Complexity in Phonological Representations

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1. The research objectives

The notion of complexity, though seldom characterized explicitly, plays an important role in much work in phonology. At the segmental level, it is often claimed that certain segments occur more or less frequently in the languages of the world, or do or do not tend to participate in certain phonological processes because of their internal complexity. At the prosodic level, constituents may be more or less complex in various ways, and their relative complexity influences what positions they may appear in. Besides accounting for asymmetries in the observed distribution of segmental and prosodic systems, considerations of segmental and prosodic complexity might be expected to play a role in the course of language acquisition, with simple representations preceding more complex ones at various levels of grammar.

The goal of our research program is to develop appropriate and explicit notions of phonological complexity which will serve to correctly characterize a range of facts concerning phonological inventories, processes, and acquisition. We are exploring the following general hypotheses:

i. At each level of the phonology, there is a relevant notion of complexity.
ii. There is a meaningful notion of phonological head that cuts across segmental and supersegmental levels.
iii. Phonological heads show the maximum complexity allowed by a grammar. Thus, heads and dependents may be equally complex; but if there is an asymmetry, it will always be the head that is more complex than the dependent.
iv. The origin of head-dependent asymmetries can be located in the acquisition process. We assume that learners begin with relatively impoverished representations, and move to more richly articulated representations under the pressure of data. Moreover, a strategy of ‘pay attention to heads’ implies that heads will be expanded before dependents.

2. The research projects

The research is divided into three subparts, one involving the internal organization of segments, a second concerning higher levels of phonological organization, and a third dealing with the effects of complexity on the learnability of phonological systems at various levels.
2.1 Segment structure

Much recent work in the last fifteen years has led to several basic conclusions about segment structure which are shared by many researchers. First, it has been argued that segments have internal structure (e.g. Clements 1985, Sagey 1986, McCarthy 1988). The distinctive features that compose a segment are structured into class, or organizing, nodes which define a hierarchical structure, and content nodes which define the actual distinctive features of the segment. Second, not all features that define a segment are present underlyingly: certain features may be underspecified, or absent from underlying representation. The exact conditions under which features may be absent is a topic of controversy (e.g. Archangeli 1984, Steriade 1987, forthcoming, Clements 1988, 1993, and many others). Third, phonological rules are operations that apply to structures.

In this project, we are working to extend the results of research by Avery & Rice (Avery & Rice 1988, 1989, Rice & Avery 1989, 1990, 1991a, 1991b, forthcoming, Rice 1992, 1993) and other phonologists. This theory has a number of properties, identified below.

i. Privativity. All features are privative. Thus, no feature-changing operations can exist.

ii. Segment structure. The features that make up a segment are organized hierarchically, with major nodes indicating place of articulation, sonority, air flow, and laryngeal features.

iii. Underspecification. All versions of feature geometry posit a certain amount of inherent underspecification (Archangeli 1988). This, plus the geometry, allows us to elegantly express natural processes such as place assimilation. Privativity provides automatically for a certain degree of underspecification. Further underspecification is provided for by considerations of markedness.

iv. Markedness. Unmarked features are absent in underlying representation, and as such can play no role in the phonology of a language. Markedness is thus encoded directly in the representation; basically, the more marked a segment, the more structure it has (cf. Kaye, Lowenstamm & Vergnaud 1985).

v. Importance of contrasts. Whether a feature is marked or not with respect to another feature is determined on a universal basis; however, there are instances in which unmarked features may be present in underlying representation. We will take as our starting point the Node Activation Condition proposed by Avery & Rice 1989, which states that if a secondary content node is the sole distinguishing feature between two segments, then the primary feature is activated for the segments distinguished. Active nodes must be present in underlying representation. Presence or absence of a particular feature in the representation of a segment thus cannot be determined without knowing which segments are in contrast with each other in the phonology of the language, a basic insight of Steriade 1987.

vi. Heads. Rice & Avery 1991a propose that head-dependent asymmetries exist in rule application: for example, assimilation of a head requires assimilation of dependents. This is a type of operational complexity: operations affecting heads must affect dependents. Head structure forms the backbone of a segment; dependent structure elaborates on the structure given by the heads. Heads can take a kind of dependent structure (e.g. number of places of articulation available to coronals) that dependent features cannot.

vii. Rules. All modifications in representations are caused by operations on structure. Avery & Rice define three basic operations: spreading, fusion, and delinking.
2.2 Prosodic structure
We assume that phonology above the segmental level applies in the domain of prosodic structures which are projected from the syntax by building up progressively larger levels of structure in conformity with the Prosodic Hierarchy (e.g. Nespor & Vogel 1986, Selkirk 1986, Hayes 1989).

Following initial proposals by Drescher & van der Hulst 1991, we are investigating the role of complexity and heads in the prosodic phonology. As with segment structure, complexity is a relative notion. Head-dependent asymmetries can be seen to exist at all levels of prosodic structure. For instance, in Tiberian Hebrew (Drescher 1989, in press) such asymmetries are found at the level of the phonological phrase: the rightmost phonological phrase, which is the head of its intonational phrase, is sensitive to the foot structure of its constituent words, but nonhead phonological phrases are not. Hence, a dependent phrase 'sees' only the word level, whereas the head phrase looks further, to the foot level. Similar asymmetries are found at the word level. Athapaskan languages provide further examples of such cases. The verb in most Athapaskan languages is obligatorily bisyllabic, while other constituents can consist of one or more syllables. If the verb is treated as the head of its phrase, the reason for this asymmetry becomes apparent: the head phrase requires greater complexity of structure than the dependent, just as in Tiberian Hebrew. Slightly different situations hold of the word level in other languages. For example, a minimal word in Old English must have at least two moras, a requirement that is imposed on major class words, but not on minor class items.

Head-dependent asymmetries can also be found at the foot level. For example, in languages such as English, primary stress makes reference to syllable weight while secondary stress is insensitive to weight. Similar examples can be found at the syllable level. Thus, head-dependent asymmetries are found from the intonational phrase down through the level of the segment, with heads allowing greater complexity than dependents.

2.3 Learnability
We are pursuing the hypothesis that a proper account of language acquisition requires reference to both complexity and heads (see Drescher forthcoming for a review of the role of complexity in theories of acquisition of phonology). Avery & Rice 1988, Rice & Avery 1991b, forthcoming have argued that the elaboration of segmental inventories proceeds from simpler to more complex structures: learners start off with a fairly impoverished system, adding features to the system only under the pressure of data from the language in question. Drescher & van der Hulst 1991 propose that a number of apparently disparate facts at different levels of the phonology appear to be consequences of an acquisition strategy of 'pay attention to heads' (cf. Rizzi's commentary included with Lightfoot 1989 for a similar notion in syntax).

3. An overview of the volume

The papers in this volume focus largely on the first two research areas, segment structure and prosodic structure, although learnability as a theme underlies all of the work. The major topics examined in the papers include (i) the role of contrast in phonology, (ii) the issue of complexity, and (iii) the importance of heads, and their relationship to complexity.

Two of the papers provide a general overview of the issues. Drescher & van der Hulst develop a theory of head-dependent asymmetries. They argue, drawing on evidence from both prosodic and segmental phonology, that the notions 'head' and 'dependent' are well-defined at all levels of structure. These roles are important in that heads may have more structure, or may
be more complex than, dependents. Rice & Avery focus on complexity at the segmental level, arguing that given an appropriate notion of segment structure and complexity, it is possible to account for a wide range of facts involving inventory shapes.

Dyck discusses head-dependent asymmetries in Spanish, as shown by the distribution of vowels. She proposes that head positions at various levels can tolerate vowels which are more structurally complex than nonhead positions can. She argues that metaphony in some Spanish dialects is best viewed as a process that increases the complexity of heads when they are less complex than adjacent dependents. Head-dependent asymmetries thus play a critical role in determining the form of a phonological rule.

Three papers deal with vowel harmony. Rose and Walker both explore the importance of contrast in determining the representation of high front vowels. Both claim that high front vowels are unmarked for place of articulation unless they contrast with underlying high central vowels, in which case the central vowels have no specified place of articulation and the front vowels are marked as coronal. Rose presents evidence for this position drawing on the asymmetrical patterning of front vowels in vowel sandhi, vowel harmony, and epenthesis in a wide range of languages. Walker concentrates on developing a procedure for contrastive specification in terms of a feature hierarchy which determines how place of articulation contrasts are marked. She shows that this procedure, combined with Structure Preservation, makes the right predictions with respect to neutrality in vowel harmony systems. A different account of the problem of neutral vowels in harmony systems is presented by Wilson. He outlines a model of segmental representation in which segments are composed of heads which may enter into dependency relations with one or more nonhead features. The patterning of various vowel harmony processes is shown to follow from the licensing conditions pertaining to heads and dependents. The formalism employed, developing ideas of Kaye, Lowenstamm & Vergnaud 1985, Anderson & Ewen 1987, and van der Hulst 1989, is different from that of the preceding two papers; like them, however, this account also assigns a central role to contrast, since the licensing conditions are determined by the contrasts which obtain in each language.

Rice examines the special relationship between coronal and velar consonants, arguing that they may arise from a single underlying representation. She argues that while this representation is often interpretable as either a coronal or a velar, only the velar realization is possible when certain types of contrasts are present within an inventory. More generally, she suggests that organizing nodes are phonetically interpretable, and proposes a new account of how variability can arise from a single underlying representation.

A basic assumption in many of these papers is that markedness is related to structural complexity: a more complex structure is more marked relative to a less complex one. Hamilton takes a rather different approach to determining markedness. In an examination of the rich consonant inventories of many Australian languages, he argues that markedness asymmetries exist even among segments which have the same structural complexity. He concludes that complexity alone is not sufficient to encode these asymmetries, and proposes that there exists a markedness hierarchy in terms of valency which is independent of segment structure. Hamilton thus challenges the assumption that structural complexity and markedness are intimately related.

Ghini focuses on prosodic structure in his discussion of the phonology-syntax interface in Italian. He proposes a new approach to the formation of phonological phrases in Italian: domains delimited by the right edge of a maximal projection are parsed into phonological phrases according to weighted principles of uniformity, average weight, symmetry, and increasing units. His analysis sheds new light on the role of phrasal complexity in prosodic structure.
References

Clements, G. N. (1993) "Underspecification or Nonspecification?" paper read at ESCOL 10, Ohio State University. Ms., CNRS (Paris) and Cornell University.


