

THEMES IN POST-GENERATIVE PHONOLOGY

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Chomsky & Halle's monumental *The sound pattern of English (SPE)* (1968) was an attempt at a coherent theory of the phonology of English which has been enormously thought-provoking and influential for phonologists and anyone interested in language ever since its publication. In *SPE*, a formal notation was developed to try to allow both an efficient encoding of segments (called 'representations') and processes (rules), and a way of showing the relationships between these. The authors hoped eventually to reach a psychologically real and explanatory description of the phonology of English (and ultimately, they hoped, of universal phonological processes), where the underlying representations could be shown to approximate the forms in which morphemes are stored in the brain, and where the rules could be seen as the processes by which underlying representations are transformed into the surface forms of speech. They aimed to achieve in the long term a theory of phonology which would be adequate 'observationally' (ie. presenting the facts), 'descriptively' (ie. not only describing the facts accurately but also capturing generalisations in psychologically valid terms) and, even more challenging, 'explanatorily' (ie. allowing a reasoned choice among competing descriptively adequate grammars) (Smith 1989: 116).

The book was aimed at an audience interested in theoretical issues rather than immediate practical applications, and with a clearly stated concern in the first instance for consistency and generalisability, rather than for a complete description taking account of all exceptions and irregularities (*SPE*: viii-ix) or for a 'realistic', empirical study of child language development; though desirable for the long-term, this was explicitly postponed until after the more 'idealised' model had been thoroughly investigated (*SPE*: 331). Its powerful portrayal of an attempt to bring a mass of elusive data and concepts into a unified and principled orientation confirmed for many that the aim of 'scientific' linguists everywhere (as of all scientists) should be the establishment of strong, verifiable (or at least potentially falsifiable) theoretical models, and it stands as the foundation or 'standard' statement of what is termed 'Generative Phonology'. Given that *SPE* was developed and written over several years - Smith (1989: 23) notes that it had been announced as forthcoming in 1959, though it was not finally published until 1968 - and the pivotal function it has had in stimulating discussion ever since that time, most writers seem to use 'post-generative' and 'post-*SPE*' as

synonymous (Durand 1990: 1; Clark & Yallop 1990: 341; Anderson 1985: 328); so these terms will be regarded as equivalent for our purposes in this paper, too.

Important though *SPE* may have been in general terms, however, it has also been subject to criticism ever since its publication. Chomsky and Halle themselves indicated, even in the Preface and more specifically in the final chapter, that they considered their theory needed extension, enrichment and sharpening (*SPE*: vii; 400ff), especially with regard to suprasegmental phenomena and to the question of distinguishing 'natural' features and rules, and the connections between them, from those which are 'unnatural' or 'unexpected'. In particular, the role of phonetic content had been reduced in their description of the phonological system to the point where only the most generalisable features were regarded as relevant and hence recorded by the notational system. It was acknowledged that this fact, plus the very powerful and unconstrained nature of the phonological rules in *SPE*, meant that less common or even impossible features and processes could be expressed quite as easily as the more common ones, and that this detracted from the predictive power that any phonological theory ought to have (ie. the ability to predict whether a given process is likely, unlikely or impossible). In other words, the expressive power of the theory was emphasised over its predictive power, though clearly both are crucial. Chomsky and Halle saw such difficulties as being due to the notation, and in the final chapter of *SPE* itself they proposed a theory of 'markedness' - perhaps more accurately a modification to the notation system - to deal with this problem. Other researchers, however, have considered the question of 'naturalness' to be even more far-reaching. This concern with the 'naturalness' of underlying representations and of rules has been one of the basic themes of post-generative phonology.

Other scholars, both from within and outside the generative movement, have tackled a number of further issues arising from *SPE* where it has been felt that modification either of detail or of overall approach is required. The question of whether or not phonological phenomena are universal, and how they are acquired and stored, is one such issue. The relative importance of rules and representations - the interrelationship and balance between these - has been another subject of continuing debate. Moreover, and very importantly, a number of problems arise from the fact that, despite the claims of Chomsky and Halle that they were rejecting the segment-based descriptions of the structuralists, the standard generative approach is itself segment-based: both phonological and phonetic representations are expressed as sequences of segments, in principle independent of each other and uniform in size, with no internal structuring or

ordering of their constituent features, and without any systematic reference to phonological units larger than the segment (eg. syllables) (Anderson 1985: 347).

Thus, the themes which have evolved during the post-generative period and which will be examined in this paper are the following, all clearly interconnected: the naturalness/markedness question, mentioned above; the universality or otherwise of phonological phenomena; the shifting inter-relationship between representations and rules; the re-examination of the linear approach to analysis of the generativists to take better account of both subsegmental features and suprasegmental phenomena; and, accompanying all of these, the search for a system of notation or at least mode of description appropriate to express all the above. Advances in these areas over the post-generative period have not only gone a long way towards solving the problematical aspects of *SPE*, but have deepened our understanding of phonological issues.

Some researchers have been intensely critical in their reaction against the generative approach, or aspects thereof (eg. Foley 1977; Sampson 1980; Lass 1984: 233). Foley, for instance, refuses to take generative phonology seriously as a theory, or as phonology, at all: he refers to it rather scathingly as 'transformational phonetics'; asserts that it has nothing to say about the actual nature of language, only about the writing or notational system to be used in making descriptive statements concerning the observable data of language, which is not itself a theory; and claims that this is because it is subject to a number of fundamental philosophical errors, including descriptivism, reductionism and simplicatism. The majority of writers, however, are rather less dismissive of the generative model than Foley; they typically acknowledge their indebtedness to generative notions for valuable insights and helpful initial frameworks, though they often move far beyond *SPE*'s original formulations to new ways of conceptualising phonological facts or theory, and to applications of these to data from many different languages. Some of the 'schools' or approaches which have arisen in the post-generative period, and whose contributions to the above-mentioned themes we will be considering in this paper, are Natural Phonology, Lexical Phonology, Natural Generative Phonology, Autosegmental Phonology, Metrical Phonology and Dependency Phonology.

Since it had been raised by Chomsky and Halle themselves as a problem in their own work, the naturalness issue was one of the first to be taken up after *SPE* appeared. *SPE* had presented rules which indeed described many of the phonological processes that occur in English fairly adequately (if in a somewhat

complex form of notation), but one difficulty was that there was nothing in the theory or the notation to limit or constrain what these rules could express; and in fact it was quite possible to use the notation to describe processes which not only never occurred but were impossible to imagine ever occurring. Early responses to this problem came from scholars who were part of the Generative movement and who wished to clarify or even modify aspects from the inside, as it were: eg. Schane (1973), Hyman (1975). Since the formal notation is such an integral part of this theory, the Generativists, including Chomsky and Halle themselves, at first tried to find ways of modifying the notation so that it would in itself contain the evaluation metric they sought: eg. by imposing additional constraints upon the rules in analyses; by experimenting with including or excluding redundant features in the underlying representations; or by building in a feature of 'markedness' for the less natural or less frequent elements, such that rules including these elements would be more complex or 'costly' than those without, and that eventually it would be impossible to formulate non-occurring rules. These avenues of research however, failed to provide any easy solution, and the question has faded in its original form from the literature in recent years, as Anderson notes (1985: 345); partly because it was not merely a notational issue but more fundamental - the difficulty of defining 'natural' and 'marked' in other than a circular fashion, and the fact that such concepts would in any case seem to require data in a more detailed phonetic form than the abstract underlying representations favoured in *SPE* - but also partly because more recent developments have in fact made the problem less relevant by their different concerns and frameworks, as will be seen below.

Although the specific notion of markedness may no longer be such a central one, the general question of naturalness, and the related notion of the universality (or otherwise) of phonological features and processes, and of language development, have continued to be explored. The proponents of Natural Phonology, for example, especially Stampe & Dcnegan (Anderson 1985: 342-347; Clark and Yallop 1990: 342-343; Katamba 1989: 109-113; Sommerstein 1977: 233-237), focussed on the criticism made of Generative Phonology that, whereas it might (with some refinements) come to describe what is possible in the phonology of English and other natural languages, it could not define what was natural about these: that is, why natural languages assume the forms they do, and whether certain forms are more likely than others. In contrast, Natural Phonology seeks an adequate definition of this naturalness, beginning from the assertion that language is the way it is because 'the living sound patterns of languages, in their development in each individual as well as in their evolution over the centuries,

are governed by forces implicit in human vocalisation and perception' (Donegan & Stampe 1979: 126, cited in Clark & Yallop 1990: 343). Natural Phonology thus centres on the naturalness of rules: its proponents maintain that children are born with a set of universal natural processes (eg. vowel nasalisation before nasals, obstruent devoicing, etc) which they 'know' from the outset, and which they will then selectively retain, or modify, or re-order, or unlearn, depending on the specific rules of their native language (which are not necessarily the same as the natural processes). Thus Natural Phonology maintains that there are certain rules which are more 'natural' to languages; and languages which do not have these pay a higher price in complexity than those that do (Anderson 1985: 343). These rules ought to be reflected in other phenomena besides first language development, too: eg. the evolution of languages over history, relaxed adult speech, slips of the tongue, etc.

Evaluations of the importance of this movement to linguistics generally are somewhat mixed. Sommerstein (1977: 237) regards this theory as 'one of the most important developments in phonological theory, if not the most important, since GP itself'. Clark & Yallop (1990: 143) likewise find much to commend:

The theory offers genuine explanation by presenting language not as merely conventional but as a 'natural reflection of the needs, capacities, and world of its users' (Donegan & Stampe 1979: 127).

Anderson (1985: 344-347), on the other hand, notes a number of findings which counteract some of the claims of this approach (eg. dissimilar rates of occurrence for certain phenomena in child and adult speech; and the fact that linguistic change in language history can go in different directions, not always the most 'natural'). He concludes that, like *SPE* itself, Natural Phonology 'errs in confusing the projects of description and explanation in phonology' - that is, it falsely claims that, by describing general patterns of data (in this case language acquisition in children), it has in fact explained these phenomena, whereas there remain many exceptions and conflicting pieces of evidence still to be explained - but he still considers the theory has had a valuable impact. Katamba (1989: 115) remarks that the theory emphasises ease of articulation as an explanatory tool while ignoring the equally important ease-of-perception dimension, with which the former may be in conflict, and is therefore doubtful about 'its predictive value and hence its place in a rigorous theory of phonology'. Natural Phonology seems, however, to be sufficiently flexible, open-ended and empirically testable for it to exercise a continuing influence potentially on both linguists and experimental psychologists, and thus to encourage continuing exploration of

some aspects of the child language research program and the search for language universals which *SPE* posited for the long-term.

To a large extent, the investigation of these issues, and of the question of the psychological reality of various approaches to phonological analysis, has been taken up by the experimental phonologists (Durand 1990: 132; Clark & Yallop 1990: 352-354) and the psycholinguists: for instance, many of the articles in collections such as those by Kavanaugh & Mattingly 1972, Reber & Scarborough 1977, Frith 1980, Henderson & Beers 1980, and Luelsdorff 1987, deal with the psychological reality of features or underlying representations or the syllable, and the application of linguistic theories to such domains as learning to read, learning to spell, dyslexia, differing writing systems, and the relationships between speech and orthographies. A detailed account of these aspects falls outside the scope of this paper, but they add an important dimension to the overall picture of recent phonology-related research.

Further examples of the continuing interest in discovering universal (and hence natural?) - or at least recurrent - characteristics of languages are the interrelated concepts of the Sonority Hierarchy (eg. Lass 1984: 264; Durand 1990: 210; Goldsmith 1990: 110-112) and of (Universal) Consonant Strength (Vennemann 1988: 9; Foley 1977: 145-146 esp.). Sounds which are the most sonorous have greater carrying power (perceptually), require less energy (acoustically) and, in articulatory terms, correspond to a freer passage of air through the vocal tract: the Sonority Hierarchy therefore has 'the most vowel-like' sounds - open or low vowels - at the upper end and 'the least vowel-like or most consonant-like' sounds - plosives - at the lower end, while the consonants will be ranked in the reverse order in a Consonant Strength Hierarchy (from which vowels will, of course, be absent). There are some differences between languages, but in general terms these hierarchies take the following forms.

Sonority Index (SI)	Sound
10	a
9	e, o
8	i, u
7	r-sounds
6	laterals
5	nasals
4	voiced fricatives
3	voiceless fricatives
2	voiced stop
1	voiceless stop

Diagram 1: Sonority Hierarchy, based on Selkirk (Durand 1990: 210).

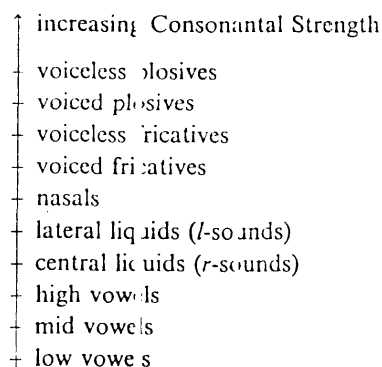


Diagram 2: Consonantal Strength Hierarchy (Vennemann 1988: 9).

These concepts are to some extent a rediscovery of earlier work (Hawkins 1984: 98), and come from the analysis of such phenomena as historical change in languages, syllable structure, and the characteristics of rapid speech. While hardly constituting full theories in their own right, they are of interest as evidence of at least some universal tendencies across different languages, and they have been taken up by researchers espousing differing approaches to phonological analysis, particularly those investigating the nature of the syllable and multi-linear modes of representation (see later discussion of Autosegmental, Metrical and Dependency Phonology).

The third theme noted above is the shifting relationship between representations and rules. In *SPE*, the main emphasis was on the formulation of phonological rules which could express 'linguistically significant generalisations'; and it has been argued that the elements in the underlying representations were chosen to fit the rules - or at least arranged so as to maximise the generality of the rules - rather than being determined by validity in their own terms (Anderson 1985: 323-325; also Kiparsky, in van der Hulst & Smith 1982: 146). This resulted in the underlying representations being pared down to the most abstract, redundancy-free forms, characterised by the fewest possible features needed to distinguish one form from another, while the rules which operated to change them into surface forms were very complex. The assumption seemed to be that storage space in the mind was at a premium, and that therefore the need for storage should be minimised by memorising words 'in a maximally economical form in which redundant (predictable) properties are eliminated' (Halle & Clements, cited in Durand 1990: 129). However, some scholars argue that this is not necessarily the case, and that the human mind prefers concrete operations and patterns to



abstract ones, so it more likely stores a large number of items organised in terms of relatively simple rules (Durand 1990: 129; Anderson 1985: 13; Lass 1984: 222).

Even within Generative Phonology itself, discussion arose soon after the publication of *SPE* as to the permissible degree of abstractness for underlying representations. Kiparsky, for example, criticised the excessive abstractness of certain forms, in particular those which exemplified the 'diacritic use of phonological features' (ie. using a phonological distinction, which in fact does not appear as such on the surface, to distinguish two forms which differ in some other way) and those which involved the 'phonological use of diacritical features' (where an arbitrary, non-phonological feature is attached to particular forms and then used to invoke the operation of a rule). He initially proposed what was termed the Alternation Condition, which basically sought to ensure that (surface) morphemes which are always the same have the same phonological representations, while morphemes which always differ phonetically have distinct underlying representations. Kiparsky has continued to refine, with others, on the problems of the relationships between morphology and phonology, resulting in the approach termed Lexical Phonology (Clark & Yallop 1990: 349-350; Kiparsky, in van der Hulst & Smith 1982: 131-175; Pulleyblank 1983).

Lexical Phonology introduces strata or levels to its analysis: each level consists of particular derivational and inflexional processes of a language, together with the related phonological rules, while the sequence of levels reflects the (possible) sequencing of the morphological processes involved in word-formation. In Kiparsky's words: '[...] the main explanatory burden is carried by simplicity and the structure of the grammar itself, as opposed to conditions on rules or representations' (van der Hulst & Smith 1982: 173). As in *SPE*, Lexical Phonology permits abstract underlying forms, expressed in terms of 'distinctive features' (ie. 'underspecified', noting only the unpredictable aspects, the predictable being dealt with by the rules). However, in Lexical Phonology there is also a level of representation similar to that of the Structuralists' phonemic level, and there are important differences in the way rules operate. In *SPE* it was considered that the phonological rules only operated after determination of the full morphological representation of the word, which itself only occurred after the operation of the syntactic rules; here, on the other hand, it is proposed that the morphological processes precede the syntactic. Thus, there is a distinction made between 'lexical' and 'post-lexical' rules (hence the name of the approach): the 'lexical' rules (mainly 'morphophonemic' in the traditional sense, according to Clark & Yallop

1990: 350) may apply cyclically to the output (possibly word-internal) of the word-formation process at each level, and result in an output quite similar to a traditional phonemic transcription; the 'post-lexical' (similar to Stampe's 'natural processes', or the allophonic processes of traditional phonemics in the view of Clark & Yallop) are applied non-cyclically after words have been combined into phrases or sentences, and result in phonetic forms.

As well as more 'segmental' units of phonology, the approach can deal with stress and tone (Pulleyblank expresses interest in the Autosegmental approach in this regard, too). Cyclical rules (which apply recursively) had already been introduced into *SPE* to deal with the phenomenon of stress, but their use had not been fully developed or applied to a wide range of phenomena. The combination of strata and cyclical rules in Lexical Phonology, along with some further refinements such as the Elsewhere Condition (a 'default' condition), permits 'major simplifications' (Kiparsky 1982: 161). Thus, although Kiparsky regards Lexical Phonology as remaining within the mainstream of Generative Phonology, he also claims that it marks an advance overall in both conceptual and empirical terms, not least because it comes closer to the goal of reconciling 'maximal generality and elegance of descriptions on the one hand, and maximal realism, naturalness etc. on the other' (van der Hulst & Smith 1982: 173).

Other scholars starting from within the Generative Phonology school have initiated rather different responses to the perceived extremes of abstractness of some of the *SPE* analyses. Natural Generative Phonology, primarily linked with the names of Venneman and Hooper, is concerned with the naturalness of representations even more than with rule naturalness (Anderson 1985: 339-342; Clark & Yallop 1990: 341-342; Durand 1990: 134-150; Lass 1984: 223-228). NGP reacted very strongly against what it saw as excesses in *SPE*, in particular the abstractness of underlying representations in classical Generative Phonology, claiming that these 'were more a matter of the ingenuity of linguists than of the reality of natural language' (Anderson 1985: 339); and asserting that 'the phonological component need only deal with transparent, phonetically motivated, regular, productive processes [...]. All other regularities should be handled by the morphological component' (Katamba 1989: 140). A central idea, then, is that underlying forms must have a much more direct relationship with the surface phonetic forms. At its most extreme, the 'strong naturalness condition' of NGP banished underlying forms totally (Durand 1990: 134), or, a little less radically, stated that the underlying form must be one of the surface allomorphs; a milder version, the 'true generalisation condition', stated that 'all

rules should express transparent surface generalisations, generalisations that are true for all surface forms and that, furthermore, express the relation between surface forms in the most direct manner possible', and hence that 'no phonological features appear in the lexical representations of a morpheme except those that occur in some surface representation of that morpheme' (Hooper 1976: 13, 20, cited in Durand 1990: 135). As Clark & Yallop point out: 'Rules are now to be regarded as generalisations across surface forms rather than as the means of generating surface forms' (1990: 342).

In order to express these more direct connections between underlying and surface forms, a number of rule types are differentiated by NGP, which roughly link in with the traditional divisions between morphophonemic, phonemic and phonetic representations (Durand 1990: 24) (whereas *SPE* rules were all classified as phonological): P-rules (phonological rules proper, by the above definition), sandhi rules (referring to word- or morpheme-boundaries), MP rules (morphosyntactically conditioned), syllable rules, morphological spell-out/word-formation rules, and via-rules (to connect related morphemes or MP alternants) (Lass 1984: 224).

Natural Generative Phonology attacked abstractness more thoroughly than did other groups, but in rejecting abstractness so absolutely, and in imposing fairly strict limits on the area of study 'proper' to phonology, it may have lost some of the advantages that accrue from a theory which can establish revealing generalisations. Such an extreme stance - 'impoverished', in Anderson's view - has not had a strong public following (Anderson 1985: 342; van der Hulst & Smith 1982: 2), but there has resulted 'a gradual trend toward more concrete accounts of phonological systems', which suggests the reservations it expressed were in fact more widely held; and we have already noted that both Natural Phonology and Lexical Phonology espoused some of the same causes, albeit in contrasting ways. Durand (1990: 150) comments that 'the attempt to set up a motivated stratal organisation [...] is a worthwhile one', and we shall see below some other moves in a similar direction.

The shift from the *SPE* model of phonology, where rules seem to have the major role and representations are somewhat subservient, via the above approaches where the expressive power and pre-eminence of rules are questioned and representations, both surface and underlying, assume more importance in their own right, has been taken even further by more recent schools of thought in phonology, including Autosegmental, Metrical, and Dependency Phonology.

These approaches began from varying starting problems, but share a common concern that the linear, segment-based approach of standard Generative analysis does not permit phonological descriptions of English or other languages which are even observationally or descriptively, let alone explanatorily, adequate. Their explorations of both the 'suprasegmental' and 'subsegmental' layers of phonology have resulted in descriptions and notations which vary from one another in detail but which are all non-linear and multi-tiered, and where processes are expressed directly in relation to representations, or in simple English, without needing the rigorously formal apparatus of *SPE*. Rules which are formally possible but in reality impossible, which had been one of the most criticised aspects of *SPE*, can not be formulated in this kind of representation, whereas rules which 'conspire' to a common outcome but which are not formally related - and which therefore in the standard Generative approach could not be linked to one another - can now be seen clearly to be connected (Sommerstein 1977: 199; Smith 1989: 125). All in all, these recent approaches have permitted, firstly, a better analysis of the nature of and relationships between subsegmental features (or elements, or components, as they are now sometimes called), and secondly, an examination of the nature and role of the syllable and other phenomena which do not seem to be tied to segments in a neat one-to-one relationship (eg. tone stress, vowel harmony, nasalisation).

Autosegmental Phonology is an approach which, because of its enriched form of phonological representation, has aroused increasing interest since Goldsmith published his thesis in 1976 with that title (Anderson 1985: 192-193, 347-349; Clark & Yallop 1990: 344-347; Cruttenden 1986: 63-67; Goldsmith 1989; van der Hulst & Smith (eds) 1982). As noted above, traditional phonological representations (including those of *SPE*) have had the form of a single linear layer of atomic segments, which are of uniform size and independent of one another, and each of which is an unordered set of features: the metaphor 'string of beads' is frequently used by those who feel that this is a deficient depiction of the phonological facts (eg. Anderson 1985: 348). The only units larger than the segment which were recognised were morphological ones, defined by the insertion of boundaries between segments, but no structural units (eg. syllables) were systematically represented: significantly, although the term 'syllable' occurs in *SPE*, it is never defined, nor used as a subheading, nor given an index entry.

Goldsmith's view of speech (in many respects reminiscent of Firthian prosodic analysis - a connection Goldsmith acknowledges, in contrast to the total disregard afforded Firth in *SPE*, where he is not even listed in the bibliography) is that it

resembles instead an orchestral score. He posits a 'skeleton' or 'timing' tier, whose 'segments' are specified as  $\pm$  syllabic], the options being V [+syllabic], C [-syllabic], or X [unspecified for syllabicity], along with several autonomous (hence 'auto-') tiers or layers of 'autosegments', each tier representing the contribution of a different feature (eg. lip movement, velum lowering, tone). Unlike the binary distinctive features of *SPE* which are locked into segments and thus always operate in inseparable bundles, the unary features of the autosegmental tiers function independently - there is no positing of a one-to-one connection between the features on different lines - but they are linked by association lines to the skeleton tier to indicate where a particular feature characterises a given segment. Changes to sounds are indicated merely by reattaching the association lines. Such a notation allows one feature to be spread over more than one segment (eg. tone, lip shape, nasality), or the reverse - a single segment to have more than one feature mapped onto it - and overall provides a flexible and elegant way of explaining phenomena such as complex tones, vowel harmony, nasalisation of adjacent sounds, and so on. The theory is also causing a wide-ranging reassessment of previously studied phenomena: eg. assimilation may not involve a feature of one segment 'changing' to resemble a feature of a neighbouring segment, but rather that independent feature attaching itself equally to the two segments. It may also shed fresh light on the child's learning of phonology (Clark & Yallop 1990: 345). In short:

[...] there are few rules in the phonologies of the moderately well studied languages whose form remains unaffected when considered in terms of autosegmental structure and associations rather than as changes in the values of features (Anderson 1985: 349).

The following diagrams exemplify Autosegmental analyses of varying complexity, to illustrate the notation used.

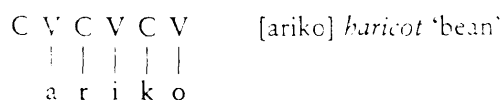


Diagram 3: Analysis of the sequence [ariko] *haricot* 'bean' (Goldsmith 1990: 57)

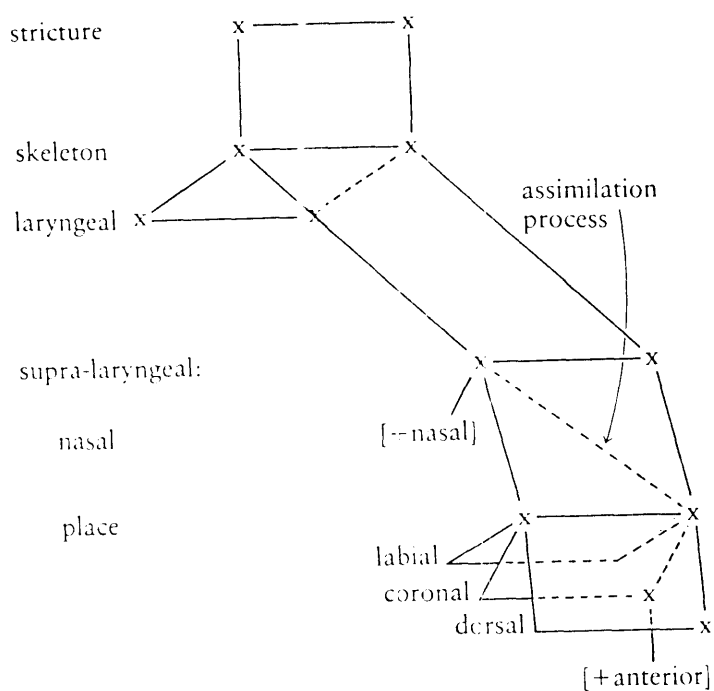


Diagram 4: Assimilation of a nasal's point of articulation (Goldsmith 1990: 282)

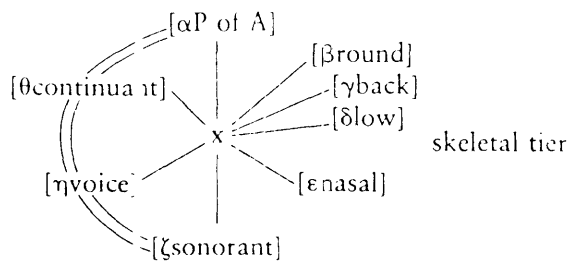
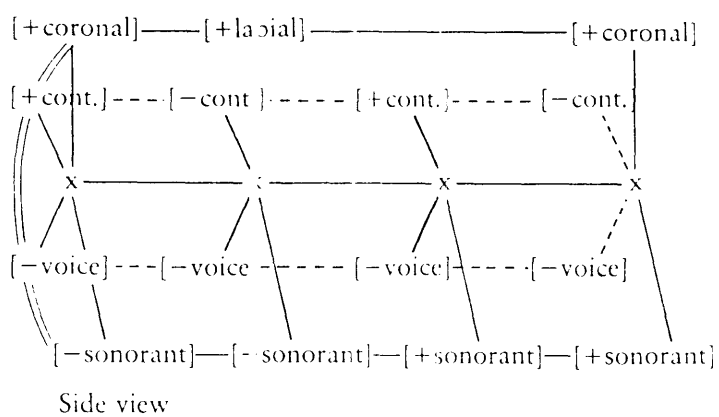


Diagram 5: 'Spiral notebook' model (Goldsmith 1990: 283)

Another approach now often associated with Autosegmental Phonology is Metrical Phonology, whose best-known scholars are Liberman & Prince (Anderson 1985: 349; Goldsmith 1990: 169-216; van der Hulst & Smith 1982: 45). The particular contribution of Metrical Phonology has been the insight that stress should be regarded less as a feature attached to individual segments, and rather as a relationship between hierarchically organised units (syllable, mora, foot, prosodic word); and the development of a layered system of notation not unlike that of Autosegmental Phonology to represent this analysis (trees, grids and 'spiral notebook' systems are all found: see below). In addition, the syllable, long regarded as a pivotal unit in eg. speech perception, language acquisition, writing system development, and so on, had always eluded specification, and indeed Chomsky and Halle, while using the term in an informal way, chose not to explore it as a speech unit in *SPE*, as noted earlier. Metrical Phonologists have tackled this challenge and made some progress in formalising the structure of the syllable, and in analysing the syllable structure of various languages in this light. The Sonority Hierarchy noted earlier is important here, as it helps explain why the components of syllables are ordered in the way they are, and why certain processes occur within syllables: eg. there must be a gradual rise in sonority to a peak at the nucleus, and then a gradual fall to the end of the syllable (though a syllable-initial pre-plosive /s/, as in 'split', poses some difficulties for this model).

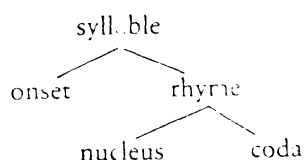


Diagram 6: Internal structure of the syllable (Goldsmith 1990: 109).

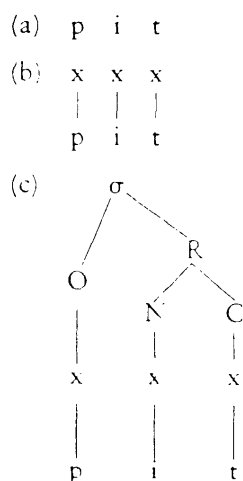


Diagram 7: The syllable 'pit' (Goldsmith 1990: 152).

(Note that the skeleton tier slots are marked as 'x' rather than C, V or X; because the nucleus of the syllable must be [+syllabic], it is no longer necessary to include this information on the skeleton tier.)

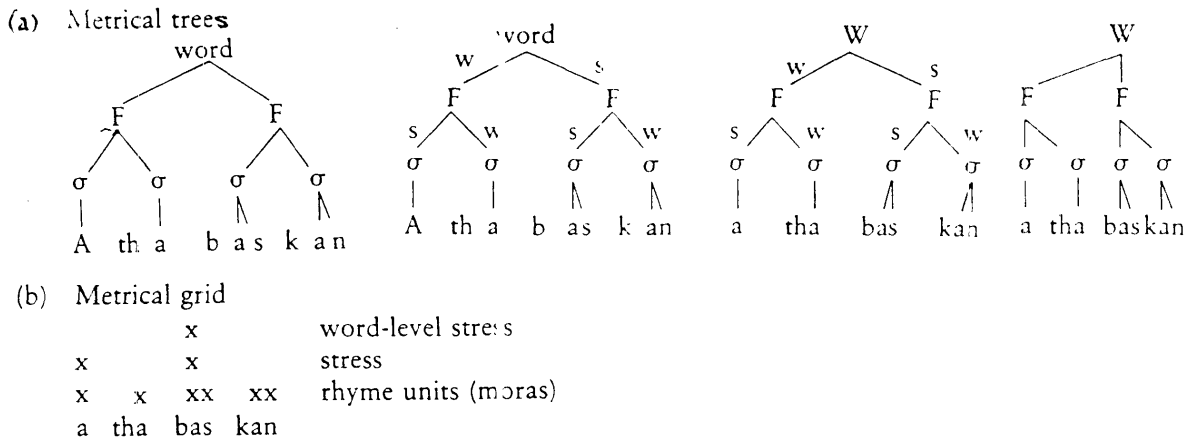


Diagram 8: The word 'Athabaskan' in various tree and grid forms (Goldsmith 1990: 171, 169, 184).

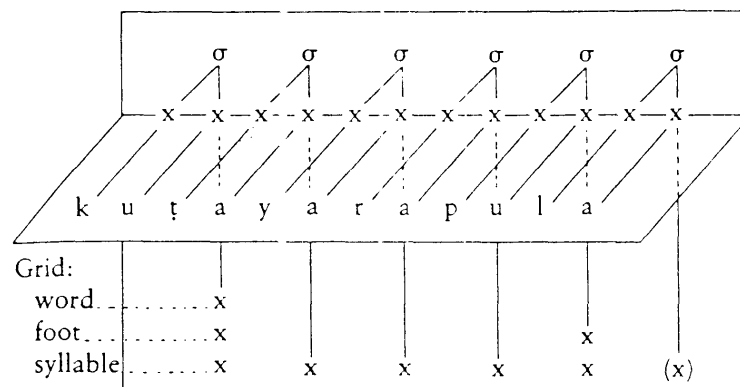


Diagram 9: Prosodic structure of the Watjarri word 'kuṭayarapula' (Goldsmith 1990: 195).

Although these two approaches initially arose in response to different issues (Autosegmental in relation to African tone languages, Metrical as a theory of stress), they share many common aspects such as a concern with both sub- and suprasegmental phenomena and a tiered view of phonological representation (where feet and syllables are once more of interest, after their neglect in *SPE*), and they not infrequently tackle similar questions, providing distinct but not necessarily conflicting analyses. Metrical Phonology highlights in addition the



hierarchical organisation of the various components, which, as we shall see, is taken even further by Dependency Phonology. Leben (in van der Hulst & Smith 1982: 189) suggests that Autosegmental Phonology is in fact just a special case of Metrical Phonology. Goldsmith does not go quite so far, but gives Metrical and Autosegmental Phonology equal mention in his recent book (1990), as well as devoting a chapter to Lexical Phonology, and suggesting that a development integrating advances from all of these approaches has a great deal to offer the contemporary phonologist.

The final approach to be mentioned here is Dependency Phonology, with which the names of J. Anderson and Ewen are principally linked (Anderson & Ewen 1987; Clark & Yallop 1990: 321-323, 351-352; Durand 1990: 99-108). Like the previous two approaches, Dependency Phonology is concerned with both suprasegmental and subsegmental structures, whose complexity was not well revealed in *SPE*; it goes beyond them, however, in the rigorous way in which it establishes relationships of hierarchy or dependency between units at different levels. At the suprasegmental level, it uses unlabelled dependency trees (rather than the labelled ones of Metrical Phonology) to represent the phonological organisation of utterances: position in the hierarchy and direction of change or modification are depicted even more directly in this way. For example:

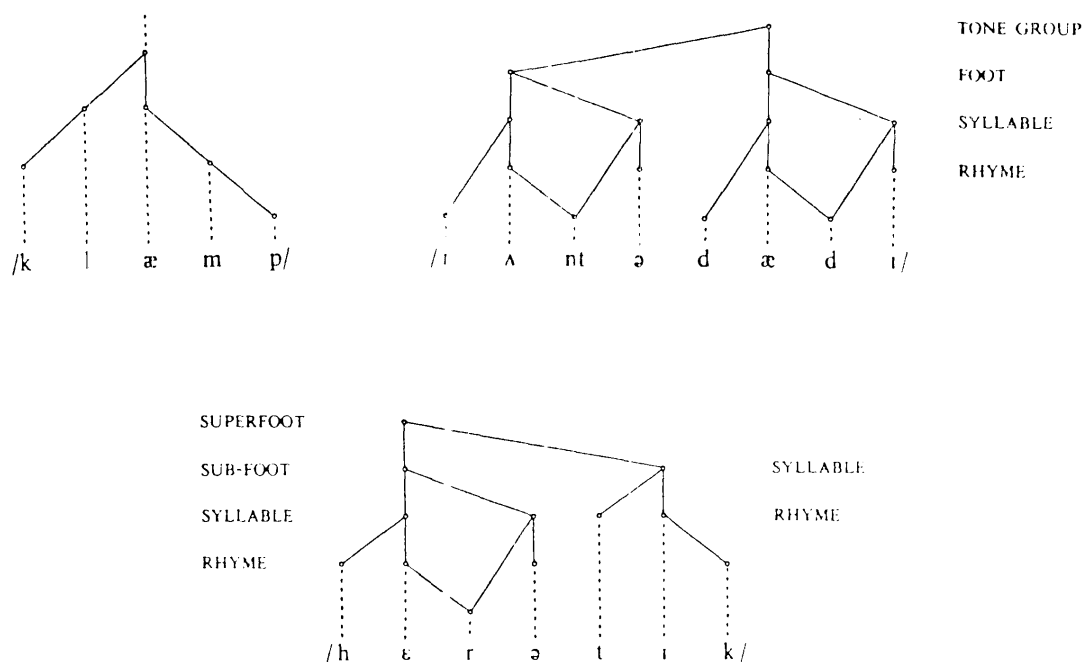


Diagram 10: The utterances 'camp', 'run to Daddy' and 'heretic' (Anderson & Ewen 1987: 97, 101, 102).

At the subsegmental level, Dependency Phonology groups features into subgroupings or 'gestures' of various types:

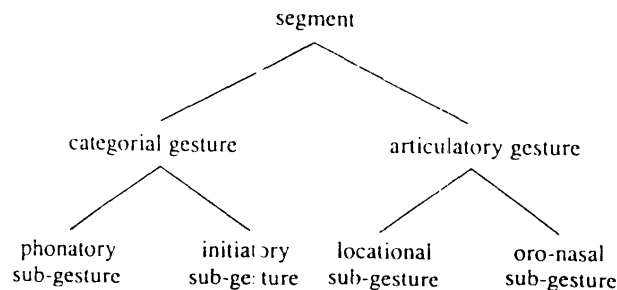


Diagram 11: Structure of the segment (Anderson & Ewen 1987: 149).

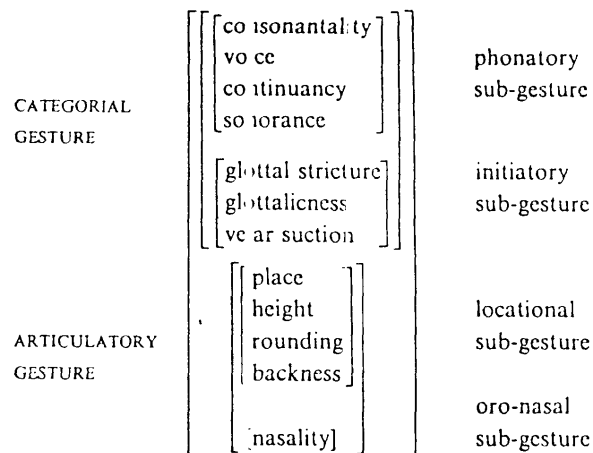
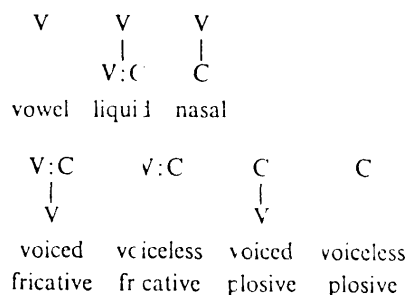


Diagram 12: A formalisation of the notion of gesture, and of particular groups of features forming recurrent domains for phonological processes (Anderson & Ewen 1987: 150)

At an even more detailed level, by utilising the Sonority Hierarchy with |V| and |C| as the two components and symbols to indicate various relationships or combinations of these, Dependency Phonology can characterise the representations of the phonatory subgesture in the following economical way:



#### Natural classes in the phonatory sub-gesture

The system in (4.13) allows us to characterise natural classes of segments in a very transparent and componentially appropriate way. Some major classes that can be distinguished are shown in (4.14):

(4.14)	vowels	$\{V\}$
	sonorants	$\{V \rightrightarrows\}$
	sonorant consonants	$\{V \rightrightarrows C\}$ or $\{C \nrightarrow\}$
	obstruents	$\{C \rightrightarrows\}$
	consonants	$\{C\}$

Other sub-classes which can be characterised are:

(4.15)	fricatives	$\{V, C \rightrightarrows\}$
	continuant consonants	$\{V, C\}$
	non-continuant obstruents	$\{C \rightrightarrows\}$
	voiceless obstruents	$\{C \nrightarrow V\}$
	voiced obstruents	$\{C \rightrightarrows V\}$
	voiced continuants	$\{V, V\}$

(where  $\rightrightarrows$  = 'unilaterally governs' and  $\nrightarrow$  = 'does not unilaterally govern': notice that a representation such as  $\{V \rightrightarrows\}$  includes  $\{V\}$ , which governs the identity element, thus correctly characterising vowels as a sub-class of sonorants). Again, componentiality is satisfied.

Diagram 13: The representations for the phonatory sub-gesture, and natural classes in the phonatory subgesture (Anderson & Ewen 1987: 158).

The articulatory subgesture needs three components rather than two: |i| 'frontness', |a| 'lowness', and |u| 'roundness'. Again, these are used in various combinations to represent this aspect of vowel sounds, while the addition of a few further components, such as |l| 'linguality', |t| 'apicality', |d| 'dentality', |n| 'nasality', permit the representation of place/articulation for various consonant types. An example of the way in which components can be expressed in this notation, and how this notation itself can assist the development of a hierarchy, can be seen in the following table:

Table 1: Hierarchy of relative complexity in the articulatory gesture (Anderson and Ewen 1987: 127)

$\{\sim a\}$	(a segment whose articulatory gesture contains a component other than  a )
$\{a\}$	(a segment whose articulatory gesture contains  a )
$\{ \sim a \}$	(a segment whose articulatory gesture contains only a component other than  a )
$\{ a \}$	(a segment whose articulatory gesture contains only  a )
$\{a, \sim a\}$	(a segment whose articulatory gesture contains  a  and a component other than  a )
$\{ a, \sim a \}$	(a segment whose articulatory gesture contains only  a  and a component other than  a )
$\left\{ \begin{array}{l} \{ \sim a \rightrightarrows a \} \\ \{ a \rightrightarrows \sim a \} \end{array} \right\}$	(a segment whose articulatory gesture contains only  a  and a component other than  a , in which one governs the other)
$\{ \sim a \rightleftarrows a \}$	(a segment whose articulatory gesture contains only  a  and a component other than  a , in which each governs the other)

Anderson & Ewen consider that Dependency Phonology offers advantages over other models of phonological representation (1987: 256, 271):

This greater structural variety allows a correspondingly greater richness in segmental representation, while at the same time constraining the ability of the notation to express a number of non-recurring and, *a fortiori*, non-occurring segment types.

A number of commentators are similarly excited at the possibilities opened up by this approach: eg. Durand 1990, Kaye 1989. Certainly, the suprasegmental level and phonetic considerations play a much greater role in all the recent approaches to phonology than in orthodox Generative Phonology, with a concomitant gain in the richness and completeness and the concreteness and naturalness, of representations. In addition, because the questions being asked are multi-dimensional, and many more languages than just English are being examined by phonologists, there is hope that it may be possible eventually to find features or components which are indeed universal. Moreover, rules have been simplified from complex structural changes or mutations to a more 'configurational' approach (Durand 1990: 273) of additions or deletions of components, or reassociations of features, which are built into the notation more than in *SPE*. The ongoing search for universal processes has resulted not only in some answers but a paradigm shift (and thus more, and more sophisticated, questions to ask). Phonologists seek to construct explanatory models of phonology which are as plausible, consistent, parsimonious and elegant as possible, and to devise phonological notations which express clearly these phonological groupings and relations. In post-generative phonology, there is a real sense of radical progress.

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