$də +$nə +$waa
SHORTENING	a d +$də +$nə +$wa
	[ad$də$nə$wa]

Having motivated a general phonological rule which yields geminate consonants, we can now attempt to account for the gemination in forms like (31a-f) by hypothesizing that a consonant-glide sequence, subject to GLIDE ASSIMILATION, either arises at some stage of the derivation or is lexically present.

Two such hypotheses suggest themselves. In the first, we assume that the root of a form like [pottə], (31a), is /potu-/. Such roots would differ from roots like /putu-/ in (24g) in that they would be lexically marked as exceptions to GLIDE INSERTION. When the latter rule fails to apply to a form like / potu + a /, the prevocalic /u/ would be converted into a glide by a rule roughly like (42):

(42) $$\begin{bmatrix} +\text{syll} \\ +\text{high} \end{bmatrix} \rightarrow [-\text{syll}] \;/\; \underline{\quad\quad} \; [+\text{syll}]$$

Rule (42) would precede and feed GLIDE ASSIMILATION; the derivations of [pottə]/[potu] and [putuwə]/[putu] would proceed as follows (we will omit syllabification here for simplicity of exposition):

(43)

	a. / potu + a /	b. / potu /
⋮		
GLIDE INSERT	[BLOCKED]	--
RULE (42)	potw + a	--
GLIDE ASSIMIL	pott a	--
REDUCTION	pott ə	--
	[pottə]	[potu]

	c. / putu + a /	d. / putu /
⋮		
GLIDE INSERT	putu w a	--
RULE (42)	--	--
GLIDE ASSIMIL	--	--
REDUCTION	putu w ə	--
	[putuwə]	[putu]

In the second analysis, we assume that the glide destined to undergo assimilation is already present in the root itself. Hence [pottə] is / potw + a / underlyingly, in contrast with [putuwə], which is / putu + a / underlyingly. No ad hoc lexical marking is necessary, since the two forms differ phonologically in a way that explains the failure of the first to undergo GLIDE INSERTION. To derive the appropriate outputs, we would have to postulate a rule we will call VOCALIZATION, which converts glides to vowels in final position:

(44) VOCALIZATION

$$\begin{bmatrix} -\text{syll} \\ -\text{cons} \end{bmatrix} \rightarrow [+\text{syll}] \; / \; [+\text{cons}] \; \_\_\_ \; \#\#$$

The derivations of relevant forms are given below:

(45)

	a. / potw + a /	b. / potw /
⋮		
GLIDE INSERT	--	--
VOCALIZATION	--	potu
GLIDE ASSIMIL	pott + a	--
REDUCTION	pott + ə	--
	[pottə]	[potu]

	b. / putu + a /	d. / putu /
⋮		
GLIDE INSERT	putu w a	--
VOCALIZATION	--	--
GLIDE ASSIMIL	--	--
REDUCTION	putu w ə	--
	[putuwə]	[putu]

The very fact that the first hypothesis entails that a rather large set of roots be marked as exceptions to GLIDE INSERTION, an otherwise quite general rule, is sufficient to cast doubt on its adequacy. The second hypothesis requires no such exceptionality. But both hypotheses involves rules -- the glide formation rule (42), and VOCALIZATION -- which have yet to find independent justification. In the following subsection, we will show that there is indeed motivation for choosing the rule of VOCALIZATION, hence the second hypothesis for dealing with the forms in (31).

3.1.4. Independent Motivation for VOCALIZATION

There are two vowel epenthesis processes in Sinhalese. One inserts /a/ in certain morphologically defined environments; the second inserts /u/ interconsontally across internal boundaries more generally.

The data in (46) reveal one environment where epenthetic /a/ (which subsequently reduces to [ə]) occurs:

(46)

Inanimate Nouns

	Root	Nom. Def.	Nom. Indef.	Dat. Def.	Dat. Indef.	Gloss
a.	pot-	potə	potak	potəTə	potəkəTə	book
b.	mal-	malə	malak	maləTə	maləkəTə	flower
c.	putu-	putuwə	putuwak	putuwəTə	putuwəkəTə	chair
d.	potw-	pottə	pottak	pottəTə	puttəkəTə	core
e.	gas-	gasə	gasak	gasəTə	gasəkəTə	tree

We have already seen that the Inanimate Definite Determiner is /a/, which surfaces as [ə]. It is apparent from the Indefinite cases in (46) -- compare especially the Nominative Indefinite and Nominative Definite forms -- that the Inanimate Indefinite Determiner is underlyingly /ak/. When a vowel follows /ak/, as in the Dative Indefinite cases, REDUCTION applies, and it surfaces as [ək]; when /ak/ is word-final, and REDUCTION cannot apply (as in the Nominative Indefinite) it surfaces as [ak].

By the assumptions we have made thus far, the underlying representation of a Dative Definite form like (46a), [potəTə], will be / pot + a # Ta /. This will surface as the correct phonetic form with the application of REDUCTION. But by the same assumptions, the underlying representation of the Dative Indefinite of (46a), [potəkəTə], would be / pot + ak # Ta /. With only the rules we have postulated thus far, this will surface as *[potakTə]. The actual surface form contains an additional [ə] between the [k] of the Indefinite and the [T] of the Dative.

One possible approach to explaining the presence of this [ə] would entail that it be part of the Dative formative underlyingly: /#aTa/. Thus the underlying form of [potəkəTə] would be / pot + ak # Ta /. REDUCTION would apply appropriately. But the underlying form of [potəTə] would then be / pot + a # aTa /. One instance of /a/ must be deleted, but neither can except by an ad hoc rule. In addition, we expect GLIDE INSERTION to apply between the two instances of /a/, inserting a /y/.

We will therefore assume that there is a rule epenthesizing /a/ in the grammar, ordered before REDUCTION:

(47) A-EPENTHESIS

$$\emptyset \rightarrow /a/ \;/\; C \_\_ \# C X]_{\begin{bmatrix} N \\ -Anim \\ +Dat \end{bmatrix}}$$

We cannot formulate A-EPENTHESIS more generally, as there are other morphological environments in which Inanimate nouns exhibit epenthetic /u/ instead.

A case of this type involves the postposition /#t/ 'with (accompanying)'.[28] Both Inanimates ((48a-b)) and Animates ((48c-d)) may exhibit epenthesis of /u/ when the cliticized postposition occurs:

(48) Noun # /t/

	Root	Root + Det # t	Surface	Gloss
a.	pot-	pot + a # t	potat	with the book
b.	pot-	pot + ak # t	potəkut	with a book
c.	put-	put + aa # t	putaat	with the son
d.	put-	put + ek # t	putekut	with a son

Epenthetic /u/ occurs as well throughout the Animate Indefinite nominal paradigm:

(49) Animate Singular Nouns

Root	Det.	Nom.	Gen.	Dat.	Instr.
a. put- 'son'	Def.	putaa	putaage	putaaTə	putaageŋ
	Indef.	putek	putekuge	putekuTə	putekugeŋ
b. minih- 'man'	Def.	miniha	minihage	minihaTə	minihageŋ
	Indef.	minihek	minihekuge	minihekuTə	minihekugeŋ

One might argue that the [u] in these cases is part of

[28] /t/ is an independent lexical item which is inserted under the node P in strings of the form [[NP] P $]_{PP}$. When such a structure enters the phonology, it usually has the form NP##P. Epenthesis does not occur across external word boundaries -- /pot##kipeak/ 'several books' does not surface as *[potukiipeak] -- but it does apply (cf. (48)) between /t/ and a preceding consonant final NP. Hence we assume that NP##t undergoes cliticization, by an early readjustment rule, to NP#t. In (49) it will be clear that epenthesis (of /u/) must apply across #.

the case formatives themselves: /#uTa/, /#uge/ and /#ugen/ for the Dat., Gen. and Instr. suffixes respectively. This analysis would require a rule deleting /u/ to account for the Definite forms. But such an analysis suggests that it is accidental that all of the case suffixes as well as a variety of other formatives (such as /t/, and the "focus" formative we will discuss shortly) all have initial /u/. It would also require that the Dative formative have two shapes in the lexicon, /#uTa/ for Animates and /#Ta/ for Inanimates.

Having restricted A-EPENTHESIS to a particular morphological environment in Inanimate nouns, and having seen that [u] occurs epenthetically in both Animates and Inanimates, under conditions not covered by A-EPENTHESIS, we postulate a rule of U-EPENTHESIS:

(50) U-EPENTHESIS

$$\emptyset \rightarrow /u/ \quad / \; C \_\_ \# \; C$$

Were we to state A-EPENTHESIS as a general rule, and restrict U-EPENTHESIS morphologically, the latter rule would have to refer to Animate nouns in the Dat., Gen. and Instr. cases, to Animates and Inanimates with the postposition /t/, as well as to other enclitic forms. We therefore assume that the two epenthesis rules, (47) and (50), are in the grammar of Sinhalese.

One additional circumstance in which U-EPENTHESIS comes into play involves cases with the "focus" clitic.[29] This formative normally surfaces as [y] following vowels and as [uy] following consonants:

(51) Nouns

Root		Normal Form	Focus Form	Gloss
a. pot-	i.	potə	potay	book, sg.def.
	ii.	potak	potəkuy	book, sg. in.
	iii.	pot	potuy	book, pl.
b. put-	i.	putaa	putaay	son,sg.def.
	ii.	putek	putekuy	son,sg.in.
	iii.	puttu	puttuy	son, pl.
c. gam-	i.	gamə	gamay	village,sg. def.
	ii.	gamak	gaməkuy	village, sg. in.
	iii.	gaŋ	gamuy	village,pl.

There is one form, the verbal auxiliary /puluwan/ 'be able,' which is anomalous with respect to this formative. Since the root is C-final, we expect the focus form to be *[puluwənuy]. But instead it is [puluwəni].

Thus the "focus" formative -- let us call it Y mnemonically -- has three surface realizations: [y], [uy] and [i].

We would clearly be mistaken in assuming that the under-

[29] This formative does serve a focusing function, but the label is too narrow, as it also serves a wide variety of other functions (cf. Gair (1970) for discussion): it is introduced transformationally in a number of syntactic environments. We assume that it is cliticized to stems, bounded by #.

lying form of Y is /uy/: [u] occurs with focus forms in precisely the same environment where it would be inserted by U-EPENTHESIS. In addition, a non-epenthesis account would render accidental the "fact" that such suffixes begin underlyingly with /u/. Furthermore the task of accounting for the anomalous form [puluwəni] would entail an ad hoc rule deleting /u/ in just this one form.

Suppose we claim instead that Y is underlyingly /i/. In order to account for a form like [potay], whose underlying representation would then be / pot + a # i /, we would need a rule converting /i/ to /y/ when preceded by a vowel; this rule would precede and bleed GLIDE INSERTION. The rule could be collapsed with the rule of glide formation suggested in (42):

(52) $\begin{bmatrix}+\text{syll}\\+\text{high}\end{bmatrix} \rightarrow [-\text{syll}]\ \%\ \_\_\_\ [+\text{syll}]$

To derive [potuy] from / pot # i /, we would first have to somehow insert /u/ in the environment C ___ # i , and then apply rule (52).

The anomalous [puluwəni] would have the underlying form / puluwan # i /; the root would have to be marked as an exception to whatever process inserts /u/, and would then surface in its correct form.

But the insertion of /u/ in these instances is rather problematical. We must either postulate a new, ad hoc rule inserting /u/ in the environment C ___ # i, or collapse this "rule" with the independently-motivated rule of U-EPENTHESIS. But the latter rule would then have to be formulated as (53):

(53) $$\emptyset \rightarrow /u/ \ / \ C \_\_\_ \# \left\{ \begin{matrix} C \\ \begin{bmatrix} +syll \\ +high \\ -back \end{bmatrix} \end{matrix} \right\}$$

This complex reformulation contains a highly unexpected environment for vowel epenthesis.

The alternative is to claim that the basic form of Y is /y/. Forms like [potay] are derived from / pot + a # y / with no trouble. [potuy] derives from / pot # y / by applying U-EPENTHESIS (which must precede VOCALIZATION, if the latter rule is in the grammar).

[puluwəni] would have the underlying representation / puluwan # y /. Since no epenthetic /u/ occurs, we assume that /puluwan/ is marked lexically as an exception to U-EPENTHESIS; therein lies its anomalous nature. In order to derive the final [i] of [puluwəni] from /... n#y##/, there must be a rule in the grammar converting final glides following consonants into vowels. Rule (44), VOCALIZATION, has just this effect.

In summary, if we accept the first hypothesis for dealing with nouns like [pottə]/[potu] -- with a glide formation rule, and no vocalization rule -- we must not only mark these nouns as exceptions to GLIDE INSERTION, but we must also complicate the otherwise general rule of U-EPENTHESIS. By adopting the second hypothesis, with the rule of VOCALIZATION, we can avoid a great deal of unnecessary lexical exceptionality, and permit a simple and general accoutn of epenthesis. We therefore accept the second hypothesis; the underlying form of the root in cases like [pottə]/[potu] is /potw/, and the grammar contains the VOCALIZATION rule (44).

3.1.5. Evidence for a Cluster Simplification Rule

Consider the following data:

(54) Animate Nouns

	Root	Singular	Plural	Gloss
a.	put-	putaa	puttu	son
b.	gon-	gonaa	gonnu	bull
c.	sat-	sataa	sattu	animal
d.	wed-	wedaa	weddu	doctor
e.	haa-	haawa	haawo	hare
f.	elu-	eluwa	eluwo	goat
g.	li-	liyaa	liyoo	woman
h.	daru-	daruwa	daruwo	child

The forms in (54) represent a class of Animate nouns whose plural is manifested by root-final consonant gemination followed by [u], or by [oo]/[o] when the root is vowel-final.

We have already seen that geminated consonants can arise by the application of the P-rule GLIDE ASSIMILATION. If the underlying representation of the Animate Plural formative for the class represented by (54a-h) were a glide followed by /u/, we could account quite straightforwardly for at least the forms in (54a-d). There is unfortunately little synchronic evidence as to the nature of the glide (historically the plural formative contained an /h/). Since the /Gu/ sequence will have to be converted to /oo/ to account for the vowel-final cases (54e-h), it is perhaps most plausible to assume that the glide is /w/, from which /oo/ retains its backness and roundness. We will therefore take the Animate Plural formative (for this class) to be /wu/, and assume the following morphological rule:

(55) OO-PLURAL FORMATION

$$\begin{array}{ccccl} [+\text{syll}] & + & /\text{wu}/ & X &]_{\text{N} \left[\begin{array}{l}+\text{Anim.}\\+\text{Plur.}\end{array}\right]} \\ 1 & 2 & 3 & 4 & \Rightarrow \\ 1 & 2 & /\text{oo}/ & 4 & \end{array}$$

Forms like [puttu], (54a), and [daruwo], (54h), have the following derivations:

(56)

	a. / put + wu /	b. / daru + wu /
USC	pu$t+ wu	da$ru+$wu
OO-PLURAL FORM	--	da$ru+$oo
GLIDE INSERT	--	da$ru+$woo
GLIDE ASSIMIL	pu$t+ tu	--
USC links	pu t$+tu	--
SHORTENING	--	da$ru+$wo
	[put$tu]	[daruwo]

Animate nouns like those in (54) may occur in nominal compound forms; in such forms the first noun surfaces in its bare root form, and is uninflected. It is followed by a second, fully-inflected noun:

(57) Nominal Compounds

a.	put wæDə	'son's work'
b.	gon wæDə	'bull's work'
c.	haa kæaemə	'hare's food'
d.	daru wæDə	'child's work'
e.	li wæDə	'woman's work'

The space between nouns in (57a-e) indicates that the bare root and the inflected noun are separated by a full word-boundary, ##. Note that in a nominal compound like [siigiri galə] 'Sigiriya Rock' the [a] of the second element, [galə] 'the rock', is not reduced to [ə].

Now consider the forms in (58):

(58) Animate Nouns

	Singular	Plural	Gloss
a.	balla	ballo	dog
b.	kurulla	kurullo	bird
c.	ibba	ibbo	tortoise
d.	wassa	wasso	calf
e.	mæssa	mæsso	fly
f.	boonikka	boonikko	doll

In cases like (58a-f) it would appear superficially that the root is consonant-final, in fact, geminate-final. The underlying representation of a plural form like (51c), by our assumptions thus far, should be / ibb + wu /, which would undergo the following derivation:

(59) / ibb + wu /

⋮

OO-PLURAL FORM	--
GLIDE ASSIMIL	ibb + bu
Later Rules	ibØ + bu
	*[ibbu]

The problem with (59), of course, lies in the fact that nouns of the type in (58) exhibit [o] as the surface form of the plural, in spite of the fact that they appear to be consonant-final. We might take advantage of the fact that the nouns in (58) differ from those in (54a-d) in that the former appear to be CC-final, whereas the latter roots are C^1-final; we would then complicate the rule of OO-PLURAL FORMATION so that its first term is $\left\{ \begin{array}{c} [+\text{syll}] \\ CC \end{array} \right\}$. But it is clear that no real generalization is expressed by such a conflation.

The assumption that these forms have CC-final roots underlyingly, however, is not tenable in the light of evidence from nominal compounds. Consider the following cases:

(60) Nominal Compounds

a. balu wæDə 'dog's work'
b. kurulu kæaemə 'bird food'
c. ibi kæaemə 'tortoise food'
d. wasu kæaemə 'calf food'

If the root of a form like [ibba] were indeed CC-final, we would expect the (bare) root to surface in nominal compounds as *[ip]: /ibb##/ would simplify to /ib#/ by a rule we will discuss shortly, and the final /b/ would devoice to /p/ by a neutralization rule we have not discussed.[30]

If the root of [ibba] were vowel-final -- i.e., /ibi-/, as the nominal compound might suggest -- we would expect the ordinary singular and plural forms to be *[ibiya] and *[ibiyo] respectively.

An alternative analysis is available, however, now that we have motivated the rules of GLIDE ASSIMILATION and VOCALIZATION. Assume that the underlying form of the root of [ibba] is /iby-/, and that OO-PLURAL FORMATION is revised such that its first term is [-cons] rather than [+syll], yielding /oo/ from /wu/ after both vowels and glides in Animate Plurals. The derivations of the singular, plural and nominal compound forms, [ibba], [ibbo] and [ibi], for example, would then proceed as follows:

(61)	a. / iby + aa /	b. / iby + wu /	c. / iby /
USC	i$by+ aa	i$by+ wu	iby
OO-PLURAL FORM	--	i$by+ oo	--
VOCALIZATION	--	--	ibi
USC links	--	--	$i$bi
GLIDE ASSIMIL	i$bb+ aa	i$bb+ oo	--
USC links	ib$b+ aa	ib$b+ oo	--
SHORTENING	ib$b+ a	ib$b+ o	--
	[ib$ba]	[ib$bo]	[i$bi]

The fact that these forms can now be derived in a sim-

[30]This rule, FINAL OBSTRUENT DEVOICING, accounts for such alternations as [digə] 'justice,sg.def.', [dik], 'justice, pl.'

ple, direct and general manner provides additional strong evidence for the rules of GLIDE ASSIMILATION and VOCALIZATION.

Now consider the forms in (62):

(62) Animate Definite Nouns

	Singular	Plural	Gloss
a.	pissa	pisso	madman
b.	boonikka	boonikko	doll

Both of these forms (and others like them) appear to be identical in nature to those (58); hence we expect their roots to be /...CG-/ in structure, and we expect that the bare root form in nominal compounds will be of the form [...C^1V], as in (60). We find, however, that the nominal compound forms of (62a-b) behave differently: [pissu wæDə] 'madman's work', and [boonikki hisə] 'doll's head'. In these cases, the bare root, like the singular and plural forms, contains a geminate consonant.

In order to account for the [o] plural in (62a-b) it is necessary to assume that the forms are glide-final underlyingly: /w/ and /y/-final respectively. In order to account for the fact that geminate consonants surface in the nominal compound, bare root forms, it is also necessary to assume that the underlying roots contain geminate consonants (which are quite common in lexical representations). Taking these two assumptions together, the underlying form of a case like (62a), for example, must be /pissw-/. In nominal compounds, with the bare root, /pissw/ is simply converted to [pissu], correctly, by VOCALIZATION. But consider the derivation, by our assumptions thus far, of the Definite Singular:

(63)	/ pissw + aa /
GLIDE ASSIMIL	pisss + aa
SHORTENING	pisss + a
	*[pisssa]

The medial cluster in [pissa] is of normal geminate length; there is certainly no reason to believe that a triple consonant cluster occurs in systematic phonetic representation. But we have seen that it is necessary to postulate a CCG sequence underlyingly (which by GLIDE ASSIMILATION becomes a CCC sequence) in order to account for a variety of separate phenomena.

In order to account for the appropriate surface form, we postulate the following rule:

(64) CLUSTER SIMPLIFICATION[31]

$$C \rightarrow \emptyset \ / \ C \_\_ \ C$$

---

[31]We will see in later sections that this rule can be expressed more revealingly in terms of syllable structure, utilizing $.

Additional evidence for this rule is found in the behavior of /n/-final verb roots (the only consonant-final root type), to which CC-initial suffixes (e.g., the infinitival marker /-nna/) may be attached:

(65) Infinitives

	Root + Infin.	Surface	Gloss
a.	kapa + nna	kapannə	to cut
b.	madi + nna	madinnə	to rub
c.	gan + nna	gannə	to get
d.	dan + nna	dannə	to know

Note that (65c-d) surface with ordinary geminates, although they contain sequences of three consonants underlyingly.

It is not necessary for all three consonants to be identical for cluster simplification to occur, as the above cases might suggest. The infinitive formative is (in some dialects) in free variation with /nTa/. Thus (65a) may also occur as [kapanTə], (65b) as [madinTə]. Similarly, (65c) may also occur as [ganTə].

The fact that / gan + nTa / surfaces as [ganTə] means that it cannot be the third member of a CCC cluster which is deleted by CLUSTER SIMPLIFICATION; the cases so far show that either the first or the second C must delete. We will shortly see that it must be the middle of three consonants (or <u>CC#</u> sequences) which is eliminated, hence the formulation in (64).

3.1.6. The Representation of PNCs

3.1.6.1. Alternations between $NC and N$C

We have previously observed that there is a surface contrast in Sinhalese between such forms as [kan$də] 'the hill' and [ka$ndə] 'the trunk'. Heterosyllabic NC sequences and PNCs in Sinhalese are also related by a morphophonemic alternation, exemplified by the data in (66):

(66) Inanimate Nouns

	Singular	Plural	Gloss
a.	kan$də	ka$ndu	hill
b.	hom$bə	ho$mbu	chin
c.	haen$də	hæ$ndi	spoon
d.	kon$də	ko$ndu	backbone
e.	lan$də	la$ndu	orchard
f.	æn$də	æ$ndi	fence

Note that these examples are quite similar to those in (31): they are of the non-"/wal/ class" of Inanimates (plurals); where a geminate cluster in the singular alternates with a single consonant in the plural in (31), an N$C sequence in the singular alternates with a PNC in the plural in (66). We showed in 3.1.3. that the alternation evident in (31) could be accounted for by assuming that the root contains the single consonant observed in the surface plural, followed by a glide homorganic to the vowel which occurs finally in the plural. This glide vocalizes in the plural (in word-final position) and assimilates to a preceding consonant otherwise.

In the Sequential Analysis, PNCs are taken to be underlying NC sequences. If we adopt for the cases in (66) the analysis which accounted for those in (31), we will assume that the underlying form of the root in (66a), for example, is /kandw-/. Thus [kan$də] and [ka$ndu] will have the underlying representations / kandw + a / and /kandw / respectively. The form [ka$ndə], whose plural is [ka$ndəwal], has the underlying representation / kand + a/. Thus for these cases, at least, the surface contrast between <u>N$C</u> and <u>$NC</u> is resolved as a phonological contrast between /NCG/ and /NC/.

We must now demonstrate how the mapping of /NCG/ and /NC/ into [N$C] and [$NC], respectively, can be effected.

Consider first the following partial derivations:

(67)

	a. / kandw + a /	b. / kandw /	c. / kand + a/
USC	kan$dw+ a	$kandw$	kan$d+a
VOCALIZATION	--	$kandu$	--
USC links	--	kan$du	--
GLIDE ASSIMIL	kan$dd+ a	--	--
USC links	kand$d+ a	--	--
	/ kand$d + a /	/ kan$du /	/kan$d+a/

At this intermediate stage of derivation, the sequences which must surface as PNCs are still distinct from those which will surface as heterosyllabic <u>N$C</u> sequences: the former are intervocalic, the latter precede a consonant. We therefore propose the following language-specific syllabification rule (LSR) to account for what surface as PNCs in Sinhalese:

(68) $NC SYLLABIFICATION

$$\begin{array}{cccccc} [+seg] & [+nas] & \$ & \begin{bmatrix} +cons \\ +voi \end{bmatrix} & [+syll] & \\ 1 & 2 & 3 & 4 & 5 & \Rightarrow \\ 1 & 3\ 2 & \emptyset & 4 & 5 & \end{array}$$

The tautosyllabicity of PNCs in Sinhalese, which is established by (68), is certain: Perera and Jones (1919:13) remark that "the groups <u>m̆b</u>, <u>n̆d</u>, <u>N̆D</u>, <u>ŋ̆g</u>, <u>ɲj</u>[32] are felt by Sinhalese speakers to belong syllabically to what follows. Thus the word <u>huᵑgak</u> 'much' is divided syllabically thus: <u>hu-ŋgak</u>."

The Homorganicity and Obstruence Conditions guarantee that neither heterorganic nor sonorant <u>$NC</u> sequences will arise by (68), hence the relevant features need not be specified in term 4. <u>N$T</u> sequences, where T is voiceless, are not resyllabified to <u>$NT</u> in Sinhalese; since such sequences are not precluded universally, the specification [+voi] must be included in term 4.

Note that the structural change of (68) involves the feature [SB]; hence the USC will not link to $NC SYLLABIFICATION, and the marked syllable structure <u>$NC</u> remains.

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[32] It was claimed earlier that affricate PNCs do not occur in Sinhalese. Perera and Jones suggest here that they do, but we are not aware of any examples, at least in the Colloquial variety of the language.

$NC SYLLABIFICATION must precede CLUSTER SIMPLIFICATION. Recall the intermediate derivation / kand$d+a /, which must surface as [kan$də]: If CLUSTER SIMPLIFICATION preceded $NC SYLLABIFICATION, the latter rule would first yield / kanØ$d+a /. This would feed $NC SYLLABIFICATION, incorrectly yielding *[ka$ndə] for this form. In the correct derivation, $NC SYLLABIFICATION fails to apply to / kand$d+a /. The CLUSTER SIMPLIFICATION applies, giving /kanØ$d+a/. $NC SYLLABIFICATION, an ordinary P-rule, does not reapply.

Note that it cannot be the first member of a CCC sequence which deletes by CLUSTER SIMPLIFICATION; this would incorrectly convert / kand$d+a/ into / kaØd+da /, ultimately yielding *[kad$də]. As we have seen, it cannot be the last member either. Hence the formulation in (64), where the middle of three consonants deletes, is correct for present purposes.

The complete derivations of forms like [kan$də] 'hill, sg.def., [ka$ndu] 'hill,pl.' and [ka$ndə] 'trunk, sg.def.' are given below:

(69)	a. /kandw+a/	b. /kandw/	c. /kand+a/
USC	kan$dw+a	$kandw$	kan$d+a
VOCALIZATION	--	$kandu$	--
USC links	--	kan$du	--
GLIDE ASSIMIL	kan$dd+a	--	--
USC links	kand$d+a	--	--
$NC SYLLABIFIC	--	ka$ndu	ka$nd+a
CLUSTER SIMP	kanØ$d+a	--	--
REDUCTION	kan $d+ə	--	ka$nd+ə
	[kan$də]	[ka$ndu]	[ka$ndə]

3.1.6.2. Additional Evidence from the Verbal Paradigm

The generality of the analysis we have adopted is revealed in the behavior of verbs as well as nouns. Recall the Non-Causative and Causative forms we cited in (37), for example, [kapənəwa] 'cuts' and [kappənəwa] 'makes s.o. cut.' A parallel alternation obtains in such cases between PNCs and heterosyllabic NC sequences, just as it did between the nouns in (31) and (66):

(70) Non-Past Indicative Verbs

	Root	Non-Causative	Causative	Gloss
a.	imbi-	i$mbinəwa	im$bənəwa	kiss
b.	wandi-	wa$ndinəwa	wan$dənəwa	worship
c.	anda-	a$ndənəwa	an$dənəwa	put on

The assumption that the roots in (70) contain NC sequences is of course a function of the Sequential Analysis. Recall that the general underlying form of Causative verbs is ##ROOT + CAUS + TENSE + MOOD##; the CAUS formative is absent in Non-Causatives. Thus the underlying forms of the Non-Causative and Causative of (70c), for example, are / anda + na + waa / and / anda + wa + na + waa / respectively. The derivations of the appropriate surface forms [a$ndənəwa] and [an$dənəwa] are given in (71). Note that except for rules which apply only to verbs in general, no rules are needed to account for the forms above except those we have postulated independently to account for a variety ofphenomena in the nominal paradigm.

(71)	a. /anda + na + waa/	b./anda + wa + na + waa/
USC	anda+na$+ waa	anda+wa$+na $+waa
ROOT VOWEL DEL	--	an$dØ$+wa$+na $+waa
USC links	--	an$d +wa$+na $+waa
GLIDE ASSIMIL	--	an$d +da$+na $+waa
USC links	--	and $ +da$+na $+waa
$NC SYLLABIFIC	anda+na$+ waa	--
CLUSTER SIMP	--	anØ $ +da$+na $+waa
REDUCTION	a$ndə$+nə$+ waa	an $ +də$+nə $+waa
SHORTENING	a$ndə$+nə$+ wa	an $ +də$+nə $+wa
	[a$ndə$nə$wa]	[an$də$nə$wa]

3.1.6.3. Summary

We have seen that the "contrast objection" to a Sequential Analysis of PNCs in Sinhalese can be met. The surface contrast between PNCs and heterosyllabic N$C sequences is accounted for (with independent motivation) by postulating that surface PNCs have underlying simple NC sources, whereas surface N$C sequences have NCC sources. Independently-motivated rules yield the correct systematic phonetic representations, within a theory which incorporates a formal syllabification mechanism. It must be stressed again that the Sequential Analysis in general, and our account of Sinhalese prenasalization in particular, require some coherent formalization of syllable structure. The theory of syllabification which was presented in Chapter I has served quite adequately. But if some other approach to syllabification should prove more generally useful, there is every reason to think that the Sequential Analysis of PNCs will be consistent with it.

3.1.7. The Representation of Non-Alternating N$C sequences

There are some (relatively few) forms in Sinhalese containing N$C sequences (where C is voiced and homorganic to N) which do not alternate morphophonemically with PNCs: for example [hin$da] 'because'. Hence we cannot argue from any independent phonological evidence for an NCC source. Geminate consonants, however, occur freely in Sinhalese; we have already shown the necessity for underlying intramorphemic CCC clusters (e.g., /ssw/). There is no a priori reason why there should not be lexical representations with /NCC/; we maintain that forms like [hin$da] are simply examples of this type. Thus the underlying form of [hin$da] is /hinddaa/ (as opposed, for example, to [ho$ndə] 'good', whose underlying representation is /honda/). The derivations of such forms are given in (72):

(72)	a. / hinddaa /	b. / honda /
USC	hind$daa	hon$da
⋮		
$NC SYLLABIFIC	--	ho$nda
CLUSTER SIMP	hinØ$daa	--
REDUCTION	--	ho$ndə
SHORTENING	hin$ da	--
	[hin$da]	[ho$ndə]

3.1.8. The "Monosegmental Behavior Objection"

Having shown that an analysis utilizing the syllable will provide a descriptively adequate account of PNCs in Sinhalese, we will now show that the use of $ also enables us to capture a number of significant generalizations about Sinhalese in a unified way, answering at the same time the objection to the Sequential Analysis wherein it is argued that PNCs "act like" single segments.

3.1.8.1. Three Arguments Against a Sequential Analysis

Gair (1970:24) claims that there are three situations where PNCs appear to behave monosegmentally:

> ... the prenasalized stops pattern with single consonants in [intervocalic] position. For example, [ə] never occurs before clusters, including those of nasal and stop, but does before prenasalized stops: [kolə^{m}bə] 'Colombo'. The unit interpretation also leads to simpler allophonic statements, since all first elements in clusters are allophonically long, but by the [Sequential Analysis, the nasal segments in $NC clusters] would constitute exceptions. Simpler morphophonemic statements are also achieved. For example, in disyllabic genitive forms in [e] or [ee], [ee] occurs after (C)V(C) -- but [e] after (C)VCC - : [potee] 'of the book', [watte] 'of the estate.' Here, as elsewhere, prenasalized stops pattern with -VC, not -VCC: [ka^{n}dee] 'of the trunk'. Compare [kande] 'of the hill'.

Two of these arguments refer to rules we have already motivated: REDUCTION and SHORTENING. The third deals with a (low-level) process yet to be discussed. We will deal with them in that order.

3.1.8.1.1. REDUCTION and $NC

The rule of REDUCTION, as we have formulated it thus far, is restated below:

(73) = (21) REDUCTION

$$\begin{bmatrix} +\text{back} \\ +\text{low} \\ -\text{long} \end{bmatrix} \rightarrow [-\text{low}] \ / \ V \ C_0 \ \_\_ \begin{Bmatrix} CV \\ \#\# \end{Bmatrix}$$

In the Sequential Analysis, a form like [kolə$mbə] 'Colombo' must have the underlying representation / kolamba /. REDUCTION must be able to apply to both instances of /a/. But the rule as given in (73) can apply only to the /a/ in final position: the output will incorrectly be *[kola$mbə].

Recall that such traditional notions as "open syllable" are taken as derivative in the Standard Theory. It is assumed that any generalization referring to the position immediately preceding $ (in our approach), where no C precedes $ (i.e., an open syllable in the usual sense) can be expressed by referring to the structure $\begin{Bmatrix} CV \\ \#\# \end{Bmatrix}$. But this derivative view of syllable structure fails to account for the facts of reduction before PNCs in Sinhalese. Either the Sequential Analysis of PNCs is wrong, or the rule of REDUCTION must be revised in some way.

We believe there is ample evidence for a Sequential Analysis of Sinhalese PNCs; in fact, the Sequential Analysis, incorporating a direct representation of syllable structure, allows us to revise REDUCTION in just the necessary way:

(74) REDUCTION (revised)

$$\begin{bmatrix} \text{+back} \\ \text{+low} \\ \text{-long} \end{bmatrix} \rightarrow [\text{-low}] \;/\; \text{V}\ \text{C}_0 \;\_\_\; \$$$

Given this revision, the derivation of a form like [kolə$mbə] proceeds as follows:

(75)	/ kolamba /
USC	kolamba
$NC SYLLABIFIC	kolamba
REDUCTION (Rev.)	ko$lə$mbə
	[ko$lə$mbə]

It is not the case here that PNCs behave like single segments: the real generalization is that they behave like syllable onsets.

Note that the rule required by the Standard Theory cannot adequately describe PNCs analyzed sequentially; since there is excellent reason to believe that PNCs are indeed sequences, it follows that the Standard Theory's derivative notion of syllable structure is inadequate, and that the general theory must incorporate the syllable as an independent notion.

3.1.8.1.2. SHORTENING and \$NC

The mora-counting theory of SHORTENING that was outlined in 3.1.2. accounts for the facts of SHORTENING with respect to PNCs in an entirely straightforward fashion. The relevant rule is restated below:

(76) = (29) SHORTENING

$$[+\text{syll}] \rightarrow [-\text{long}] \ / \ X^{M^{n \geq 2}} \underline{\quad\quad} \ \#\#$$

Recall that the left-hand term of the structural description of (76) is to be read: "when the mora quantity of the string preceding is greater than or equal to $\underline{M}^2$". We argued that there must be a Mora Counting Device (whose operation is triggered by the specification of $\underline{M}^n$ in a rule) which determines the mora quantity of a string by assigning fixed weights to various syllable types. In a string of the form / \$kan\$dee\$/, the mora weight of the string preceding the final long vowel is $\underline{M}^2$, since a $\$C_oVC_1\$$ syllable has the weight $\underline{M}^2$. In a form of the shape / \$ka\$ndee\$ /, the mora weight of the string preceding the final long vowel is $\underline{M}^1$, since a $\$C_oV\$$ syllable precedes, and has the weight $\underline{M}^1$. Note that the Mora Counting Device is concerned with syllable offsets and nuclei, but not onsets. Since the underlined string in /<u>\$kan\$d</u>ee\$/ has a weight of $\underline{M}^2$, SHORTENING applies. Since the underlined string in / <u>\$ka\$nd</u>ee\$ / has a weight of $\underline{M}^1$, SHORTENING cannot apply. Again, the real generalization about PNCs is that they are syllable onsets.

3.1.8.1.3. "Allophonic Length" and PNCs

Gair's third argument for the monosegmentality of PNCs involves a rule which we will formulate as (77), following his claim that "all first elements in clusters are allophonically long."

(77) $[+\text{cons}] \rightarrow [+\text{long}] \;/\; \underline{\quad\quad} \; [+\text{cons}]$

This rule would apply to a form like /Tæksiyə/ 'taxi, sg.def.', yielding [Tæk:siyə] and to / kan$də / 'hill, sg. def.', yielding [kan:$də]. As formulated, it will also apply to / ka$ndə / 'trunk,sg.def.', yielding *[ka$n:də]. Since it is clear that Sinhalese PNCs exhibit very brief duration of nasality, (77) suggests that PNCs do not behave like other clusters, at least with respect to length.

But Gair's claim that all cluster-initial consonants are long is not true: Coates and de Silva (1960:169) observe that "the first member of an initial cluster is pronounced very short..."[33] Perera and Jones (1919:12) also remark that "terminal consonants of words are always long." (77) is clearly inadequate.

The obvious generalization is that consonants are "allophonically long" when they are syllable-final: whether as the offset of a medial syllable (in a C$C cluster) or in word-final position. In initial position, a first member

[33] The only exception is initial /s/, "which in some words is pronounced long."

of a cluster is automatically a syllable onset, hence lengthening does not occur; the same is true of medial PNCs, which are analyzed (sequentially) as <u>$NC</u> syllable onsets.

(77) must therefore be replaced by (78), crucially utilizing $:

(78) SYLLABLE-OFFSET LENGTHENING

$$[+\text{cons}] \rightarrow [+\text{long}] \;/\; \_\_\_ \; \$$$

<u>3.1.8.1.4</u>. Summary

In all three cases where it might be argued that PNCs behave like single segments, it was shown that the relevant generalizations are most adequately expressed in terms of syllable structure. When expressed in such terms, the behavior of PNCs is explained naturally: they behave not like single segments, but like syllable onsets -- which is precisely what they are claimed to be in the Sequential Analysis.

<u>3.1.9</u>. CLUSTER SIMPLIFICATION as a Syllable Rule

Recall the process of cluster simplification (see <u>3.1.5</u>.); we assumed the following rule:

(79) = (64) CLUSTER SIMPLIFICATION

$$C \rightarrow \emptyset \;/\; C \; \_\_\_ \; C$$

We originally formulated this rule in terms of segment sequences alone, and showed why it must be the middle of three contiguous consonants which is deleted. But in the theory of syllabification we have adopted here, all those CCC sequences which simplify are syllabified CC\$C at the stage in the derivation where CLUSTER SIMPLIFICATION applies. Rather than regarding this rule as enforcing a phonetic constraint against CCC clusters[34] (which must be permitted lexically), it should be viewed as a process that governs possible syllable offsets in systematic phonetic representation: in Sinhalese no syllable may be closed by more than one consonant. We therefore revise (79) as (80):

(80) CLUSTER SIMPLIFICATION (Revised)

$$C \rightarrow \emptyset \ / \ C \_\_ \ \$$$

3.1.10. NASAL NEUTRALIZATION and PNCs

In 3.1.2. we saw evidence that the grammar of Sinhalese must contain a rule of NASAL NEUTRALIZATION; we restate it below:

(81) = (26) NASAL NEUTRALIZATION

$$[+nas] \rightarrow [+back] \ / \ \_\_\_ \ \#\#$$

---

[34] There is a single attested form (cf. Coates and De Silva (1960:169) where a CCC cluster does in fact occur phonetically. This is the noun [strii] 'woman', a Literary form that is occasionally heard in Colloquial speech. (79) predicts that this form should occur as *[srii]; whereas (80) does not predict simplification, since the initial [str] is a syllable onset.

Now consider the data in (82):

(82)

Inanimate Nouns

	Sg.Def.	Plu.	Gloss
a.	ra$mbə	raŋ	plaintain
b.	li$ndə	liŋ	well
c.	huləə$ngə	hulaŋ	wind
d.	a$NDə	aŋ	noise
e.	a$mbə	aŋ	mango

In these data it appears as though PNCs are indeed "behaving like" ordinary (monosegmental) nasals: like ordinary nasals, PNCs seem to neutralize to [ŋ] in final position. But we will see in Chapter IV that any attempt to deal with PNCs monosegmentally in terms of NASAL NEUTRALIZATION will lead to a complication of that rule.

In the Sequential Analysis, the "neutralizing" behavior of PNCs falls out directly and naturally from the operation of independently-motivated rules, requiring no further complication. Consider a form like (82b); the underlying root is / lind /. It is this form which underlies the plural, [liŋ]. / lind / is initially syllabified by the USC as /$lind$/; $NC SYLLABIFICATION cannot, of course, apply. But CLUSTER SIMPLIFICATION (revised) must apply -- /$lind$/ contains a two-consonant syllable offset. When the latter rule has applied, an ordinary nasal stands in final position, and is neutralized.

The derivations of [li$ndə] and [liŋ] are as follows:

(83)	a. / lind + a /	b. / lind /
USC	lin$d+a	$lind$
$NC SYLLABIFIC	li$nd+a	--
CLUSTER SIMP	--	$linØ$
NASAL NEUTRAL	--	$liŋ $
REDUCTION	li$nd+ə	--
	[li$ndə]	[liŋ]

3.1.11. The "Phonotactic Objection" and Sinhalese PNCs

As we remarked in 2.4.2., it has been argued that PNCs pattern phonotactically like single segments rather than clusters. This is quite evidently not the case in Sinhalese. The phonotactic distribution of PNCs and other clusters is strikingly parallel, whereas the distribution of PNCs and single segments is quite dissimilar.

All underlying single consonants may occur in word-initial position. So may a small number of two-consonant clusters, largely in non-native words. The majority of these involve stop-liquid clusters. But heterosyllabic NC sequences may not occur initially[35] nor may PNCs.

In medial position, most single consonants may occur in clusters with other consonants in systematic phonetic representation. But PNCs cannot occur phonetically in clusters with other (single) consonants. Nor are other

[35]There is a single exception: [m$bə], the contracted form of the second person singular pronoun [nu$mbə]. The resyllabification (after contraction) of [$mbə] to [m$bə], though idiosyncratic, is difficult to explain if PNCs are assumed to be monosegmental.

triple consonant clusters countenanced (phonetically).

In final position, single segments may occur freely, subject to neutralization processes. As we have seen, no clusters of any sort are permitted in final position in systematic phonetic representation. Nor are PNCs, which as NC sequences undergo CLUSTER SIMPLIFICATION when they are syllable offsets. We will see in Chapter IV that all monosegmental approaches require an ad hoc rule, or a complication of an existing rule, to simplify PNCs finally, in addition to the independently-motivated rule of CLUSTER SIMPLIFICATION.

3.1.12. Summary of 3.1.

In this section we presented a phonological analysis of Sinhalese in which PNCs were taken to be simple NC sequences underlyingly. We showed that the Type I surface contrast between $NC (PNCs) and N$C sequences is not problematical for Sinhalese: they are distinguished underlyingly as /NC/ and /NCC/ sequences, respectively. It was shown that a variety of complex processes involving PNCs can be handled in the Sequential Analysis utilizing independently-motivated rules and incorporating a direct representation of the syllable. A number of processes in which PNCs appeared to behave monosegmentally were shown to be a function of syllable structure; the behavior of PNCs followed from their status as $NC syllable onsets. We also demonstrated that the simplification and neutralization of PNCs in final position followed from their status as clusters, as does their phonotactic distribution.

3.2. Fula

Fula (also Fulani, Ful, Peul) is a Niger-Congo language of the West Atlantic branch, spoken widely throughout West Africa. It has been cited by a number of researchers as another case like Sinhalese where the Sequential Analysis of prenasalization is untenable. Anderson (1976:23), for example, cites Fula as a language where "prenasalized stops are unambiguously single segments." Trubetskoy (1969: 169) makes the claim that PNCs "can exist as separate phonemes only if in the given language they are distinguished phonologically from normal (nonnasalized) occlusives on the one hand, and from combinations of "nasal + occlusive" on the other. A case of this type is present, for example, in Ful ..."

We saw in 3.1. that a situation comparable to the one described by Trubetskoy obtains for Sinhalese, yet it was possible, indeed desirable, to analyze Sinhalese PNCs as sequences. In this section, we will show that a description of Fula within the Sequential Analysis is also possible, and also desirable.

3.2.1. A Description of Nasal-Oral Sequences

According to Arnott (1970)[36] Fula exhibits not simply PNCs and simple N$C sequences, but a three-way (phonetic) contrast, as follows:

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[36] Unless otherwise noted, all data and morphological analysis is due to Arnott's rich and explicit Nominal and Verbal Systems of Fula, which primarily treats the Gombe dialect spoken in northeastern Nigeria.

(i) Tautosyllabic voiced stop PNCs, with brief nasal onset

(ii) Heterosyllabic, homorganic nasal-oral sequences where the nasal has the length of an ordinary (single) nasal

(iii) Homorganic nasal-oral sequences in which the nasal is appreciably longer than in cases like type (ii) above

Arnott (1970:385) remarks:

> The nasal compounds mb, nd and ŋg are prenasalized voiced plosives, ɲj is a prenasalized voiced affricate, with brief homorganic nasal onset in each case ... there is a clearly perceptible difference between intervocalic ng (as in baŋga 'marry', gooŋga 'truth', naaŋge 'sun') and ŋ+g as in the independent pronouns haŋ.ga , haŋ.ge, haŋ.gol, etc. (where the point indicates the morphologically significant boundary between two consonants). There is a less marked difference between ŋ.g and ŋŋg (or ŋ+ŋg) as in naŋŋga 'catch', maŋŋgo (maŋ+ŋgo) 'big', liŋŋgu 'fish'. The duration of nasality is relatively greater in ŋ.g (ŋ+g) than in ŋg, and in ŋŋg than in ŋ.g, though of course in normal and quick speech the difference is minimal... There is a comparable distinction between nd, n.d ... and nnd, and between ɲj, ɲ.j ... and ɲɲj.

We thus find such (almost) minimal contrast sets as (84), given in Arnott's orthography:

(84) a. <u>baŋga</u> 'marry' b. <u>haŋ.ga</u> 'PRO' c. <u>naŋŋga</u> 'catch'

<u>3.2.2.</u> Analyzing the Sequence Types

The Sequential Analysis directs us to represent ordinary PNCs, as in (84a), as simple NC sequences underlyingly, and to claim that Fula grammar contains a costly language-specific syllabification rule (LSR) which takes the unmarked syllable configuration /baŋ$ga/, for example, and converts it into the marked structure /ba$ŋga/, which is the appropriate systematic phonetic form of (84a).

Let us ignore for the moment cases like (84b), and examine cases like (84c), of type (iii) above. These are always written by Arnott in the general form "NNC". In his discussion of the consonant system (1970:42), Arnott argues that these should be "treated as geminate clusters" (i.e., of geminate PNCs, which Arnott takes to be monosegmental for reasons we will discuss shortly). Geminate clusters do occur relatively freely in the language. But as Arnott himself notes in the passage cited earlier, some NNC structures quite evidently arise not from putative geminate PNCs, but from sequences of simple nasal and PNC. In fact, the vast majority of forms cited by Arnott are of this type. (85) contains some examples among many:

(85)

	Noun + Classifier	Surface	Gloss
a.	bin + ŋgel	biŋŋgel	child
b.	woron + nde	woronnde	fez
c.	hen + ndu	henndu	wind
d.	shon + ndi	shonndi	flour
e.	nyan + nde	nyannde	day

For the numerous examples of this type, there is no problem of distinctiveness in the representation of "true" clusters as opposed to PNCs. PNCs, as the Sequential Analysis directs, are / ...NC.../ underlyingly. These are readily distinguishable from structures like those in (85), which are represented as /...N+NC.../ underlyingly. There are also a relatively small number of morphologically unanalyzable cases of the NNC type, most of which are verb roots: jaŋŋga 'read', ?annda 'know', demmba 'sink'. These can be represented as /...NNC.../, simply a sequence of geminate nasal plus (voiced) stop.

Although Arnott never deals directly with this issue, it appears that the primary motivation for his assumption that Fula PNCs are monosegmental rests in the claim that Fula permits no triple consonant clusters. By analyzing Fula PNCs sequentially, we are claiming that the language does in fact permit such sequences, specifically CNC clusters (it is quite clear that Fula disallows CCC sequences where all C are oral). It is circular to rule out a Sequential Analysis of Fula PNCs by this kind of "permissible cluster" argument. Only by assuming a priori that PNCs are monosegmental can one say with (false) assurance that all CCC sequences are disallowed. If general theoretical and empirical considerations dictate that PNCs should be represented sequentially, then the class of permissible clusters in Fula must be enlarged. We will return in 3.2.3 to some additional evidence about Fula phonotactic structure.

The Fula rule of $NC SYLLABIFICATION is formulated as in (86):

(86) $NC SYLLABIFICATION

$$\begin{array}{cccc} [+\text{nas}] & \$ & \begin{bmatrix}+\text{cons}\\+\text{voi}\end{bmatrix} & \\ 1 & 2 & 3 & \Rightarrow \\ 2\ 1 & \emptyset & 3 & \end{array}$$

The Homorganicity Condition guarantees that N and C in (86) will be homorganic, hence the relevant features need not be specified; the Obstruence Condition excludes sonorants from term 3. No [+voi] fricatives occur in Fula. Thus only sequences of homorganic nasal and voiced stop will be resyllabified by (86).

Note that (86) applies both initially and medially. It will also resyllabify /...NN$C.../ structures (as determined by the USC) to /...N$NC.../. In fact this is the observed syllabification of NNC sequences.[37]

Thus type (i) nasal-oral sequences are represented underlyingly as /NC/; they surface as [$NC]. Type (iii) are represented underlyingly as /N(+)NC/; they surface as [N$NC]. It now remains for us to account for what is superficially the most problematical kind of nasal-oral sequence -- type (ii) forms like haŋ.ga, which seem to have failed to undergo resyllabification by (86).

[37] This observation was made by Robert Vago in the course of elicitation of data from Mr. Yero Sylla, a graduate student at UCLA who is a native speaker of Fula.

Arnott (1970:48) observes that forms in Gombe Fula containing this kind of nasal-oral sequence are "so few in number, as well as being easily recognizable from their morphology, that for most purposes [a special marking of the distinction in the transcription] is unnecessary." As noted, the vast majority of these few cases are 'independent (emphatic) pronouns' with a classifier suffix: for example, /han+ga/ which surfaces as [han$ga] rather than *[ha$nga].

Our view is that these morphologically-restricted cases constitute simple exceptions to the rule of $NC SYLLABIFICATION. If LSRs are indeed true phonological rules, as we claim, it would be quite surprising to discover (and quite unmotivated to require) that they are totally exceptionless. This is the kind of exception, one might say, that proves the rule.

In addition to the independent pronouns, there is one other suffix in Gombe Fula which seems to be regularly exceptional to $NC SYLLABIFICATION. This is a nominal/adjectival classifier with the allomorphs /-de/, /-di/ and /-du/. When suffixed to an /n/-final noun or adjective, a type (ii) nasal-oral sequence results rather than a PNC: for example, /janan+de/ 'strange', which surfaces as [janan$de]; /noon+de/ 'color', which surfaces as [noon$de]; /ton+du/ 'lip', which surfaces as [ton$du]. We assume that this classifier suffix, like the independent pronoun, is marked with an exception feature, [- $NC SYLLABIFICATION].

The Fouta-Toro dialect, described by Labouret (1952) provides a numerically much larger class of potential counterexamples, but a class which is equally explainable as a simple, morphologically delimited exception. In this dialect, the infinitival suffix (which is generally /-ki/ in Gombe Fula) is /-de/. When a verb stem is /n/-final, an N$C sequence results:

(87) Fouta Toro Infinitives

	Root	Infinitive	Surface	Gloss
a.	huun	de	huun$de	to moo
b.	tintin	de	tintin$de	to warn
c.	han	de	han$de	to bray
d.	fin	de	fin$de	to awaken
e.	nantin	de	nantin$de	to translate

These cases can readily be accounted for by marking the Fouta Toro infinitive /-de/ as a lexical exception to $NC SYLLABIFICATION. This exceptionality, it may be noted in passing, has a functional effect. /-nde/ is a common noun classifier in Fula; in such cases /nd/ always surfaces as a syllable onset (PNC). Thus /hu+nde/ 'thing' surfaces as [hu$nde]. If /n/-final infinitives were to regularly undergo $NC SYLLABIFICATION, they would be indistinguishable from /-nde/-class nouns in syntactic contexts where the infinitive serves as a nominal. Compare [hu$nde], for example, with (87a), [huun$de].

3.2.3. Independent Evidence for \$NC SYLLABIFICATION

One obvious alternative to the above analysis of N\$C type exceptions would be to claim that it is the presence of some boundary between N and C which blocks the application of \$NC SYLLABIFICATION. Chomsky and Halle (1968) have of course argued strongly for the Standard Theory convention that the ordinary morpheme boundary, + , cannot block a rule simply by its presence. In light of this, one might look for evidence that the boundaries in question in Fula are stronger than +. But there are clear cases in Fula where \$NC SYLLABIFICATION must be assumed to apply across morphological boundaries. Since these cases unambiguously involve two distinct segments, a nasal in one morpheme and an oral stop in another -- which surface together as PNCs -- they constitute independent motivation for the rule of \$NC SYLLABIFICATION. Consider the following forms in Gombe, which represent a highly general paradigmatic form:

(88) Modal Verbs

	Root	Modal	Tense	Surface	Gloss
a.	war	d	u	wardu	you come
b.	wel	d	u	weldu	you are pleasant
c.	nan	d	u	na\$ndu	you feel
d.	ʔun	d	u	ʔu\$ndu	you pound

The surface forms (88c), [na\$ndu] and (88d) [ʔu\$ndu] contain PNCs: Arnott is always careful to make special note of those few cases where orthographic NC represents a type (ii) heterosyllabic sequence; here it does not. The PNCs in these and similar cases can only have arisen from an unimpeachable sequence of N and C. Any monosegmental analysis of Fula PNCs would thus entail some additional rule converting certain NC sequences into (monosegmental) PNCs.

These data provide the first direct phonological evidence for the sequential nature of prenasalization in Fula. Having now established the existence of a rule of $NC SYLLABIFICATION with independent evidence, we feel secure in claiming that cases like (84b) and others are to be treated as exceptions to this general and productive rule.

In summary: the "contrast objection" to the Sequential Analysis of PNCs can be met for Fula, as it was for Sinhalese. Both critical Type I languages, then, are amenable to description within the Sequential Analysis (i.e., within what is essentially the Standard Theory, enriched by a direct representation of syllable structure).

3.2.4. Fula Phonotactic Structure

3.2.4.1. Triple Consonant Clusters

We have already observed that Fula does not permit all-oral triple consonant clusters. When such clusters are in a position to arise across boundaries, vowel epenthesis or cluster simplification will occur. But this tendency to avoid fully oral CCC sequences does not inform us a priori as to the status of CCC clusters where the first or second C is a nasal (as when a PNC cluster follows another consonant). As we observed in 2.4.2. nasal-oral clusters are permitted in languages which prohibit all other clusters. In medial position, we maintained, NC is the maximally unmarked cluster. The cost to a grammar of NC sequences is determined in part by the markedness interpretive convention (10), which we restate below:

(89) = (10)

$$[\text{u nas}] \rightarrow [\text{+nas}] \;/\; \left[\overline{}_{\text{+cons}}\right] \;[\text{+cons}]$$

As (89) is formulated, the relatively unmarked status of NC sequences obtains even when NC is preceded by some other consonant. Thus, all other factors being equal, a CNC or NCC sequence is more highly valued than CCC (where all C are oral). Fula, we have seen, prohibits CCC sequences in lexical representations but permits NNC sequences. It also exhibits another triple cluster-type (assuming the Sequential Analysis), CNC. These sequences do not occur lexically, but arise most commonly when a consonant-final stem precedes a PNC-initial classifier suffix like /-ŋgel/ or the derivational suffix /-ndam/, an abstract noun-former. Examples of this type are given in (90) below:

(90) Nouns

	Stem	Suffix	Surface	Gloss
a.	peer-	ndam	peer$ndam	enlightenment
b.	kis-	ndam	kis$ndam	safety
c.	mbum-	ndam	mbum$ndam	blindness
d.	ɲǰuul-	ndam	ɲǰuul$ndam	Islam
e.	gil-	ŋgel	gil$ŋgel	worm
f.	jaaw-	ŋgel	jaaw$ŋgel	fowl
g.	gim-	ŋgel	gim$ŋgel	person

The markedness convention (89) suggests that CNC sequences like those above are, all things equal, likelier than CCC sequences. Thus we find CCC (fully oral) sequences dismantled by epenthesis or deletion, but CNC sequences maintained. As *CCC, *NCC and *CCN sequences are prohibited in Fula, but NNC and CNC are permitted, the strongest generalization that can be made about restrictions on medial clustering in Fula is the following:

(91) When three consonants occur in sequence in Fula, no two contiguous consonants may be oral.

Only NNC occurs in lexical representations; across boundaries CNC sequences may arise, and are tolerated.[38] (91) suggests that NCN sequences are also possible in Fula, but there is no evidence for this kind of cluster in Arnott's data.

[38]Fula provides some evidence that NNC clusters are less marked than CNC. In at least one large verbal paradigm, the participles, there is a tendency for CNC sequences to become NNC,"by partial or total assimilation" (Arnott (1970:376). Thus boodŋgum, a class 5 past active participle of the stem 'be good' may also surface as boonŋgum or booŋŋgum.

3.2.4.2. Distribution of PNCs Within Morphemes and Words

Virtually all monosegmental consonants in Fula occur in morpheme- and word-initial position. So may PNCs, although all other clusters are prohibited initially. Critics of the Sequential Analysis may find this fact troublesome for the theory. As we saw in 2.4.2., however, there is no basis either in fact or by the strictures of markedness theory for ruling out a language like Fula. It is undoubtedly more complex by virtue of allowing only NC sequences initially, but it is not impossible.

In word-final position, Fula permits a wide variety of monosegmental consonants. But PNCs cannot occur word-finally; nor can consonant clusters of any other sort. This fact is enigmatic from a non-sequential perspective on the nature of PNCs.

In morpheme-medial and morpheme-final position, all kinds of monosegmental consonants may occur as the first member of a CC sequence where the second member is a stop:

(92)

	Sequence Type	Examples	Gloss
1.	Heterorganic Nasal + Stop	goŋɗin-[39]	tell the truth
2.	Fricative + Stop	nast-	go
3.	Liquid + Stop	kaart- holb-	spittle ankle
4.	Glide + Stop	seyb- wayt-	be pretty retrace steps
5.	Stop + Stop	dept- tept- takd-	book gather one-handed

[39] /ɗ/ is a glottalized alveolar stop.

In addition we find, of course, ordinary homorganic nasals in clusters before stops. When the stop is voiceless the sequence is heterosyllabic (does not undergo $NC SYLLABIFICATION): /wolwaŋki-/ 'to speak to'. When the stop is voiced, a PNC arises (assuming the Sequential Analysis): /ŋgoŋg-/ 'snooze.'

But PNCs may never occur as the first member of a cluster with a following stop. Thus we find no morphemes of the shape */hambd-/, */kandt-/, etc. This general exlcusion follows, in the Sequential Analysis, from (91), which states the general restriction against contiguous oral consonants in CCC sequences. It is not possible to account for the absence of PNC-stop clusters in a principled manner in a monosegmental analysis of PNCs, since all other monosegmental consonants freely occur in clusters before stops.

3.2.4.3. Summary

The evidence and discussion presented above suggests that there is no phonotactic basis of any interest for rejecting the Sequential Analysis for Fula. On the contrary, there are crucial aspects of Fula phonotactic behavior that can be accounted for in a general manner only in a sequential approach.

3.2.5. Phonological Behavior of Fula PNCs

We have already seen one situation, in 3.2.3., where the morphology requires that PNCs have a sequential source.

In light of this the burden of proof is on the monosegmental advocate, who must present phonological evidence which demands a non-sequential approach. There are relatively few other morphophonemic circumstances in which the nature of PNCs comes into question: one likely possibility is the consonant gradation system, which is discussed in 3.2.5.1.; in 3.2.5.2. we will examine some evidence involving cluster simplification and epenthesis.

3.2.5.1. Consonant Gradation

The Fula consonant garadtion system, which operates in both the nominal and verbal paradigms, is a complex morphologically-determined alternation among three sets of stem-initial sounds: "continuants," including [r w y f s h] , "stops," including [b d j g p č k]; and "nasals"[40], including [mb nd nj ng]. Ordinary nasals, glottal stop, glottalized consonants and [t] and [l] are not involved in gradation.

A given form, noun or verb, will occur in one of these three grades, depending on the morphological class of the form (usually determined by a suffix). Thus a form maximally has three shapes: for example, / dim - rim - ndim / 'free man.' A full illustrative paradigm is given in (93):

---

[40] The terms "continuant", "stop" and "nasal" are traditional and clearly do not correspond to normal phonetic usage in all cases. The task of characterizing these grades phonologically is clearly difficult; we will not attempt it here, since it has no relevance to the present discussion.

(93) a. / beer - weer - mbeer / b./ dim - rim - ndim /

Class 1	beero	dimo
Class 2	weerbe	rimbe
Class 3	beerel	dimel
Class 5	beerum	dimum
Class 6	mbeeron	ndimon
Class 7	mbeera	ndima
Class 8	mbeero	ndimo

These data are taken from Arnott (1970:98); Class 1 forms are plain singulars; Class 2 are plurals; Class 3, diminutives; Class 5, derogatory diminutives; Class 6, diminutive plurals; Class 7, augmentatives; and Class 8, augmentative plurals.

It should be apparent by comparing Class 1 forms with Class 8 forms, for example, that the conditioning of gradataion, for these cases at least, is entirely morphological. The suffix is both cases is clearly /-o/, but Class 1 governs the stop-grade, Class 8 the nasal-grade. Anderson (1976b:96), citing Doneux (1969), remarks that the related Manjaku language

> displays a gradation process which is (at least for one dialect) fully phonological, and probably represents the shape of the process as it appeared originally in an early stage of (at least the northern branch of) Common West Atlantic. In the Cur dialect of this language, the consonants [b d j g] appear only in initial position. In intervocalic position they are replaced by [v r z γ] respectively. When following a nasal, they

> are prenasalized. The nasality here sometimes arises by rule: when a pre-verbal pronoun has the form mV+, the nasality of the initial is extended over the vowel and <u>results in an epenthetic nasal consonant before stop-initial roots</u> [emphasis added]. We illustrate the resulting alternations from verb forms such as those [below]:
>
> | | Imperative | 3rd Sing. | 1st Sing. | Gloss |
> |---|---|---|---|---|
> | a. | bandi | avandi | mambandi | arrive |
> | b. | dɔl-an | arɔ | mandɔ | do |
> | c. | jɔn-an | azɔn | maɲjɔn | last |
> | d. | gac-an | aɣac | maŋgac | vomit |
>
> Here, as in Fula, roots appear in three grades: with stop, continuant or prenasal stop. In this case, however, the conditoning factors are clear and completely phonological in character.

Prenasal gradation in Manjaku can be accounted for by a simple nasal epenthesis rule, an analysis which is entirely consistent with the Sequential Analysis. Prenasal gradation in Fula can be accomplished by a similar epenthesis rule, albeit one with no apparent phonological conditioning. Anderson (1976b:100) speculates that Fula, in an earlier stage, may well have had prefixed (rather than or as well as) suffixed class markers. If those markers which now govern the nasal grade were historically nasal-final (and there is some dialectal evidence for this) the presence of the nasal element of resultant PNCs would be explained, at least diachronically. "Subsequently," Anderson writes, "the preposed copies of the class markers were lost, but their effects on stems were retained; the conditioning at this point changed from phonological to morphological."

There is at least one piece of evidence which strongly suggests that a nasal epenthesis rule is the appropriate device for describing the nasal gradation process in Fula, thus providing direct evidence for a sequential rather than monosegmental treatment of PNCs. Anderson (1976b:105) cites Klingenheben (1963:23) to the effect that:

> It is probable that the nasalization in plural verb forms [where the prefixed plural pronoun is not always nasal-final synchronically -- MHF] is originally due to the phonological effect of the first and second person nasal-final pronouns; but it has spread into all plural forms. This can be seen particularly in the Bagirmi dialect (described by Gaden (1908)), a form of Adamawa [Fula] ... In this dialect, we find not only nasalization of those consonants for which a nasal grade exists, but also intrusive nasal elements after those non-nasal-final pronouns that are plural and followed by a non-nasalizable initial: <u>be-n-ʔuwat</u> 'they will sow', with a root initial ʔ which of course does not have a nasal form.

The "intrusive nasal element" in this case must be a full-fledged nasal segment (not the nasal period of a "glottal stop PNC"), which can only have arisen by the application of a nasal epenthesis rule, like that required to account for nasal grade forms with PNCs in the Sequential Analysis. A monosegmental treatment of PNCs would have to account for normal nasal-grade forms in this dialect by a rule yielding monosegmental PNCs, and for the pre-glottal-stop "intrusive nasal" by another rule. In the Sequential Analysis, the same epenthesis rule inserts the "intrusive nasal" and the "nasal portion" of nasal-grade PNCs.

3.2.5.2. Epenthesis and Cluster Simplification

Another general phenomenon which may shed some light on the nature of PNC representation in Fula involves the often-related processes of vowel epenthesis and consonant cluster simplification.

In both the nominal and verbal paradigms, vowel epenthesis normally occurs when certain root-final consonants (see below) precede consonant-initial suffixes. We will focus here on the verbal paradigm. Fula verb roots are often associated with a "radical extension," a derivational suffix which characteristically has two shapes:[41] [...+C...] and [...+ic...]. The radical extensions are followed by tense and voice formatives. The following are examples of such extension morphemes:

---

[41] Occasionally the epenthetic vowel is [u] or [o], under generally predictable morphological conditions. For simplicity of exposition, we will ignore such cases here.

(94) Extension Suffixes

a. REVERSIVE: [t], [it]
b. INTENSIVE: [t], [it]
c. ASSOCIATIVE: [d], [id]
d. CAUSATIVE: [n], [in]
e. MODAL [r], [ir]
([d])
f. SIMULATIVE [kin], [ikin]

The occurrence of the epenthetic vowel is governed by a complex set of conditions:

(i) if a root ends in "a consonant cluster -- geminate or otherwise -- or a single consonant in the range sh, h, k, t, b, d, g, j, nd, ng, ñ, ẏ, ʔ" (cf. Arnott (1970:56) " a vowel is (almost) always inserted.

(ii) if a root ends in a single consonant in the set f, s, r, l, w, y, m, n, ɓ, ɗ then vowel epenthesis may optionally occur (though it appears to be relatively uncommon).

Consonants which do not appear in either of these groups do not occur in root-final position.

It makes no difference in the characterization of type (i) roots whether we regard PNCs as NC sequences or as a subset of the voiced stops. However we are to express the environment which obligatorily conditions epenthesis, PNCs, clusters and voiced (nonglottalized) stops will all have to be accounted for. There is thus no direct evidence here for the nature of PNCs.

The simplest account of these rather elaborate facts entails a quite general epenthesis rule:

(95) VOWEL EPENTHESIS

$$\emptyset \rightarrow /i/ \ / \ C + \_\_ \ C \ X + Y \ ]_V$$

The optionality of type (ii) roots with respect to epenthesis is accounted for by an optional vowel deletion rule, ordered after (95):

(96) VOWEL DELETION (Opt.)[42]

$$/i/ \rightarrow \emptyset \ / \ V \begin{Bmatrix} [+\text{nas}] \\ \begin{bmatrix} +\text{cont} \\ +\text{ant} \end{bmatrix} \\ [+\text{glot}] \\ \begin{bmatrix} -\text{cons} \\ -\text{syll} \end{bmatrix} \end{Bmatrix} + \_\_ \ C \ X + Y \ ]_V$$

The conflated environments in (96) certainly do not present a general, "natural" picture. But any account of the facts of epenthesis in Fula will involve a similar complication of one or theother rule, given the feature system in the current theory. (95) and (96) are, we believe, the formally simplest rules that can at present handle the facts.

The data presented below in (97) illustrate the effect of these rules:

---

[42]We are assuming that /ñ/ and /ỷ/, which cannot optionally undergo VOWEL DELETION, are clusters underlyingly: /ny/ and /ˀy/ respectively. If they are indeed single segments, rule (96) will require additional complication.

(97) Verb Roots With Extensions

	Root	Basic Gloss	Extension: Form	/ Meaning	Tense/ Voice	Surface	Extended Gloss
a.	fur-	grey, Adj.	ɗ	Verbalizer	a	furɗa furiɗa	be grey
b.	ʔool-	yellow, Adj.	ɗ	Verbalizer	a	ʔoolɗa ʔooliɗa	be yellow
c.	hes-	new, Adj.	ɗ	Verbalizer	a	hesɗa hesiɗa	be new
d.	wudd-	stunted,Adj.	ɗ	Verbalizer	a	wuddiɗa	be stunted
e.	bark-	blessing, N.	ɗ	Verbalizer	a	barkiɗa	be blessed
f.	nast-	go in, V.	d	Associative	ii	nastidii	went in together
g.	koot-	go back, V.	d	Associative	ii	kootidii	went back together
h.	daan-	go to sleep,V.	kin	Simulative	o	daankino	pretend to go to sleep
i.	faat-	be daft,V.	kin	Simulative	o	faatikino	pretend to be daft
j.	hufn-	put on a cap, V.	t	Reversive	o	hufnito	take off a cap
k.	meet-	put on a turban, V.	t	Reversive	o	meetito	take off a turban
l.	saɗ-	be difficult,V.	t	Reversive	a	saɗta saɗita	be easier
m.	femmb-	shave, V.	t	Reflexive	o	femmbito	shave oneself
n.	roond-	put on head,V.	t	Reflexive	o	roondito	put on one's head

There are some roots which, with certain extension suffixes, fail to undergo VOWEL EPENTHESIS. Thus the verb root /nast-/ 'go in,' exhibits the expected epenthetic vowel in a form like (97f), with the Associative extension: / nast + d + ii / surfaces as [nastidii] 'went in together'. But with the Modal extension /d/, VOWEL EPENTHESIS fails to apply: / nast + d + a/ surfaces not as *[nastida] but as [nasda]'bring in'. Not only is the epenthetic vowel missing, but the final consonant of the root has also deleted.

The same phenomenon is found in the behavior of the verb root /born-/ 'put on a gown'. The underlying form of the unextended root (with tense/voice marker) is / born + o/; this surfaces as [borno] 'puts on a gown'. But with the Reversive extension, underlying / born + t + o / surfaces as [borto] 'take off a gown' rather than the expected *[bornito]. Consider also the root /wolw-/ 'speak', whose unextended form is / wolw + a / underlyingly; this surfaces as [wolwa] 'speaks'. But with the Associative extension, underlying / wolw + d + a / surfaces as [wolda] 'speaks with' rather than the expected *[wolwida].

We assume that in all these cases the root is lexically marked as an exception to VOWEL EPENTHESIS in particular morphological contexts. In addition, to account for the loss of the root-final consonant (second member of a root-final cluster), we postulate the following rule:

(98) CLUSTER REDUCTION

$$C \rightarrow \emptyset \ / \ C \ \_\_ + C$$

We will see shortly that this rule applies as well to certain nominal forms, and that there are non-exceptional forms to which it applies as well.

In addition to the exceptional cases cited above -- all of which involve roots with unambiguous final clusters that simplify when epenthesis fails to occur -- we also find roots with final PNCs that exhibit precisely the same behavior.

Thus consider the root /seŋg-/, 'haft (an axe)'. Its unextended form is [se$ŋga], from / seŋg + a /. But with the Reversive extension, underlying / seŋg + t + a / surfaces as [seŋta] 'unhafts (an axe)', rather than the expected *[se$ŋgita]. Similarly, the root /gooŋg-/ 'truth' has its final PNC simplified in the Verbalizer-extended form / gooŋg + ɗ + a /, which surfaces as [goŋ$ɗa] 'be truthful' (with idiosyncratic vowel-shortening) rather than *[goo$ŋgiɗa].

A similar pattern of behavior is found in the noun system. Here an epenthetic vowel (identical to the vowel of a following suffix) is normally inserted between a stem ending in the same consonants and clusters which defined "type (i)" verbs previously, and a consonant-initial suffix (e.g., the singular and plural classifiers). Since the epenthetic vowel is always a copy of the suffix vowel, it must be inserted by an additional epenthesis rule, distinct from (95); we will not deal with its formulation here.

We thus find singular/plural pairs like those in (99); note the anomalous cases (99e-g):

(99)

	Root	Singular	Plural	Gloss
		Nouns		
a.	dept-	deptere	depte	book
b.	ramm-	rammere	ramme	flea
c.	wukk-	wukkuru	bukki[43]	eye
d.	leŋŋg-	leŋŋguru	leŋŋgi	bell
e.	doomb-	doomru	doombi	rat
f.	wamb-	wamnde	wamdi	donkey
g.	damb-	ndamndi[43]	damdi	he-goat

In the singular of (99e) the final /b/ of the stem --what will occur in some forms as the oral portion of a PNC -- is deleted before the singular suffix /-ru/, and no epenthetic copy vowel occurs. The same is true of the final /b/ in the singular and plural of (99f) and (99g), before the singular suffixes /-nde/ and /-ndi/ respectively, and the plural suffix /-di/. Once again, we find that, in the absence of epenthesis, a PNC is "simplified." All of these cases can be accounted for in a unified manner by the Sequential Analysis: if PNCs are underlyingly NC sequences, they simplify exactly as

[43] Consonant gradation affects the initial shape of these forms.

predicted by rule (98). If PNCs were monosegmental, the grammar of Fula would require an additional rule simplifying PNCs in precisely the same environment by which (98) simplifies clusters. Any monosegmental analysis, then, will fail to capture a significant generalization.

One might object that rule (98) really expresses no truly independent generalization, since the motivating cases thus far have all been anomalous forms (exceptions to vowel epenthesis processes). But the cluster-reduction phenomena is found among non-exceptional cases as well, where no epenthesis process is involved. The underlying Noun + Classifier form / hoofn + ŋgol /, for example, surfaces as [koof$ŋgol] 'greeting' , rather than *[koofn-$ŋgol]. Consonant gradation and cluster reduction must apply to yield the correct surface form. (Note that epenthesis does not occur in nouns of this class, and that /fn/ is a noncontroversial cluster.)

We also find forms which contain PNCs, are not subject to epenthesis, and undergo cluster reduction: the underlying form / rimnd + ŋgal / surfaces as [dim$ŋgal] 'pack-load'; consonant gradation and cluster reduction have both applied. Note that both /n/ and /d/ of the root /rimnd-/ are deleted; this fact suggests that (98) must apply iteratively, from right to left. Evidence for this mode of application is found in several NNC-final roots which are exceptions to epenthesis:

(100) Nouns

	Root	Extension	Tense/Voice	Surface	Gloss
a.	naŋŋg- 'catch'	t INTENSIVE	a	naŋta	take root
b.	maŋŋg- 'admire'	t INTENSIVE	a	maŋta	praise
c.	ʔommb- 'close'	t REVERSIVE	a	ʔomta	open

In each case, epenthesis exceptionally fails to apply. Rule (98) applies first to /...NNC+C.../, yielding /...NN+C.../. This latter representation is again subject to cluster reduction, as a root-final cluster still precedes a consonant-initial suffix; hence the rule reapplies, yielding /...N+C.../.

3.2.6. Summary

In this section we examined a variety of phonological phenomena in Fula, where a complex three-way contrast exists between $NC sequences (PNCs), N$C sequences and N$NC sequences. We showed that this contrast is resolvable if phonological theory can refer to syllable structure, and that an analysis of these structures in sequential terms allows for a satisfactory account of the language's general phonotactic structure. The morphophonemic behavior of Fula PNCs was examined, and it was demonstrated that there is some clear positive evidence in favor of the Sequential Analysis of PNCs; but there is no evidence that requires a monosegmental treatment of prenasalization in this language.

CHAPTER IV: A CRITIQUE OF MONOSEGMENTAL ANALYSES OF PRENASALIZATION

4.1. General Remarks

We observed in 2.1. that the class of sounds we have been calling PNCs exhibits both monosegmental and bisegmental properties. PNCs often appear to be monosegmental in their duration, and their homorganicity and tautosyllabicity reinforce the perception of PNCs as discrete units. On the other hand, PNCs appear to contain two distinct ordered components, a nasal period and an oral period which (except for their tautosyllabicity) may strongly resemble heterosyllabic nasal-oral consonant sequences which are noncontroversially analyzed as bisegmental. Linguistic theory is not directly concerned with accounting for what may (or may not) be a paradoxical characterization of PNCs from the perspectives of physical phonetics and speech perception. For linguistic theory the crucial question is whether a monosegmental or sequential approach to PNCs permits us to capture linguistically significant generalizations in particular languages, and to formalize the expression of linguistic universals in a revealing manner. In the preceding three chapters we have provided a wide range of evidence in favor of analyzing PNCs as sequences of nasal and oral consonant which surface as syllable onsets in systematic phonetic representation. It was shown that such a treatment is not only possible, but also desirable in the analysis of two languages -- Sinhalese and

Fula -- for which a monosegmental treatment might at first seem most appropriate. It was suggested at various points that monosegmental analyses of these languages would in certain respects be descriptively inadequate. These claims were made, however, without ever formalizing the notion "monosegmental PNC." In this chapter we will examine a variety of proposals for the monosegmental characterization of PNCs. It will be shown that elementary requirements of descriptive adequacy rule out any such analysis within the Standard Theory. Certain revisions of the Standard Theory, in which the "monosegmental" character of PNCs is treated rather differently, will also be shown to be problematical, both on general theoretical grounds, and as they might apply to a phonological analysis of certain phenomena in Sinhalese. We will proceed by examining proposals within the Standard Theory, first characterizing the better known ones, and pointing out their particular weaknesses. Then we will analyze some problems common to them all. Subsequently we will consider proposals which entail extensions of the Standard Theory.

4.2. Monosegmental Analyses in the Standard Theory

In the Standard Theory of Chomsky and Halle (1968) a segment is a unit which is fully specified, by the binary markings +/- for a set of phonological features. Features may be viewed as points arrayed on the vertical axis of a matrix, segments as units arrayed on the horizontal axis of the matrix. Each segment S is defined as a column of single specifications for each feature F. A single segment S may be specified once and only once for any F; a single F is associated with one and only one S. Two segments S_α and S_β cannot therefore be distinguished such that S_α has the specifications *$[+F_1,-F_1]$, and S_β the specifications *$[-F_1,+F_1]$. Such configurations of course fundamentally violate the principle of binariness of feature specification which is presumed to distinguish segments in the Standard Theory. Nor is there any inherent ordering in the column of features as they characterize a particular segment: S_α cannot be distinguished from S_β such that for S_α, F_1 precedes F_2, whereas for S_β, F_2 precedes F_1.

In order for a PNC to be representable monosegmentally in the Standard Theory, there must simply be some F such that PNCs are characterized by it (in conjunction with all other necessary feature specifications) uniquely. The relevant feature may already be available in the theory. But if no such feature is serviceable, it would be appropriate to propose a new one, since the set of features is not fixed.

In the following subsections, we will see that no currently-available feature, nor any potential new feature, is adequate to the task of distinguishing all possible PNCs, a function demanded by the requirement of observational adequacy.

4.2.1. The [Sonorant] Hypothesis

J. McCawley is reported by Chomsky and Halle (1968: 317;fn.) to propose that PNCs be distinguished from other relevant segment types by means of the feature [sonorant]. Under this hypothesis, ordinary nasal consonants (N), oral consonants (C) and PNCs would have the following feature characterizations:

$$\begin{array}{llll} (101) & \text{N} & \text{C} & \text{PNC} \\ & \begin{bmatrix}\text{+nas}\\ \text{+son}\end{bmatrix} & \begin{array}{c}\begin{bmatrix}\text{-nas}\end{bmatrix}\\ \begin{bmatrix}\text{-nas}\\ \text{-son}\end{bmatrix}\end{array} & \begin{bmatrix}\text{+nas}\\ \text{-son}\end{bmatrix} \end{array}$$

PNCs would thus be regarded as "obstruent nasals", which may be expected to pattern phonologically with true (sonorant) nasals by virtue of their [+nas] specification, or with obstruents by virtue of their [-son] specification.

The hypothesis is unsuccessful on two accounts. First, recall the discussion in 2.4.3. on the unmarked status of voiced stop PNCs. In McCawley's approach, a voiced stop PNC has the feature characterization [+nas,-son,-cont,+voi]. The segmental markedness interpretive convention for [voice] (cf. Chomsky and Halle (1968:406)) holds that its unmarked value for [-son] segments is [-voi], reflecting the implicational universal that voiced obstruents imply voiceless, but not vice versa. Without modification, the convention will value voiceless stop PNCs more highly than voiced stop PNCs, contradicting what we know to be their marked status: there are many languages with only voiced stop PNCs, but languages with only voiceless stop PNCs (and also ordinary voiced stops) are highly unlikely. The only languages which exhibit only voiceless stop PNCs contain only voiceless ordinary stops, a phenomenon which is explicable by viewing PNCs as clusters, but not otherwise. The relevant marking convention could of course be complicated by reformulating it so that the unmarked value of [voice] is [-voi] only in [-son,-nas] segments. No cost accrues to a particular grammar by such a move, but a generalization is missed in universal grammar (however such generalizations are to be evaluated): the Sequential Analysis accounts for the markedness of [voice] in PNCs by the same convention which evaluates the feature for clusters in general.

Second, there exist phonologically distinctive nasal obstruents (though they are quite rare). Stringer and Hotz (1973:526) reports that Waffa, a New Guinea language, contains a voiced nasalized bilabial fricative /ᵯ/, which contrasts with the voiced bilabial nasal stop /m/ in forms like: [ᵯooka] 'back' and [mokoo] 'live coals'. While the fricative nasal could be distinguished from the stop nasal by means of the feature [continuant], it is still necessary to characterize /ᵯ/ as [-son], since it is a fricative. /ᵯ/ would therefore have the feature characterization [+nas, -son, +cont]. But in McCawley's approach a fricative PNC would also have exactly this set of specifications; hence the proposal is incapable of distinguishing the two kinds of segments.

4.2.2. The [Continuant] Hypothesis

Trubetskoy (1969:169) argues that

> While true nasals are sonorants, and subsequently continuants, the "seminasals" [PNCs] may be considered stops. The relation $^{m}b:m$, etc., may be equated with the relation "stop: continuant."

Trubetskoy's equation of sonorance with continuance is rejected in the Standard Theory, in which nasals like /m/ are noncontinuant, since the oral airflow is completely obstructed. Anderson (1975) provides some additional convincing evidence that such nasals are, indeed, stops. Since Trubetskoy's approach (or its generative counterpart) would entail that PNCs be marked [-son], it is subject to the same criticisms we advanced in 4.2.1. But the [continuant] hypothesis is flawed in a much more fundamental way. Note that fricative PNCs would have to be specified as [-cont], since they are "semi-nasals" (PNCs). But they would also have to be specified as [+cont], since they are fricatives as well. The paradoxical double feature specification [-cont,+cont] is of course incoherent in the Standard Theory.

4.2.3. The [Delayed Release] Hypothesis

Chomsky and Halle (1968:317) report a proposal by R. Carter to the effect that

> the difference between prenasalized and ordinary consonants might be regarded as an instance of instantaneous vs. delayed release.

"This suggestion appeals to us," they remark, "but we are unable at present to present serious arguments in its favor." In fact, there are several conclusive arguments against this use of [delayed release]. First, the contradictory-specification paradox which dooms the [continuant] hypothesis also plagues the present hypothesis. We have seen that affricate PNCs occur in such languages as Margi, Chichewa, Fula, Kikuyu and others. These would be specified [-del rel], since they are PNCs, but also as [+del rel], since they are affricates.

In addition (as Herbert (1976) and Anderson (1976) have also noted) the usual definition of [delayed release] does not readily accomodate the oral-nasal release mechanism of PNCs. It refers specifically to the timing of release of oral strictures, and in addition characterizes the delayed release period as fricative-like. Under Carter's proposal, true nasals would be [+del rel] (the velic closure delayed until the end of the segment), whereas PNCs would be [-del rel] (the velum closed at the very onset of the segment); but there is no friction associated with the delayed gesture in the true nasal. The same feature would thus correlate to two distinct phonetic events; this state of affairs would be undesirable (since the phonetic function of features is coherent only if they have a uniform content for all segments) even if the feature served a necessary classificatory function. Note as well that Carter's proposal entails that true nasals and affricates form a natural class. But there is surely no empirical basis for such a claim. On this point alone the proposal must be rejected.

4.2.4. The [Prenasal] Hypothesis

In the absence of a viable feature presently available in the Standard Theory, the monosegmental advocate must propose (and defend) a new phonological feature. Chomsky and Halle, who never directly confront the question of representing PNCs phonologically, do suggest that it may be necessary to recognize (1968:317) "a feature that governs the timing of different movements within the limits of a single segment," at the phonetic level. Ladefoged (1971:35) argues for such a feature as well (and proposes that it can have a classificatory function). He calls the feature 'prenasality' (we will use the term [prenasal] here, and describes it as follows:

> This feature ... must be defined in terms of the duration of an event. It is the duration of the velopharyngeal opening which occurs before another articulation such as an oral stop or fricative, in circumstances which require the whole complex to be considered as one phonological whole.

[Prenasal] must be kept distinct from the ordinary feature [nasal]; the latter is usually understood to characterize a uniformly relaxed (open) state of the velum throughout the duration of a segment. [Prenasal], by contrast, could be defined so as to involve velar lowering only for some specified time period at the onset of a segment. Under this definition, the following kinds of feature specifications obtain:

(102)

$$\begin{array}{ccc} \text{N} & \text{C} & \text{PNC} \\ \begin{bmatrix} +\text{nas} \\ -\text{pre} \end{bmatrix} & \begin{bmatrix} -\text{nas} \\ -\text{pre} \end{bmatrix} & \begin{bmatrix} -\text{nas} \\ +\text{pre} \end{bmatrix} \end{array}$$

PNCs would thus form a natural class with oral consonants but not with ordinary nasals.

Alternatively, we could define [prenasal] so that it characterizes any segment where the velum is lowered at the onset, but not necessarily only at the onset. Under this definition the relevant classes would be specified as follows:

(103)

$$\begin{array}{ccc} \text{N} & \text{C} & \text{PNC} \\ \begin{bmatrix} +\text{nas} \\ +\text{pre} \end{bmatrix} & \begin{bmatrix} -\text{nas} \\ -\text{pre} \end{bmatrix} & \begin{bmatrix} -\text{nas} \\ +\text{pre} \end{bmatrix} \end{array}$$

Interpreted in this way, the feature would allow PNCs to function as a natural class with true nasals, by virtue of being marked [+pre], or with oral consonants, by virtue of being [-nas].

There is reason to believe that PNCs are associated phonologically with both classes of segments in the languages of the world. In Type III languages with PNCs (see <u>2.3.3.</u>), the latter are commonly derived from underlying nasals. In Sinhalese, a Type I language, both true nasals and PNCs are neutralized to [ŋ] in final position (assuming the monosegmentality of PNCs). In Type IV languages (see <u>2.3.4.</u>), PNCs are derived from underlying oral stops.

We would thus opt for the second definition for present purposes, and the feature specifications in (103).

It should be apparent that most of the problems which beset other feature proposals are avoided by the use of [prenasal]. The new feature allows us to distinctively and nonparadoxically characterize a wide range of PNC types (though not all; see below), and no modification in the definition of old features would be required.

4.3. Problems For All Feature Proposals in the Standard Theory

These advantages, however, cannot save the [prenasal] hypothesis. It suffers from at least four grave difficulties which cast serious doubt on any monosegmental treatment of PNCs in the Standard Theory. In the following subsections, we will discuss each of these problems, illustrating most of them with evidence from Sinhalese.

4.3.1. Vowel Nasalization

The following data from Sinhalese reflect a vowel nasalization process quite common in the languages of the world:

(104)	a.	mẽe	'this'
	b.	dee	'the thing'
	c.	mãase	'the month'
	d.	næ̃æ	'no'
	e.	isnãanẽ	'the bath'
	f.	bõnTə	'to drink'
	g.	ãmmã	'the mother'
	h.	kãn$də	'the hill'

(See 3.1.1. for a more detailed discussion of nasalization phenomena in Sinhalese.)

In order to account for these kinds of facts about vowel nasalization in Sinhalese, we can postulate the following (mirror-image) rule:

(105) VOWEL NASALIZATION

$$[+\text{syll}] \rightarrow [+\text{nas}] \quad \% \quad [+\text{nas}] \ \_\_\_$$

Now consider the data in (106), which demonstrate the effect of VOWEL NASALIZATION in forms containing PNCs. Comparable facts are to be found in many languages with both vowel nasalization and prenasalization; Javanese (A. Stevens, personal communication) is another example.

(106)

a.	kã$ndee	'the trunk, gen.'
b.	ã$ngə	'the horn'
c.	ã$mbee	'the eel, gen.'
d.	æ̃$ ngillə	'the finger'
f.	hulə̃$ngə	'the wind'

Observe that nasalized vowels occur before but not after the PNCs in (106).

Any analysis of these facts requires a general rule like (105). In each of the feature proposals we have examined, this general rule will regard true nasals and PNCs as a natural class, having the incorrect effect of nasalizing vowels both before and after PNCs. The most economical way of resolving this problem is, in each case, to postulate an additional rule which denasalizes vowels after PNCs only. The alternative is to complicate the general nasalization rule by exlcuding PNCs as conditioning segments, and to postulate an additional rule nasalizing vowels before but not after PNCs. In neither case can vowel nasalization be expressed as a single generalization.

All monosegmental (feature) approaches fail to deal with the obvious fact that PNCs behave with respect to vowel nasalization as though they are sequences of a nasal and an oral consonant. In the Sequential Analysis, the facts of vowel nasalization before but not after PNCs fall out directly: nasalization occurs before the nasal consonant of a PNC cluster, but not after the intervening oral consonant. This same effect is seen in (104f) and (104h), which contain heterosyllabic N$C sequences.

4.3.2. Gemination

In 3.1.3. we presented evidence (independent of facts about prenasalization) that Sinhalese grammar contains a rule of GLIDE ASSIMILATION, which takes consonant-glide sequences and, by assimilation of the glide, yields geminate consonants. This rule is repeated below:

(107) GLIDE ASSIMILATION

$$\begin{array}{cc} [+\text{cons}] & \begin{bmatrix}-\text{syll}\\-\text{cons}\end{bmatrix} \\ 1 & 2 \Rightarrow \\ 1 & 1 \end{array}$$

We showed that forms like [kan$də] 'the hill' alternate with forms like [ka$ndu] 'hills' and provided evidence that the underlying form of the root in this case is /kandw-/. In any monosegmental analysis (otherwise making the same assumptions), the underlying form of the root would be /ka^{n}dw-/, where /^{n}d/ is a monosegmental PNC characterized by some feature. To derive the plural, [ka^{n}du], VOCALIZATION applies. To derive the singular [ka^{n}də], from underlying / ka^{n}dw + a /, GLIDE ASSIMILATION would have to apply, assimilating /w/ to the preceding monosegmental PNC. The output of this rule would be / ka^{n}d^{n}d + a /. CLUSTER SIMPLIFICATION will not apply to this form, since /^{n}d^{n}d/ is simply a C$C sequence in a monosegmental analysis. There is no obvious reason why /^{n}d^{n}d/ should surface, as it does, as [nd]. Although one might expect there to be some articulatory (performance) constraint against sequences of PNCs, involving so many rapid readjustments of the velum, there are languages where comparably complex events do in fact occur. In Kaingang (cf. Anderson (1975:11), citing Wiesemann (1972)) we find what Anderson calls "medionasalized stops" (assuming their monosegmentality):

> these segments, which occur as conditioned variants of prenasalized stops between oral vowels, begin oral, are briefly nasal, and then end oral. They can be transcribed [$\widehat{bmb}$], [$\widehat{dnd}$], etc.

To account for the Sinhalese phenomenon, the grammar would have to contain an additional rule converting geminate PNCs into sequences of ordinary nasal and stop. In the

Sequential Analysis, it will be recalled, these facts were accounted for by independently-motivated rules.

4.3.3. Nasal Neutralization

In 3.1.10. we saw that word-final PNCs in Sinhalese, like word-final nasals, surface as [ŋ]. To account for the nasal-final cases, we postulated a general rule of NASAL NEUTRALIZATION, restated below:

(108) NASAL NEUTRALIZATION

$$[+\text{nas}] \rightarrow [+\text{back}] \;/\; \underline{\quad}\; \#\#$$

In monosegmental feature treatments of PNCs, both ordinary nasals and PNCs can as a class undergo (108). But the output of (108) when applied to a form like /ra^{m}b/ 'plaintains', will be *[ra^{ŋ}g], rather than [raŋ]. (108) converts ordinary nasals into velar nasals, PNCs into velar PNCs. The most adequate way of accounting for the fact that final PNCs surface as ordinary nasals, in a monosegmental feature analysis, would be to reformulate (108) as (109):

$$(109) \quad [+\text{nas}] \rightarrow \begin{bmatrix} +\text{back} \\ x\ F \end{bmatrix} \;/\; \underline{\quad}\; \#\#$$

where "[x F]" is the non-PNC value of whatever feature is assumed to distinguish PNCs from ordinary nasals. Although (108) does not involve a major complication like the additional rules required to account for nasalization and gemination, it is certainly a less general account of the facts than that provided by the Sequential Analysis.

4.3.4. A Distinctness Problem

Recall that while the nasal and oral periods of PNCs are always homorganic, hence share all specifications for features of place of articulation, they do not always exhibit this congruence for other properties. Thus we normally find that the nasal period is voiced, whereas the oral period may either be voiced or voiceless. The latter is the case for the usual voiceless stop PNC (e.g., /ᵑk/). We noted in 2.2.1., however, that at least one language -- Maxakali, cited by Gudschinsky, Popovich and Popovich (1970) -- exhibits a voiced-stop PNC, [ᵑ̥g], with voiceless nasal onset. However rare the latter sound may be, the theory must be able to distinguish it from fully-voiced [ᵑg] on the one hand, and from [ᵑk] on the other, even if these sounds do not contrast in a single language. If we specify [ᵑ̥g] as [-voi] to characterize its voiceless nasal onset, we cannot distinguish it from [ᵑk]; if we characterize it as [+voi], we cannot distinguish it from [ᵑg]. Similarly, Givon (1974:110) reports that Pakomo, a Bantu language, exhibits fully voiceless stop PNCs:[44] for example, [m̥pʰaa] 'gazelle'. If we specify this segment as [-voi] to characterize its complete voicelessness, it cannot be distinguished from /ᵐp/ with a

[44]Givon represents these in the general form N̥C, and does not explicitly claim that they are PNCs; they occur in initial position, however, where Givon otherwise notes that the nasal is syllabic by means of a diacritic. The cases in question are not marked as syllabic.

voiced nasal onset. The latter cannot of course be specified as [+voi], since it would then not be distinct from /^{m}b/.

4.3.5. Summary

All monosegmental feature analyses in the Standard Theory fail in a number of ways. Perhaps the most significant is their general inability to properly distinguish among all possible types of PNCs. In addition, such treatments of PNCs in a language like Sinhalese (which one might take superficially to be a prime candidate for a monosegmental analysis) entail a considerable loss of generality. Only the innovative feature [prenasal], or a comparable feature, escapes the internal inconsistencies which rule out existing features. But the feature, like the others, is shown to be inadequate on the grounds presented in 4.3.

4.4. Internal-Structure and Autosegmental Approaches

4.4.1. The Internal-Structure Theory

Anderson (1975) presents a number of cogent arguments (some similar to those proposed independently in this work) against feature analyses in the Standard Theory. He nevertheless remains convinced that, at least for some languages (he cites Fula as one), PNCs must be represented monosegmentally. Anderson therefore proposes to modify rather drastically the fundamental assumption in the Standard Theory about the relationship between features and segments, namely that any feature is associated with only one segment, and that every segment is specified once and only once for a given feature. He argues (1975:18) that PNCs should be characterized by utilizing only the pre-existent feature [nasal]:[45]

> If we were to recognize a single parameter [nasal], with the articulatory and acoustic correlates of nasality, it is clearly necessary to allow this parameter to shift in value within the scope of a single segment. We would then describe oral stops as homogeneous with respect to nasality ([-nasal] throughout), the ordinary nasals as homogeneously [+nasal], the prenasal stops as [+nasal] in their initial portion, but [-nasal] in their final portions ... In this case we would be recognizing a violation of the segmental abstraction: a single segment would be characterized, at least in some cases, by a sequence of specifications for the same feature, rather than by a single homogeneous feature.

Within this theory, a string of the form $[\ldots V^{N}CV\ldots]$, containing a PNC, couldbe distinguished from a string of the form [...VNCV...], with a heterosyllabic NC cluster, in the following manner:

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[45]He also argues that his theory allows an adequate characterization of postnasalization, a phenomenon we have not dealt with in this work. Prenasalized and postnasalized consonants, although there are phonetic similarities and rare phonological relationships between them, are quite distinct phenomena. Among other things, postnasalized consonants appear never to be lexically distinctive. We believe that postnasalization can be handled readily in the Sequential Analysis (as tautosyllabic CN sequences), but leave the issue for future research.

(110) a. [. . . V N C V . . .]

	V	N	C	V
syll	+	-		+
cons	-	+		-
nas	-	+	-	-

b. [. . . V N C V . . .]

	V	N	C	V
syll	+	-	-	+
cons	-	+	+	-
nas	-	+	-	-

It should be noted that this approach is in many respects identical to that of Campbell (1974), whose "complex symbol" has the same nonhomogeneous nature.

In other work (Anderson (1974)) it is suggested that the multiply-specified nonhomogeneous features constitute separate "components" of phonological and phonetic representations, which must be aligned by some theoretical mechanism into something more akin to the traditional segment. It is possible to discuss Anderson's conception of prenasalization, however, without touching on the major theoretical questions posed by such an interpretation. (See Feinstein (1976) for a discussion of these matters, in particular the theoretical power engendered by permitting P-rules -- otherwise string operations -- to refer to more than one level of structure simultaneously.)

For certain phenomena, the internal-structure approach is clearly less unsatisfactory than any of the standard monosegmental analyses we have discussed. Consider, for example, the case of vowel nasalization dealt with in <u>4.3.1</u>.

In the internal-structure theory (like the Sequential Analysis), vowel nasalization in Sinhalese and comparable cases can be expressed quite simply and directly, by rule (105). When a vowel precedes an internally-structured PNC, it immediately precedes a [+nas] specification, and so is nasalized. When a vowel follows a PNC, it follows a [-nas] specification, and the rule cannot apply. Thus the internally-structured PNC "looks like" a nasal to a rule which applies in a left-hand environment, but "looks like" an oral consonant to a rule applying in a right-hand environment.

Now consider the Sinhalese nasal neutralization phenomenon, discussed in 4.3.3. and elsewhere. In the internal-structure approach, the specification of [nasal] which precedes ## in the case of a word-final PNC is [-nas]. NASAL NEUTRALIZATION, (108), will not apply as formulated to a form like /ra^{m}b/ (where /^{m}b/ is an internally structured segment), since the final PNC will "look like" an oral consonant to the rule. Data like those in (82), however, make it quite clear that NASAL NEUTRALIZATION does indeed apply (at some stage) to forms containing final PNCs.

In order to allow (108) to apply to PNCs, we might suggest as a first approximation that the rule be revised as in (111):

(111) $[+nas] \rightarrow [+back] \ / \ [\ \_\_\_ \ ([-nas])\ ]\ \#\#$

This rule can now "ignore" the final specification of [-nas]. But (111) will incorrectly yield *[ra^{ŋ}g] from /ra^{m}b/. The only way to correctly derive [raŋ] is to delete the [-nas] specification from the internally-structured PNC. This could be done in two ways, either by incorporating in the grammar an ad hoc rule deleting the feature [-nas] from PNCs in final position and subsequently applying NASAL NEUTRALIZATION; or by revising the latter rule as (112) below:

$$(112) \qquad \underbrace{[+\text{nas}]\ ([-\text{nas}])}_{1} \quad \underset{2}{\#\#} \quad \rightarrow \quad \begin{bmatrix}+\text{nas}\\+\text{back}\end{bmatrix} \quad 2$$

Both of these approaches are seriously flawed. In the first we are forced to postulate an entirely ad hoc rule whose only motivation is to feed NASAL NEUTRALIZATION appropriately. Moreover, this new kind of "feature-deleting rule" fundamentally violates the principle of binariness in generative phonology. By permitting the deletion of a feature, rather than a manipulation of its +/- values, a third value -- ∅ -- is in effect introduced. This violation of binariness is implicit in the second analysis as well; in addition, the second analysis involves a schema which is an ad hoc conflation of two unrelated rules.

The neutralization of ordinary nasals to [ŋ] in word-final position is not an uncommon rule. It is also found, for example, in Caribbean Spanish. /ŋ/ may be the only consonant permitted in final position; the Chinese dialects described by Chen (1975) are of this type. These kinds of facts suggest that /ŋ/ is at least a candidate for unmarked status in final position. If Sinhalese did not permit oral consonants finally, it might be plausible to conflate the neutralization subrule in (112) with a rule which in effect deletes final oral consonants. The overall effect of (112) would be to allow only [ŋ] -- possibly the unmarked final nasal -- in final position. But the language does permit final oral consonants: stops, fricatives, glides and liquids as well as [ŋ]. The metatheory does not formally preclude conflations like (112), but the simple fact that two rules can be conflated does not mean that a true generalization is being expressed. In 3.1.10. it was shown that the behavior of final PNCs falls out directly from an independently-motivated account of cluster behavior in Sinhalese. In the internal-structure approach we are forced to account for the same phenomenon by complicating the otherwise simple, straightforward rule of NASAL NEUTRALIZATION, conflating it with an ad hoc deletion rule which duplicates the work of theindependently-motivated rule of CLUSTER SIMPLIFICATION. A linguistically significant generalization is clearly lost in the process.

Recall now the fact that no feature-based monosegmental account in the Standard Theory can deal adequately with the fact that PNCs can differ crucially in the voicing of their nasal and oral periods (cf. 4.3.4.). The double feature-specification that could resolve this distinctness problem is incoherent in the Standard Theory. But in the internal-structure theory, the very stricture which is so problematic for the other analyses has been abandoned. Thus a single segment like a PNC is assumed to entail multiple specifications for the feature [nasal].

But the latter feature is not the only one to "shift" in a PNC. Anderson (1975:23;fn.11) observes:

> since it is only the nasal opening that allows airflow at a rate sufficient to maintain the spontaneous mode of vocal cord vibration during the production of a nasal consonant, a shift in the domain of nasality entails a shift in the scope of sonorance by definition...

Thus [sonorant] shifts as well.[46] So must [voice], to account for the facts noted in 4.3.4. In addition, [continuant] must be a shiftable feature, since the nasal period of PNCs is always stop-like, hence [-cont], while the oral period of a fricative PNC, for example, must be specified as [+cont]. Suppose in addition that the fricative were both glottalized and aspirated; both the features of glottalization and aspiration would have to shift in value, from [$-F_1$,$-F_2$] in the nasal period to [$+F_1$,$+F_2$]

[46] This cannot be effected by universal convention, however, since nonsonorant nasal segments, e.g., nasalized fricatives, exist (though no nasalized fricative PNCs).

in the oral period.

It is true that an internally-structured segment like the voiced stop PNC in (110a) gives the appearance of a single segment whose only peculiar property is the shift in value of [nasal]. Consider, however, the picture presented by an internal structure representation of a PNC like $/{}^{m}\text{p̓}^{h}/$, a glottalized voiceless aspirated prenasalized stop found in the Shui Wei dialect of Miao, cited by Purnell (1972:104):

(113)

<table>
<tr><th></th><th>/ m</th><th>p̓h /</th><th></th></tr>
<tr><td>syll</td><td colspan="2">-</td><td></td></tr>
<tr><td>cons</td><td colspan="2">+</td><td></td></tr>
<tr><td>son</td><td>+</td><td>-</td><td></td></tr>
<tr><td>nas</td><td>+</td><td>-</td><td></td></tr>
<tr><td>ant</td><td colspan="2">+</td><td></td></tr>
<tr><td>cor</td><td colspan="2">-</td><td></td></tr>
<tr><td>glot</td><td>-</td><td>+</td><td></td></tr>
<tr><td>asp</td><td>-</td><td>+</td><td></td></tr>
<tr><td>voi</td><td>+</td><td>-</td><td></td></tr>
</table>

The "segment" in (113) looks much less like a single segment whose domain of nasality is "contoured" than it looks like a sequence of discrete consonants which happen to be homorganic. The internal-structure theory does still allow such an array of features to be treated as a single segment, by referring to the features of place, [syllabic] or [consonantal]. We cannot reject the internal-structure approach solely on the grounds that its putatively single segments may resemble true sequences in formal representation. But the multiple feature-shifting does have another undesirable consequence. Consider the fact that a feature like [continuant] must be shiftable in order to account for the phonetic nature of fricative PNCs. There is no principled way to restrict this feature so that it shifts only in the case of PNCs. The theory thus predicts that there should be other (non-PNC) segments which are structured internally and involve a shift in the domain of [continuant]. A likely candidate for such a class of segments would be the affricates. But if an affricate like /č/ is represented (in part) by the shifting configuration [-cont][+cont], we might well expect a comparable class of segments with the inverse configuration, [+cont][-cont]. As Anderson (1975:20) himself notes, "there do not appear to be instances of the opposite possibility: a continuant followed by a stop, of the type [s͡t], where there is convincing evidence that this is a single unit rather than a cluster." Since the facts of prenasalization show that [continuant] must be shiftable, the internal-structure theory is forced to countenance a segment type that does not in fact occur.

4.4.2. The Autosegmental Approach

Goldsmith (1976) advances a quite different revision of the Standard Theory (though one which is similar in many respects to the prosodic analysis of the London School, and Z. Harris' long-component analysis; cf. Langendoen (1968) for an argument that the latter two are notational variants), which also provides for a potentially monosegmental representation of PNCs.

In the autosegmental theory, certain features can be extracted from the traditional segment, and constitute independent "autosegments" in their own right. These autosegments form a chain of entities which run parallel to, but separate from, the chain of ordinary segments. [Nasal] is among the features which Goldsmith claims can be "autosegmentalized" in this fashion (although most of the evidence for his approach is based on phenomena involving tone).

A phonological representation in this theory is thus a set of concurrent segmented strings, which are associated in derivations by a set of well-formedness conditions over the "geometry" of two-dimensional structures. Thus a string like [... V ^{N}C V ...], containing a PNC, and a string like [... V N C V ...], containing a heterosyllabic <u>N$C</u> sequence, could be represented as follows:

(114) a. Segmental Level $\quad [\ \ldots \begin{array}{ccccc} V & & C & & V \\ | & / & & \backslash & | \\ O & N & & O & O \end{array} \ldots]$
Autosegmental Level

b. Segmental Level $\quad [\ \ldots \begin{array}{cccc} V & C & C & V \\ | & | & | & | \\ O & N & O & O \end{array} \ldots\ ]$
Autosegmental Level

In (114) N represents the [+nas] autosegment, O the [-nas] autosegment, and C a [+cons] segment with the [nasal] autosegment extracted.

Let us consider again the nasal neutralization process in Sinhalese. A form like /$ra^{m}b$/ 'plaintains' would have the following underlying representation in the autosegmental approach:

(115) Segmental Level / r a B /
Autosegmental Level 0 0 N 0

$$\begin{array}{lcccc} \text{Segmental Level} & /\,r & a & \multicolumn{2}{c}{B\,/} \\ & | & | & / & \backslash \\ \text{Autosegmental Level} & 0 & 0 & N & 0 \end{array}$$

As was the case for the internal-structure approach, the final segment of (115) is not subject, as it stands, to a generally-formulated rule of NASAL NEUTRALIZATION. The latter rule, in the autosegmental analysis, would have to be formulated so that it affects segments associated with a word-final N autosegment. In order to correctly derive [raŋ], the right-most (word-final) 0 autosegment must be deleted. But there is no indeoendent motivation in Sinhalese for converting the autosegmental string 0 0 N 0 ## to 0 0 N##. Again there are two possible re-analyses. First, the final 0 can be deleted by a totally ad hoc rule, and the resultant $\begin{matrix}B\\|\\N\end{matrix}$, an ordinary nasal, can be subjected to NASAL NEUTRALIZATION. Alternatively, we can formulate NASAL NEUTRALIZATION so that it simultaneously deletes final 0 and neutralizes N : i.e., we can conflate two unrelated processes, and again duplicate the effect of the independently-needed rule of CLUSTER SIMPLIFICATION.

The most conclusive objection to an autosegmental treatment of prenasalization, however, is revealed by the requirement of multiple specifications of features other than [nasal]. In Goldsmith's rather brief discussion of prenasalization (1976:62-66) he supposes that [nasal] is the only autosegmentalized feature involved in the representation of PNCs. (Goldsmith discusses some evidence from Guarani, a Type III language where a "prosodic" approach to nasality is at least plausible.) As we have seen, features like [voice] must also be specified more than once in the monosegmental representation of certain PNCs. This multiple specification cannot (by definition) by done at the traditional segmental level in Goldsmith's theory, and so must be handled by the autosegmentalization of a feature like [voice] -- implying that [voice] behaves prosodically in languages where it must be specified multiply. There are many languages with voiceless stop PNCs with voiced nasal onsets, which require multiple specification, but in such cases [voice] never behaves otherwise like anything but a segmental feature in the ordinary sense.

4.4.3. Summary

We have seen that both non-traditional approaches to the monosegmental representation of PNCs fail to account adequately for certain phonological phenomena in Sinhalese. Both approaches do allow an adequate general description of vowel nasalization, since they formally represent PNCs as complex structures (like the Sequential Analysis). But both approaches are problematical with respect to the "shifting value" of features other than [nasal] which also contribute to the complex nature of PNCs -- a complexity that is captured by the Sequential Analysis in a direct manner.

Both Anderson and Goldsmith present evidence from Type III languages only, where PNCs are derived in accordance with surrounding (or prosodic) nasality. Except for the feature-shifting problem, our objections are primarily based on the difficulties which the innovative theories pose for an account of a Type Ilanguage like Sinhalese. It might be proposed that both approaches are necessary: the Sequential Analysis for some languages, and for others an extension of the Standard Theory's notion of the segment. But the Sequential Analysis alone is the more restrictive theory, since PNCs are describable only in terms of ordinary segment sequences and $. A combined approach entails a multiplicity of descriptions for the same general phenomenon. Hence the burden of proof is on the opponent of the Sequential Analysis to show that there are cases which it cannot handle. This has not been done. In fact, the Sequential Analysis alone is adequate to the task of accounting for the whole range of prenasalization phenomena.

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