Nonlinear Phonology 1982–1994

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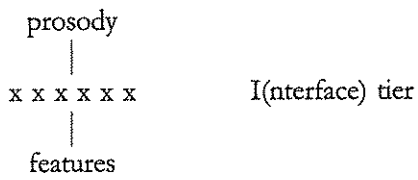
1. Introduction

Van der Hulst & Smith (1982) aimed at showing how Autosegmental and Metrical Phonology extended their domains of application since they were first conceived five or six years before that time, in the work of Goldsmith (1976) on autosegmental phonology and Liberman (1975) and Liberman & Prince (1977) on metrical phonology. In this paper we will present our understanding of the present state of phonology, and sketch the developments that have taken place during the last decade. We will also try to relate the papers in this volume to these changes.

In their introduction van der Hulst & Smith sketched the problems that arose with regard to the division of labour between the two models. For example, certain types of harmony systems were treated in terms of metrical mechanisms, as Halle & Vergnaud (1981) had proposed, whereas other harmony systems were said to be autosegmental. In the area of **syllable structure,** which, strictly speaking, formed part of neither subtheory as originally designed, Kahn's (1976) autosegmental formalism and the "metrical" interpretation of the more traditional onset–rhyme model were competitors. At the present moment, such issues seem to have been decided: harmony processes are generally regarded as belonging to the autosegmental sphere, and syllable structure is regarded as a separate field.

As a result of settling such matters, most generative phonologists at some point came to agree that there is a layer of representation which mediates between the phonological features and the prosodic organization. In this paper we will take a neutral position with respect to the nature of the layer between features and prosodic structure, and refer to it as the **interface tier.** This tier is shown in (1):

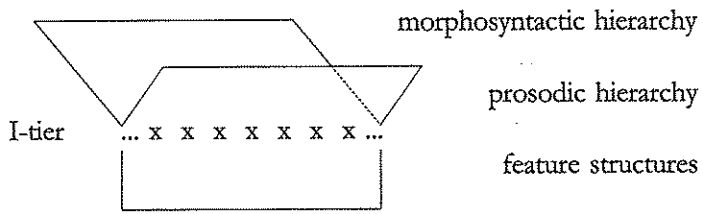
(1)



Besides forming the starting point for the featural and prosodic organisation, the Interface tier is also the starting point for the morphosyntactic organisation, or rather, its basic elements, the **morphemes.** When the prosodic organisation came to be accepted (due to the work of Selkirk 1984; Nespor & Vogel 1986, among others), the issue how this organisation should be related to the morphosyntax became a topic of debate.

A schematic representation of the phonological organisation that has become accepted appears in (2) (see e.g. Sagey 1986, p. 17):

(2)



The morphosyntactic and prosodic hierarchies typically form the **domains** over which operations on the latter are defined.

In the remainder of this article we will discuss some of the major developments which have taken place in the various parts of this "T-model" of phonological structure.

2. Autosegmental phonology

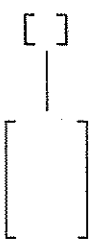
First, we will focus on the segmental part, i.e. the feature structures of the model in (2). In this section we will deal with the concept of feature grouping, which represents one of the most important developments of the last decade, the head-dependency relation, questions regarding underspecification and single-valued features and issues concerning complex segments.

2.1. Feature grouping

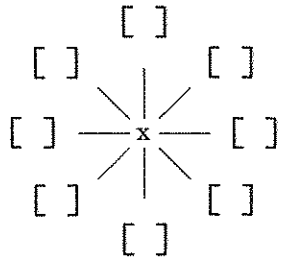
In 1982 the idea had become accepted that at least some features can be autosegmentalised on a language-specific basis, that is, placed on a tier of

their own, to explain long-distance assimilation effects such as tone spreading, vowel harmony, and nasal harmony. In Firthian terms we would say that in these cases the features concerned act like prosodies. Later on, it was proposed that all features **always** occupy tiers of their own, also in the absence of prosodic behavior. These two views on feature structure may be referred to as the *SCLAM* model and the *UMM* model of feature structure, respectively. Both are shown in (3):

(3)



SPE cum Language-specific Autosegmentalization Model (SCLAM)



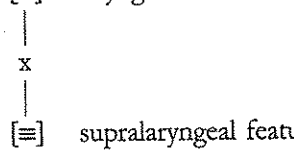
Universal Mississippi Model (UMM)

If, as in (3b), all features are granted "autosegmental status", there must be a tier to which all features ultimately associate, in order to express their coordination or linear ordering. Although linear order is imposed on each individual tier between the features or feature values on that tier, features on different tiers are not linearly ordered with respect to each other. To represent phonological forms which can be phonetically interpreted, **intertier** relations must be established. For this we need a "reference point" or tier which allows us to express how features on different tiers are coordinated with respect to each other. The lowest unit of the prosodic hierarchy (let us say the syllable) is not suited for this purpose, because there is distinctive ordering of features within this domain. The appropriate tier is the interface tier we already mentioned. The units on this tier then are the remnants of the "segments" or "phonemes" in previous models. We also need this tier in order to be able to express the fact that languages may disallow certain cooccurrence patterns of features.

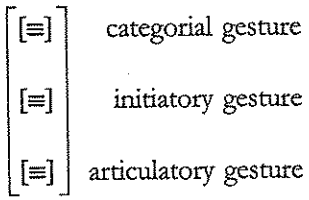
In early versions of Autosegmental Phonology, the Interface units were called skeletal points, and later they became known as x-slots. For some time the controversy was whether these units should be labeled as C or V, or whether such labeling was redundant as it was predictable from syllabic organization. At present, the issue seems to have been decided in favor of the "x-slot" notation. We will return to the question whether the I-tier consists of x-slots or of moras later on.

One of the most striking developments of Autosegmental Phonology involved the introduction of **feature grouping.** Van der Hulst & Smith (1982) drew attention to the possible advantages of the concept of grouping, which was already present in Dependency Phonology (Anderson & Jones 1974; Lass 1976; Anderson & Ewen 1987), and in a proposal of Thraínsson, who in 1978 argued in favor of separating laryngeal features from supralaryngeal features on the basis of pre-aspiration in Icelandic. Thraínsson's proposal was roughly as in (4a), and the Dependency Phonology proposal is given in (4b). In Dependency Phonology, such feature groups are referred to as **gestures.**

(4) a.



b.



In 1983, both Mohanan and Mascaró proposed to impose a grouping of this kind on sets of tiers. Both proposals remained unpublished manuscripts, however, and Dependency Phonology was so little known or considered so outlandish that nobody took much notice of this model. The vocabulary and ideas of Dependency Phonology will be discussed in **Davenport**'s article in this volume, and applications are also found in **Sandler**'s contribution and that of **Dresher & van der Hulst.**

Basing themselves on the proposals by Mohanan and Mascaró, Clements (1985) and Sagey (1986) made the concept of feature grouping familiar to a larger audience. Both made considerable progress in working out the basic idea. Grouping was basically proposed to explain why certain classes of features show affinities with one other in phonological processes. Such affinities would be accidental if all features directly associate to the Interface tier, as in the Mississippi model in (3).

Currently, views differ with respect to the details of the grouping. Den Dikken & van der Hulst (1988) present an overview of proposals up to then, which today could be extended considerably. From the codified *SPE* set of features, we have moved to a situation in which every phonologist seems to have her or his private set of primitives, the present authors not excluded. This is not in itself a bad situation, as it is indicative of a lively field, possibly in progress. It is also due to the increasing attention to research into languages of all the world, and to the application of phonological theory to the diverse processes encountered. This research greatly widens the empirical domain which phonological theories have to cover

nowadays. We would like to note that this scope includes both possible phonological processes and possible phonological segment inventories: neither angle is in itself a better or worse one to start from.

Two prominent topics in the feature geometry discussion are, in our view, the representation of major class and manner distinctions, and the representation of Place features in consonants and vowels. Both the actual set of features that is necessary and the organisation of these sets are topics of debate.

Let us briefly discuss the organisation of major class and Manner features. In Clements (1985) the proposal was made that all these features were under one Manner node, although the status of this node was already questioned by Clements. In Sagey (1986) this node was abolished and all the relevant features were assigned a relatively independent status. Later, the major class features were proposed to be attached to the root node, or else to make up the root (McCarthy 1988). Some phonologists tried to abolish such features altogether, and proposed that major class distinctions could be represented configurationally (see Dogil 1988 and Rice 1992 for two rather different ways of achieving this). Nowadays proposals are again being made for nodes to organise [nasal] and [lateral] (Avery & Rice 1988; Rice & Avery 1991; Piggott 1991), for instance, and some would say that it is necessary to recognize something like a separate Manner node to express the unity of the Manner dimension *vis-à-vis* syllabification and weakening and strengthening processes (Anderson & Ewen 1987; van de Weijer 1992; van der Hulst, to appear, forthcoming).

In this volume, there are three papers dealing with Manner features. These deal with [nasal], [lateral] and [cont] (or rather the relation between [cont] and Place), respectively. Let us briefly look at these.

A major issue in the literature has been how to represent the fact that all lateral segments are coronal. In her paper, **Brown** shows that representing the feature [lateral] under the coronal node is not a viable solution (cf. also Shaw 1991). This leads her to propose that the difference between a sonorant rhotic and a sonorant lateral is expressed as the difference between a liquid with a coronal node, and one without such a node.

Davenport's article is concerned with nasality, which addresses an old but important point. That a particular segment is a nasal can be read off twice in the Dependency Phonology representation of nasals: once in the so-called categorial gesture (which represents manner and major class), and once in the so-called articulatory gesture (which represents place of articulation) (cf. (4) above — although the labels in Davenport's article may be different). Davenport proposes to eliminate this redundancy.

Such a dual status of nasality has a counterpart in one feature geometry proposal, namely that of Piggott (1992), in whose model the feature [nasal] can be associated to a Soft Palate node or to a Spontaneous Voicing node.

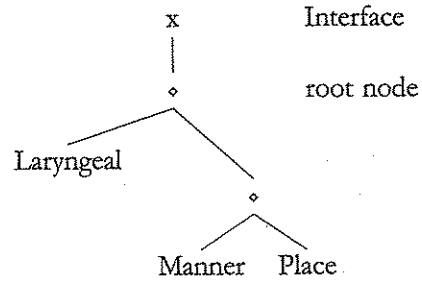
Finally, the paper by **Palmada** examines the way in which underspecification might interact with feature geometry. She deals with the relation between Manner and Place in this respect, attacking some recent proposals in this area. Basically, the paper explores the idea that if a feature can be shown to be specified, its dominating nodes must also be specified.

Let us turn to a second major issue, namely the representation of Place features in vowels and Place features in consonants. Recently a great deal of attention has been paid to the interaction of Place features between the two. It has been argued that since consonant Place can affect vowel Place directly, and *vice versa,* there is only a single set of Place features for both consonants and vowels (as in Jakobson, Fant & Halle 1952; Smith 1988; Pulleyblank 1989; Clements 1991, 1993; van der Hulst 1994, forthcoming; van de Weijer 1994). A partial identification of consonant and vowel Place features had also been proposed in Dependency Phonology. Ní Chiosáin & Padgett (1992) note formal and empirical problems in Clements's approach to such phenomena, and argue that consonant-vowel interaction effects can only be the result of the spreading of vocalic features, which, then, consonants must have redundantly.

With respect to the laryngeal and tone features, the former are the subject of two recent MIT dissertations (Duanmu 1991; Bao 1991), as well as of Snider (1990). For work in this area, see, for instance, several of the contributions to van der Hulst & Snider (1992), and the introduction in that volume. The general trend in this area seems to be of a unification of features for tone and phonation, as already present in the work by Halle & Stevens (1971). The trend is in fact the same as those noted above for Place features: a feature is interpreted differently according to its position in a particular configuration. Work on laryngeal features is absent from this volume.

With respect to the relation between the different sets of features, in a number of recent studies it has been recognised that there is a closer relation between Manner and Place features than between either of these and Laryngeal. This was already the case in Clements (1985), where both Manner and Place are dominated by a Supralaryngeal node. This is expressed in (5), intended to be informal. We will return to the status of the **root node** here, which mediates between the Interface and the various class nodes.

(5)



Finally, we should like to note that — although all feature geometry proposals **look** very formal — they are not always as precise about what various aspects of their representations mean as one might wish. It is therefore fortunate, in our view, that various frameworks (such as unification theory: Bird 1990; Scobbie 1991; Bird, Coleman, Pierrehumbert & Scobbie 1992) have tried to rigorously define such aspects as what it means for a feature to be associated to a node, and incorporate the answers in a well-defined theory.

2.2. The head-dependency relation

A basic concept of Dependency Phonology is that a combination of two features that belong to a particular group involves a dependency relation, and that a combination of the same two features in which this relation is reversed, formally represents a different linguistic object. Two different such objects are given in (6):

(6)

	A		B	head
	|	≠	|	
	B		A	dependent
e.g.	/e/		/ɛ/	

Dependency relations also hold between feature groups in this model.

A related, though not equivalent, concept of dependency has also been explored in geometrical phonology in the work of Mester (1986) and McCarthy (1988), and since then in most current work. It has not always been clear, however, what different researchers have meant by this term. We would like to emphasise that the term needs a rigorous definition. Ewen (forthcoming) looks at this issue in detail, making a crucial distinction between dependency (which essentially involves a sisterhood relation in which one of the two nodes is the stronger, i.e., it is the reverse of

government) and dominance (which essentially involves a mother–daughter relation). Dependency, if understood as a strong–weak relation, also plays a role in metrical phonology.

In the contribution by **Dresher & van der Hulst,** head-dependency relations in various areas of phonology are discussed in more detail; attention is drawn to differences in the composition of heads and dependents, and the suggestion is made that at various levels of phonological representation the asymmetries between what is allowed in a head and what is allowed in a dependent can be expressed in the same way.

2.3. Underspecification and single-valued features

To turn back to the 1982 volumes edited by van der Hulst & Smith, these also contain Kiparsky's contribution in which he laid down the foundations of **lexical phonology** (Kiparsky 1982a, b). His proposal had two aspects.

First, generalizing an idea of Siegel (1974), he proposed that phonological rules could be grouped into blocks which apply in tandem with, or directly after blocks of morphological rules. Recently this leveling theory has been reformulated in prosodic terms by Inkelas (1989).

The second aspect of Kiparsky's article involved the concept of **underspecification.** Kiparsky proposed that for every feature one value could be designated as unmarked and that this value could be left unspecified. This proposal was baptized **radical underspecification** theory in Archangeli (1984), and has continued to grow since then, culminating in Archangeli & Pulleyblank's (1993) *Grounded Phonology.*

For Place features, the idea has gained popularity that the fact that Coronal is unmarked among the Place features may also be expressed by leaving this feature or node unspecified in underlying representation (see Paradis & Prunet 1991). These issues come up in the contributions of Brown (see above), **Grijzenhout** and **Hall.** Hall shows that, although coronals lack a place specification underlyingly, this must be inserted in the course of the lexical derivation in the case of German.

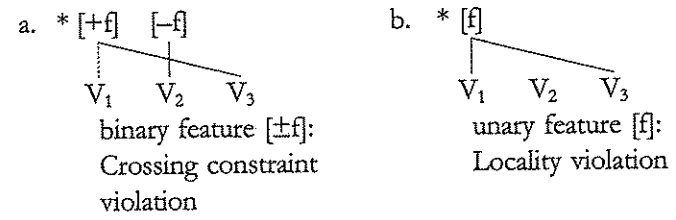
An idea which competes with radical underspecification is that features are single-valued. The difference with Radical Underspecification is, roughly speaking, that the unmarked feature values are deprived of all phonological status. We note that the idea of unary features had been part of Dependency Phonology since this framework was first introduced. While Dependency Phonology advances the strict view that **all** features are unary, several proposals have been made that some features are unary, while others are binary. Goldsmith (1985), for instance, makes such a distinction, which

he refers to as a distinction between privative and equipollent features.

Currently, the idea that all or some features are unary has gained support. For example, in Sagey (1986) the class nodes Coronal, Labial and Dorsal act exactly like single-valued features. Numerous publications have followed this line since then, and have added to the list of features that were proposed to be unary (see den Dikken & van der Hulst 1988 for discussion).

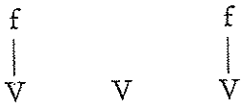
A consequence of replacing binary features by unary features is that the scope of the no-crossing constraint (Goldsmith 1976) is reduced. For instance, in vowel harmony processes the "non-spreading value" of a binary feature can no longer be used as a potential blocker of the spreading feature — as in (7a) below. This implies that a greater role must be attributed to **locality constraints.** The explanation for the fact that the third vowel in the sequence in (7b) does not undergo harmony must then be one involving locality, combined with a constraint that [f] cannot associate to V_2 due to a feature cooccurrence constraint:

(7)



A similar point can be made with regard to the OCP (Leben 1973; McCarthy 1981, 1986). The question arises if (8) is an OCP violation, for instance:

(8)



According to Archangeli & Pulleyblank (1993) the structure in (8) does **not** constitute an OCP violation. Hence, in their framework the OCP also requires to be locally defined with reference to some dominating tier.

2.4. Complex segments

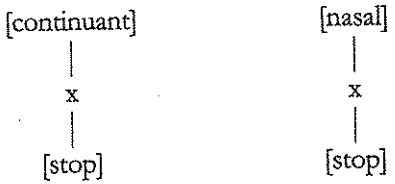
One of the major motives for Autosegmental Phonology was the proper representation of contour tones and complex segment types such as affricates and prenasalized segments. The representation of such segments is still a lively area of research, in which Sagey (1986) is a cornerstone work.

It is interesting to note that the initial motivation that such segments lent to autosegmental phonology has partly disappeared. In early autosegmental phonology, affricates bore two values of a feature like [continuant], which necessitated a notion like "tier" and a notion of many-to-one association of two instances of a single feature to one unit on the I-tier.

With respect to affricates and prenasalised consonants, it has recently been suggested that these are not characterized in terms of two linearly ordered specifications of the same feature, but rather by two independent unary features (as in (9) below). Such a representation of affricates is found in a number of papers on Basque by Hualde (e.g. Hualde 1988), and in Lombardi (1990). A similar approach to prenasalized stops was suggested in van de Weijer (1991).

We note that, to the extent that many-to-one association motivated the design of Autosegmental Phonology, the argument of complex segments disappears.

(9)



affricates prenasalized stops

The representations in (9) are related to another development, namely the one just mentioned, which involves the growing popularity of unary features. Clearly, a theory which only uses unary features will never represent contour segments in terms of linearly ordered feature specifications. However, linear order might be argued to play a role in **contour tones,** that is, a rising or falling tone on a single vowel. Such vowels might be candidates for a two-root representation such as that in (11b) below.

2.5. Conclusions

To conclude the segmental picture, grouping, dependency, unary features and consonant-vowel featural identity represent innovations in Autosegmental Phonology which were introduced after 1982 or around that time. We have seen that all four notions were at least partly available in one generative model, namely that of Dependency Phonology. In 1987, Anderson and Ewen's book on the principles of Dependency Phonology finally brought this model to the attention of a wider audience.

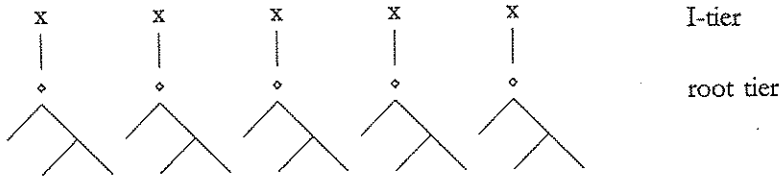
3. Syllabic phonology

Let us now move from the segment to the syllable level, and upwards from there.

3.1. The nature of the I-tier and syllabic organisation

The introduction of feature grouping led to a tier which soon became a competitor of the interface tier, namely the tier which consists of so-called **root nodes.** Both tiers are shown in (10):

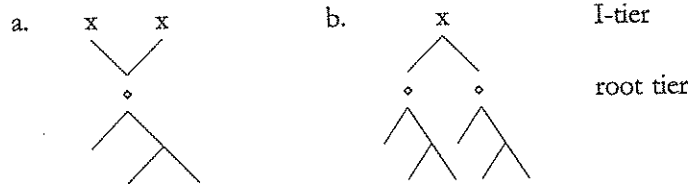
(10)



If the relation between the units on both tiers were always as in (10), namely one-to-one, it would be redundant to have both a skeleton and a root tier.

The basic motivation for making a distinction comes from cases where this relation is not one-to-one, as in the case of length and certain types of complex segments. In (11a) a long segment appears. In (11b) a complex segment is given which consists of one position on the interface tier connected to two root nodes.

(11)



Complex segments which involve two roots are relatively poorly explored. It is unlikely, for instance, that the complex segment types in (9) fall into this category. In van der Hulst & van de Weijer (in progress) we examine this category of complex segments in some detail. If they exist, this helps to motivate the independence of both an I-tier and a root tier.

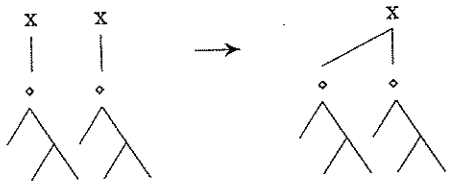
The skeletal tier usually links to a syllabic organization, and syllables are traditionally divided into onset and rhyme.

A development which in 1982 was not yet visible involved the introduction of yet another syllable model, namely the moraic model. This was introduced by Hyman in 1985, on the basis of a 1983 manuscript, and has

been very influential, especially because of its success in dealing with processes of compensatory lengthening, as argued by Hock (1986) and Hayes (1989).

Hyman proposed to regard x-units as moras, to which he referred as **weight units.** The irrelevance of onsets for weight was explained by dissociating onset segments from their x-units in the course of the derivation, as shown in (12).

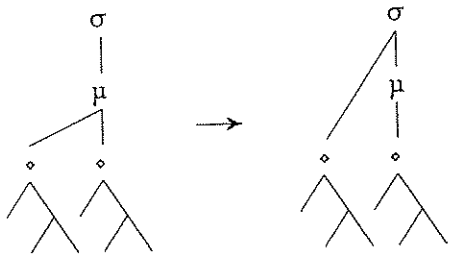
(12)



On this view the skeletal tier changes its function during the course of the derivation. After rules like that in (12) have applied, the I-tier in effect becomes a mora tier.

In later versions of moraic theory, a slightly different conception emerged: mora nodes were assigned by rule to a string of root nodes. In one version (by Hayes 1989), the idea that onset material forms part of the mora that contains the syllable peak is given up. Two rival versions of moraic theory are given in (13).

(13)



There are also versions of moraic theory that impose the moraic organization on the X-tier (cf. van der Hulst 1984 and, with an explicit defence of this, Lahiri & Koreman 1986).

A major difference between Onset-Rhyme theory and moraic theory involves the status, or rather non-status, of onsets in the latter. Another issue concerns the distribution of long segments. In Onset–Rhyme theory a geminate can be part of the onset (unless additional constraints are imposed), but this is impossible in the moraic theory.

A third issue concerns the presence of a nucleus node in the Onset-Rhyme theory. In Onset–Rhyme theories syllables with long vowels are represented as having a branching nucleus, and closed syllables as having a branching rhyme. In a recent elaboration of moraic theory, Hayes (1991) mirrors the nucleus/rhyme division by proposing that there are two mora layers, as shown in (14).

(14)

μ μ	μ	'nuclear moras'
μ μ	μ μ	'rhymal moras'
c v v	c v c	

On the first layer every segment in the "rhyme" is marked as having a mora, but on the second layer only "nuclear moras" are marked. Hence, rules may refer to either the first or the second layer, which therefore reintroduces the possibility of referring to a bipositional rhyme or a bipositional nucleus.

3.2. Government phonology

A new trend in phonology emphasises the claim that syntax and phonology should be approached in the same way.

This approach is pushed furthest in the framework of **Government Phonology,** elaborated by Kaye, Lowenstamm & Vergnaud (1985, 1990). Government Phonology is a very restrictive theory of phonological representations — especially of syllable structure — and an essential role is attributed to a set of principles which define various forms of **government.** In addition, onset as well as rhyme can be at most binary-branching. Another important principle involves the claim that coda consonants must be licensed by a following onset. This, among other things, has the consequence that word-final consonants cannot be codas, but must be onsets of syllables which have an **empty nucleus.**

In this volume, **Piggott** and **van der Hulst & van Engelenhoven** will avail themselves of some of the insights of Government Phonology, both focusing on processes that are crucially related to syllable structure.

4. Metrical phonology

An important paper in the development of metrical phonology between 1982 and 1992 is Prince (1983), which contains three important ideas.

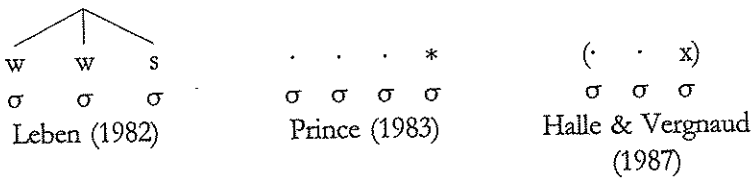
First, a striking innovation was that stress can be assigned without imposing a constituent structure involving feet. Whether feet as constituents

are needed is still a controversial issue, although some evidence seems to point in the direction of constituent structure.

A second very important point was that in Quantity-Sensitive systems all heavy syllables formed complete metrical units by themselves. That is, what Prince called perfect gridding was an rhythmification of light syllables preceding, in between and following the heavies. In other words, the iambic or trochaic units were all essentially Quantity-Insensitive. In our view, Kager (1989) also adopts this approach, although he does use feet as constituents.

A third point, anticipated by Leben in his contribution to the 1982 volumes, suggested that **unbounded** metrical structure need not be strictly binary, a suggestion which has become generally accepted. The historical evolution of unbounded constituents is given in (15).

(15)



Halle & Vergnaud (1987), who otherwise largely keep to the standard theory developed by themselves in 1978 and by Hayes in 1980, propose a notation which seems to compromise between Prince's grid idea and the traditional metrical constituents. In our view, however, it is important to stress that bracketed grids are by and large notational variants of the traditional tree representations. The only case in which this is not true is in recent theories like that of Idsardi (1992) and Halle & Idsardi (1992), in which brackets function like, and can be manipulated like, boundary symbols (see also McCarthy & Prince 1993).

Different proposals have been made with respect to the **foot inventories** over the years, among others by Hayes, McCarthy and Prince. The table in (16) summarizes the foot inventories in the standard theory, the revised standard theory and the Kager/Prince theory (in QI systems all syllables count as light).

It will be clear that the second and third foot inventories are the most restrictive, but unlike the revised standard theory, Kager's model is a parametric one, because the two bisyllabic foot types can be seen as parametric choices with regard to head marking.

(16)

		standard	revized standard	Kager/Prince
		Hayes (1980) Halle & Vergnaud (1987)	Hayes (1991) McCarthy & Prince (1986)	Kager (1989) (Prince 1983)
QS	(x .) h l	Y	N	N
	(. x) l h	Y	Y	N
	(x) h	Y	Y	Y
QI	(x .) l l	Y	Y	Y
	(. x) l l	Y	N	Y
	(x) l	Y	N	N

The complete disallowance of monomoraic feet seems problematic in any uneven sequence with initial and final stress. Consider the form in (17a).

(17) a. (x ·)
ó σ ó

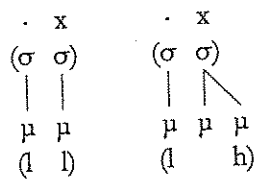
How can the final syllable be a foot if monomoraic feet are disallowed? Catalexis, introduced by Kiparsky (1991), provides an answer, as shown in (17b):

(17) b. (x ·) (x ·)
ó σ ó [σ]

A catalectic syllable is one which does count for stress, but which is not heard. **Kager** (this volume) discusses the consequences of introducing the mechanism of catalexis. Catalexis, by the way, has a predecessor in the concept of **zero syllables** proposed by Giegerich (1985) and in Selkirk's **silent beats** (Selkirk 1984).

Polgárdi (this volume) tries to preserve the restrictive foot inventory of the Kager theory, by arguing that foot-induced iambic lengthening need not be formally represented as mora addition, which, as she points out, would create non-permitted surface feet of the (l h) type, as shown in (18).

(18)



An issue which is gaining more attention involves the relation between main stress and rhythm. In the traditional view rhythm assignment precedes main stress assignment: on this view main stress involves adding more prominence to one of the rhythmic beats. A different view on the relation between main stress and rhythm was developed in van der Hulst (1984, 1991), who argues that in most cases rhythm is a postlexical by-product of main stress assignment (Hayes 1991 refers to this as top-down parsing).

5. Templatic morphology

A major change during the last decade involves the introduction of prosodic templates in morphology, see McCarthy (1979, 1982), for instance. An extensive work in this area is McCarthy & Prince (1990), which develop the case studies first discussed in McCarthy & Prince (1986).

McCarthy & Prince assume a moraic theory of the syllable and therefore can no longer adhere to a skeletal definition of templates. Instead, they define templates in terms of syllabic or moraic structure, or in terms of higher prosodic units.

Van der Hulst and van Engelenhoven propose that in Leti the template essentially consists of a sequence of light syllables [CV....]. Guerssel & Lowenstamm (1993) make a similar proposal for Arabic. The restricted theory of syllable structure in Government Phonology, then, also eliminates the need to express templates as sequences of skeletal positions. If all syllables are CV there is no point in making reference to skeletal positions in the characterization of the template. Moreover, the difference between moraic theory and onset–rhyme theory becomes non-existent, since all CV syllables are "monomoraic".

6. Constraint-based frameworks

In recent years some models of phonology have been developed which refocus attention from **derivation** to **constraints,** whether inviolable or potentially conflicting.

Kisseberth (1970) is an early paper which drew attention to the inadequacy of standard theories to handle "conspiracies", i.e. the syndromes of properties that are caused by the application of diverse, formally unrelated rules. He pointed out that such phenomena are better dealt with by way of general constraints, which need not be stated in the individual rules themselves. This approach has given rise to a number of parallel research programmes, which we will briefly review and place in a historical context. One surface-oriented phonological model is based on the concept of **unification** (Scobbie 1991). In this framework, also referred to as Declarative Phonology, all constraints are surface-true, which at times makes them perhaps overly technical and specific. This idea harks back to the True Generalization Condition of Natural Generative Phonology (for instance Hooper 1976). Other approaches attribute an essential role to constraints and repair rules which apply in order to satisfy these constraints in case violations occur (e.g. Paradis 1988; see also Stewart 1983; Paradis 1993; Paradis & Prunet 1993). Such approaches seem to dissect SPE-style phonological rules into their structural condition (which represents the constraint), and their structural change (which takes the form of the repair rule). Goldsmith (1989) explores such constraint-repair strategies under the heading of **Connectionism.** In **Optimality Theory** (Prince & Smolensky 1993) it is assumed that from an underlying representation a number of candidate representations are generated, which are evaluated by a series of universal, ranked constraints. Differences between languages follow from differences in the way in which the constraints are ranked. Such an approach has a number of precursors, among which are for instance Cairns & Feinstein (1982), who also propose free generation of a number of candidate syllabifications, one of which is elected on the basis of a number of unordered language-specific constraints. In this volume **Dor** explores some long-standing problems in Modern Hebrew phonology in the Optimality framework.

7. The syntax–phonology connection

The last decade shows a large amount of work on how the prosodic hierarchy is related to the morphosyntactic organisation. This is a complex area which, despite fruitful results, suffers from the fact that the investigator must be an expert in two areas, namely syntax and phonology.

An issue which deserves attention is the lexical-postlexical division. A question which has gained increasing attention is at what point prosodic categories are constructed, and precisely which level of syntactic structure

forms the input. Another important question is whether phonological rules must be allowed to refer to both organisations at the same time. One view is that prosodic constituents are created post-lexically, on the basis of a fairly superficial syntactic structure, which however encodes features of the informational structure of the sentence (Gussenhoven 1984). There is, however, an increasing amount of evidence that certain lower level prosodic categories such as syllable and foot must already be built in the lexicon.

Helsloot elaborates on the idea that a distinction must be made between the lower prosodic categories such as syllable, foot, but also including prosodic word and clitic group on the one hand and the higher ones, such as intonational phrase and utterance on the other. She draws attention to the category **phonological phrase,** which, as it were, mediates between these two groups. The area with which she is specifically concerned is metrics, or poetic language, in which area the tools of prosodic phonology can be shown to be just as much rule-governed as normal-language phonological phenomena.

8. Applications to special areas

It is to be expected that after an initial phase during which new theories gain recognition as improvements over their predecessors, a second phase begins during which the new theories are applied to areas for which these theories were not originally designed. In the case of nonlinear phonology such applications can be found in the study of language acquisition, language change and variation, speech pathology, language games, metrics and sign language phonology.

In this volume there are three such contributions, which deal with acquisition, metrics and sign language, respectively. Each of these explores the application of concepts which form part of the current vocabulary to special areas.

Geilmann explores the usefulness of the concept of underspecification when it is applied to the acquisition of phonemic contrasts in German. Acquisition studies have gained enormous ground in the last few years (cf. for instance also Fikkert 1994; Levelt 1994). Helsloot examines the operation of the prosodic hierarchy in Italian poetry.

The application of nonlinear phonology to the study of **sign language** phonology cautiously started around 1982 (Liddell 1982). Sandler's (1987) dissertation is a major contribution in this area. She shows how concepts like feature grouping, spreading and the like, can be fruitfully applied to the study of American Sign Language. In her contribution to the present

volume **Sandler** pushes the similarities between spoken language phonology and sign language phonology further and explores the usefulness of insights from Dependency Phonology to characterise detailed aspects of hand configuration.

9. Laboratory phonology

Non-linear phonology has also led to explorations in two areas of inquiry which are closely linked to research in speech technology, namely phonetics (especially of intonation) and computer implementation. The term "laboratory phonology" is often used in this connection, and three large collections with the same name have come out which are relevant to any phonologist (Kingston & Beckmann 1987; Docherty & Ladd 1992; Keating 1994).

The in itself fruitful interaction between phonetics and phonology has led to the question whether explanations for certain processes should come from the phonology or from the phonetics. The borderline between the two areas becomes increasingly blurred.

Models inspired by computer implementation, apart from being embedded in speech technology research, were also advanced as attempts to formalize nonlinear phonology rigorously (see section 2.1 above). Here we can expect to see positive results of the symbiotic relation between phonology and speech technology.

10. Conclusions

Against the background of a certain consensus concerning the general organisation of phonology and the merits of the autosegmental and metrical frameworks, the eighties showed an enormous research expansion. We can see two directions in which this research has gone.

On the one hand, phonologists have focused on what we would like to call **important matters of detail.** In autosegmental phonology, the introduction of feature grouping should be singled out as a major change, which led to a proliferation of proposals for changes in the universal feature geometry. In syllable theory many different conceptions of syllable-internal structure and the Interface tier emerged, which stimulated the proposal of a new model, namely the moraic one. In metrical phonology, new views on foot typology and, of course, Prince's grid theory, led to a wide variety of metrical models. With respect to the design of the overall machinery of how

phonology works, we note the emergence of several varieties of constraint-based approaches.

On the other hand, phonologists have entered into fruitful lines of **interdisciplinary** research, as well as forays into new areas of exploration such as sign language and first language acquisition. To researchers from other disciplines or from applied areas of linguistics, non-linear phonology apparently had a greater appeal than the SPE-type.

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Resolving Prosodic Mismatch in Modern Hebrew

Outi Bat-El

1. Introduction

Recent studies in prosodic phonology and morphology (McCarthy & Prince 1986, 1990; Itô 1986, 1989; Archangeli 1991; McCarthy 1993, and others) have followed the general trend in contemporary linguistics to abandon arbitrary rules and rule ordering, in favor of a grammar based on principles and parameters. The present paper addresses the role of prosodic principles and parameters in the formation of Modern Hebrew denominatives.

The analysis of Modern Hebrew denominatives presented here differs in some crucial aspects from the view of McCarthy (1981), Bat-El (1986), and Yip (1988) on Semitic verb formation. It relies on the claim made in Bat-El (1989), that Modern Hebrew verb formation is non-templatic in the sense that there is no constant CV template for each verbal derivational category (binyan). It is claimed there that the shape of each verb can be determined by the syllabification rules of the language.

In this paper, while maintaining the view that verbs are derived via syllabification I will also show that the array of consonantal and vocalic positions is determined by the base, where the base is a mixed string of segments, vowels and consonants. The information transferred from the base to the derived form is not just a string of consonants, as believed in earlier studies on Semitic verb formation, and therefore the method of root-to-template association (McCarthy 1981), which, in a derivation from a fully specified base must be preceded by extraction (Bat-El 1986), is found to be wrong.

Verbs in Modern Hebrew are restricted by a bisyllabic template, and syllabification of the base melody may yield the two possible sorts of prosodic mismatch. In some cases there are too many segments to fit into the template, in violation of Prosodic Licensing (Itô 1986). In others, the base does not have enough segments to satisfy the template, in violation of Template Satisfaction (McCarthy & Prince 1990).