Metrical phonology

Harry van der Hulst

1. *Introduction*

This article intends to inform the reader about Metrical Phonology, i.e. the theory about **word level** stress. I will discuss its original motivation and scope, how it extended its empirical domain, which changes it underwent and what the current situation is. Since we deal with a theory that was introduced twenty years ago, it would be easy to write a whole book dealing with these matters. In the few pages that I have here I will therefore have to limit myself to a selection of proposals (and references) that, in my view, are representative of crucial developments in the theory. I will not present a strict historical overview, but rather organize the discussion around various aspects of the theory, such as the central principles and parameters, the notation and the most important developments. For reasons of space I will not discuss the interplay between stress and morphology and refer to Revithiadou (1998). The stress theory discussed in this article, then, is essentially designed for fairly straightforward rhythmic aspects of word stress, applying within a domain that is either morphologically underived, or derived in terms of affixes which create morphological structure that is essentially invisible to the stress rules. Also, I limit my attention to the word domain; as a consequence, I will not deal with prosodic structure at a higher level, nor with the syntax- phonology connection (cf. Selkirk 1982; Nespor & Vogel 1986; Inkelas & Zec 1990), nor with the metrical approach to poetic meter (cf. Hayes 1983; Rice, this volume). I will not discuss the phonetics of stress (or the distinction between stress- and pitch-accent languages), nor the role of stress vis-à-vis intonation (cf. van der Hulst 1999, Dogil & Williams 1999, and Gussenhoven & Bruce

1999). The reader must also be warned for the fact that this overview reveals some of my own special interests. Finally, I will be brief on the Optimality Theory treatment of stress systems, and concentrate on the standard parametric approach. Burzio (this volume) will bring the reader up to date with the OT-way of analyzing stress systems.

2. *The beginning*

Metrical theory was first developed in the MIT dissertation of Mark Liberman (1975). This thesis primarily deals with the intonational system of English, but Liberman included a new proposal for the representation of English word stress in his work. The proposal owes to ideas put forward by Alan Prince in his 1975 MIT dissertation on Tiberian Hebrew and the theory in its initial form is best known from an article that Liberman & Prince published together in 1977 in *Linguistic Inquiry*.

English word stress had already been extensively analyzed in Noam Chomsky and Morris Halle's *The Sound Pattern of English* (1968; henceforth *SPE*). In the approach offered by Liberman & Prince, the *SPE* rules were not abandoned. As before, word stress was assigned to vowels by a modified version of the *SPE* Main Stress Rule and the Compound Stress Rule.

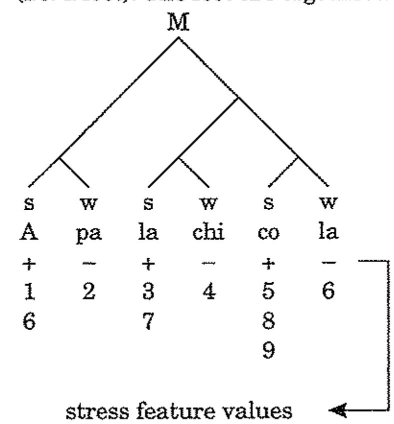
The novelty was that, after stress assignment, the string of segments was now fed into an algorithm that parsed it into a constituent structure. This structure was called "metrical" because of the central role of a unit called **foot**, a term that was borrowed from poetic meter.

Liberman & Prince assumed that segments are organized in syllables; *SPE* had tried to do phonology without syllables, but the reintroduction of this unit in phonology had been argued for by many phonologists, among others Vennemann (1972). Kahn (1976) had proposed a hierarchical representation of syllables and Liberman & Prince adopted this proposal without committing themselves to any particular view on the internal structure of these units.

The metrical algorithm that Liberman & Prince introduced added to the syllabified string a layer of bisyllabic constituents, called feet. The resulting tree structure was augmented with the labels "Strong" and "Weak". The S label was assigned to syllables that contained a stressed vowel:

(1) a. Every sequence of syllables +−, +−− etc. forms a metrical tree (i.e. a foot). The feet are organized into a right branching tree:

b.



In this proposal "being stressed" corresponded to being in the strong part of the foot. As shown in (1), a further layer of structure was added, grouping feet into a constituent labeled M (for **Mot**). This term was chosen to make it clear that the notion of "word" alluded to here was not that of a unit in the morpho-syntactic structure, but rather a "P(honological)-word", a unit that forms part of the metrical (i.e. phonological) constituent structure (Peperkamp 1997).

In (1) we see that in addition to phonological constituent structure, Liberman & Prince introduced a second phonological plane, called the **grid**. The grid represented relative prominence that could be "read off" from the tree according to the algorithm in (2), Liberman & Prince (p. 316):

(2) In any constituent on which the strong-weak relation is defined, the designated terminal element of its stong subconstituent is metrically stronger than the designated terminal element of its weak subconstituent

At this point, the reader undoubtedly notices a certain redundancy in the theory, certainly to the extent that the expression of stress is concerned. In fact, it would appear that stress is expressed three times, i.e. in terms of [±stress], S/W-labeling and Grid columns.

If other phenomena than stress are taken into consideration, it could perhaps be argued that each level exibits independent properties. One could, for example, argue that the [±stress] distribution is the result of a grammaticalized rule that refers to "abstract" levels of representation and is governed by idiosyncratic lexical and morphological information (much as in *SPE*). The S/W labeling could be seen as a projection from segmental structure onto a phonological structure that governs the application of phonological processes such as aspiration and flapping. The grid, finally, could be seen as an independent layer, if it could only partially be projected from the tree, e.g. because there are rules that add "beats" to "improve" the rhythm only with reference to this level. Be this as it may, in the next stage of development metrical theory underwent changes that were motivated by attempts to eliminate this overlap.

Selkirk (1980) proposed to build the *SPE* stress rule into the foot formation algorithm by making the factors that determine the distribution of this feature directly responsible for the distribution of feet. Thus, footing (incl. S/W-labeling) became the way in which stress was assigned, whereas it first was a mere projection from segmental structure.

Kiparsky (1979) showed that the rules that had motivated the grid level (among others the well known Rhythm Rule applying in *THIRteen men*) could also be reformulated with reference to the tree structure alone. His argument was generally accepted and grids disappeared from the scene.

In retrospect, it is perhaps the case that the use of S/W labeling concealed the fact that Liberman & Prince were actually proposing that phonological constituent structure is **headed**. The daughter labeled "S" was really the head of the foot and the foot that was dominated by S nodes alone was the head foot of the P-word. Prominence or stress could simply be regarded as one of the suprasyllabic exponents of headedness. Thus, metrical theory was a first step toward recognizing the central organizing rule of head-dependency relations in phonology. Gradually the S/W notation was replaced by other graphical means to indicate headedness (cf. below).

3. *The great developments*

In 1978 a very important grey paper came into circulation: *Metrical Phonology, A fragment of a draft* by Jean-Roger Vergnaud and Morris Halle. The importance of this paper lies in transforming the Liberman & Prince theory of English stress into a parametric theory of stress systems.

The Liberman & Prince analysis of English involved a particular algorithm for foot and P-word formation, which, as Vergnaud & Halle show, can be seen as just **one** member of a family of algorithms. Other members would involve the same type of foot, but assigned from left to right, or another foot type and so on. Each step in the algorithm was taken to be an "off/on", "left/right" or "yes/no" parameter.

Vergnaud & Halle discovered that the word stress rules of a great variety of languages could be "unraveled" and represented in terms of settings for these parameters. Their proposals were elaborated and richly documented in a 1980 MIT dissertation by Bruce Hayes.

The basic parameters that emerged from these works are given in (3):

(3)	a.	Foot Form	:	left-Strong/right-Strong	left
	b.	Foot Type	:	quantity-sensitive/quantity-insensitive	QS
	c.	Foot Size	:	bounded/unbounded	bounded
	d.	Direction	:	left-to-right/right-to-left	R-to-L
	e.	Extrametr.	:	yes/no	yes
	f.	Edge	:	left/right	right
	g.	Word Form	:	left-Strong/right-Strong	right

The settings indicated in the righthand column characterize (ignoring important details) English word stress.

I will now briefly discuss these parameters by explaining the terminology and looking at some of the theoretical developments that have taken place since the early eighties.

3.1. *Foot form and foot type*

Foot form allows the choice of "trochee" or "iamb". A system is quantity-sensitive if certain syllables (i.e. heavy syllables) cannot appear in the W position of the foot. The distinction between heavy and light syllables may be drawn on slightly different grounds in different languages, but the basic point is that heavy syllables have "something extra" in their rhyme when compared to light syllables. The "something extra" could be vowel length, syllable closure, a high tone and so on. For the purpose of foot theory it does not matter how many ways there are to bifurcate the class of syllables in light and heavy syllables, nor how the distinction is precisely represented.

The term "mora" will be used here to refer to the units in the syllable that contribute to weight (cf. Hyman 1984; Hayes 1989). By definition, light syllables have one such unit, whereas heavy syllables have no more than two; thus h = ll. What is called Moraic Phonology represents a particular view on the internal organization of syllables (contrasting with the traditional so-called onset — rhyme theory), but for our purposes we do not have to enter into this debate. Hayes (1995) utilizes the term "prominence" for instances of weight which involve some specific property (like tone or high sonority) rather than quantity and syllable closure.

In a quantity sensitive (QS) language, then, strings of syllables making up words are typically not parsed in a nice two-by-two fashion. Heavy syllables must be heads. In (4) I give a string of seven syllables forming a word. In (4a) this string is parsed in QS mode, while (4b) shows the typical pattern of QI (quantity insensitive) parsing.

(4) a. R-to-L QS trochaic parsing

```
 | | /\ /\ |
[ l h h l l l h ]
```

b. R-to-L QI trochaic parsing

```
 | /\ /\ /\
[ l h h l l l h ]
```

Strictly speaking it makes no sense to classify syllables into light and heavy if the language is QI. Still, it is useful to realize that a QI language may have distinctions among its syllables that are the same as those of a QS language. Kager (1992) suggests that QI languages that contain differences in syllable shapes that in other language determine weight, often have more subtle weight effects.

In accordance with the parameters foot form and foot type we could have four foot types. Hayes (1980) provides examples for all of them in both directions of footing, thus revealing eight types of languages. Subsequent research has revealed, however, that not all types are widely attested. Hayes (1985, 1995) reported that systems making use of the feet in (5) are suspiciously rare, or, worse, produce unattested patterns under certain circumstances (i.e. in interaction with other parameter settings):

(5) RARE FEET (IN EITHER DIRECTION)
a. QI iamb
b. QS trochee

Hayes therefore proposes to eliminate the QI iamb and to replace the QS trochee by a so-called **moraic trochee**. A moraic trochee is a left-headed foot type that maximally contains two light (i.e. monomoraic) syllables or one heavy (i.e. bimoraic) syllable. McCarthy & Prince (1986) proposed a similar foot theory.

The cases that were represented in earlier works with QI iambs and QS trochee were now in need of an alternative analysis. By allowing certain manipulations at the edges of stress domains (like excluding syllables from the parse by extrametricality) or postulating empty syllables (catalexis), such alternative could usually be found.

The possibility of making these reanalyses showed that the standard theory was overly rich anyway. The reanalyses of course had to express the same prominence patterns but usually led to different constituent structures when compared to the original analyses. Even though details of foot structure may in principle play a role in the application of segmental phonological rules, such evidence requires access to details of the phonology that were often not studied or reported in grammars or phonological sketches.

The next step was taken by Kager (1989, 1993) who extended the bimoraic upper bound of moraic trochees in two ways. Firstly, he proposed that QS iambic systems do not require (l h) feet. He suggested reanalyses for the few cases that were originally analyzed with such feet. Secondly, Kager suggested that the bimoraic requirement was also the **lower bound**, which implies that so- called monomoraic (also "unary" or "degenerate") feet were banned. Hayes (to appear) accepts Kager ban on monomoraic feet with certain qualifications which I will not discuss here.

Van de Vijver (1997) and van der Hulst (to appear) question the existence of iambic feet in more radical terms, both arguing for different ways of dealing with "iambic" systems.

Both the ban on (hl)/(lh) feet (often called "unbalanced feet") and degenerate feet results in leaving left-over light syllables **unparsed**. Mester (1994) refers to these as "trapped" syllables and shows that diachronic changes and synchronic alternations can sometimes be understood as strategies to avoid trapped syllables. Unparsed syllables raise a problem since it is unclear whether and, if so how, such syllables are incorporated into the prosodic structure. If they get incorporated directly into higher levels, another problem arises, because in all other respects it has been assumed that prosodic structure is strictly layered, i.e. that all units at each level get incorporated into units of the next higher level. cf. Nespor & Vogel (1986) and Itô & Mester (1992) for a discussion of this issue that is essentially unresolved to date.

An interesting consequence of banning unary feet is that so-called minimal word effects find a principled explanation. This effect involves the absence of monosyllabic (QI) or monomoraic (QS) content words. (Minor, closed class words, including phonological clitics are usually allowed to be undersized.) If feet must be binary, words must be minimally bisyllabic. Cf. Itô & Mester (1992), Kager (1995) and Dresher & van der Hulst (1995) for examples and discussion.

Before turning to the parameter foot size, which introduces a distinction between the **bounded** feet that we have discussed so far and so called **unbounded** feet, I will briefly discuss the need for feet that are bigger than two moras (QS) or two syllables (QI) but which are nonetheless bounded.

It would seem that the feet we have discussed so far are incapable of generating **ternary** rhythmic patterns. In the early metrical literature the occurrence of such patterns was regarded as marginal, but more recently it has become more widely recognized that in some systems feet heads are separated by two stressless syllables rather than one.

Hayes (1995) argues that ternary patterns can be produced with binary feet if the footing algorithm skips a syllable each time a foot has been assigned. Another, perhaps more interesting proposal can be found in

Dresher & Lahiri (1991) and Rice (1992). In these works a parameter is added to the system which may require that foot heads are branching. Thus, if heads must branch, feet will contain three syllables if the system is QI and three moras if the system is QS. This proposal is more principled since it is quite common to find that the head — dependent asymmetry is expressed in terms of a greater (allowed or required) complexity for heads.

3.2. *Foot size*

In systems that make use of the foot types discussed so far, primary stress cannot be further away from the edge than three syllables (QI), or three moras (QS). The maximal distance can be reached by applying binary feet **and** extrametricality, or by applying ternary feet.

Unbounded feet were considered necessary for systems in which primary stress can be located further away from the edge, in fact, anywhere in the word. Rather than going into the details of how unbounded feet were applied, I refer to the view set out in Prince (1985), who proposed to abandon the unbounded feet of the standard theory and derive unbounded systems with binary feet which target heavy syllables only, leaving all light syllables unparsed. This proposal, however, naturally leads to the conclusion that unbounded systems are more properly characterized by assuming that in these cases primary stress assignment is not dependent on foot structure at all. This view is partly present in Hayes' (1995) account of unbounded systems and more fully developed in van der Hulst (1996, 1997, 1999).

In such cases, then, primary stress is assigned to edges (if the system is QI) or to the left- or rightmost heavy syllable if the system is QS. A typical example of the latter type are given in (6):

(6) Stress falls on the rightmost heavy syllable and, if there is no heavy syllable on the leftmost syllable (e.g. Classical Arabic)

The "default" edge case can be identical or opposite to that of the edge where the primary-stress heavy syllable is located.

Next to weight-based unbounded systems, we also find **lexical accent**-based systems. In such systems morphemes contain accented syllables (or are accentless). The location of these syllables must be lexically marked. But once morphemes are strung together, primary accent is located by rules relating to the left-rightmost accent or, as argued in Revithiadou (1998), to morphological head-dependent relations.

A consequence of representing unbounded systems without foot structure (whether bounded or unbounded) is that this necessitates an independent status for a grid representation:

(7)

(	l	l	h	l	h	l	l	l)	
	x	x	x	x	x	x	x	x	level 0 stress bearers
			x		x				level 1 heavy syllables
					x				level 2 primary stress

(7) represents a "last heavy" case. The projection of (heavy) syllables onto the grid is perhaps redundant. The rule that assigns primary stress, then, is not an instruction to build a particular kind of word tree, but rather a pure grid-based rule. Following a practice stemming from Prince (1983) (cf. below) we refer to this rule as the End Rule.

3.3. *Direction and word form*

To establish direction of footing we need to assign stress in words with an odd number of syllables. In that case a two-by-two count will leave one syllable in the cold, located at the edge that is opposite to where the parsing began.

If we cross-classify direction with the word tree parameter, we arrive at four possible cases:

(8)

Word \ Dir	L-to-R	R-to-L
Left-headed		x
Right-headed	x	

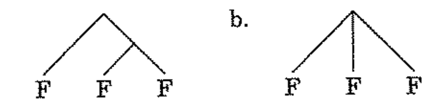
The options not marked with "x" are the most frequent. In those cases, primary stress is located on the edge were parsing started. Thus, except when a peripheral non-branching foot is ignored (cf. below), primary stress falls on the first foot that is assigned. Van der Hulst (1984, 1996) has argued that in this type of case it is perhaps not insignificant that it is not necessary to exhaustively parse the whole word into feet in order to find the location of primary stress. He proposed that those parts of the metrical structure that express secondary stress could just as well be done at a later stage of the derivation. This "primary-stress- first" approach has a number of advantages, as has also been argued in works such as Harms (1981), Roca (1986) and Hurch (1992). The most interesting variety of this theory is one in which secondary stresses are assigned post-lexically.

This "reverse order" of footing and primary stress assignment is impossible in the cases in (8) that are marked with "x". In such systems, called *count systems* in van der Hulst (1996), the location of primary stress is crucially dependent on a complete count of all syllables. Consider an example in (9):

(9) Stress fall on the first syllable if the number of syllables in the word is even, and on the second syllable otherwise (e.g. MalakMalak, discussed in Goldsmith 1990, pp. 173–177)

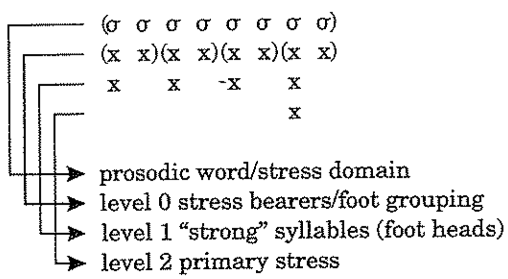
Such count systems are reconciled with the primary-accent first approach in van der Hulst (1997). In the Liberman & Prince theory the word form was represented in terms of a binary branching structure which implies that a word that has more than two feet contains a number of inclusive domains (cf. 10a), but since evidence for such nesting was never produced it became common to represent the prosodic word as "flat" (10b):

(10) a. b.



A consequence of a flat representation is that primary accent location in foot-based systems can be handled by the End Rule. This is the case because the prosodic word domain is pre-given, that is, it exists prior to or independent of foot construction.

(11)



The grid-like notation adopted in (11) is a variant of the so called bracketed grid notation that we discuss in Section 4.2.

3.4. *Extrametricality*

In some systems apparent ternary feet arise only at edges or when there is evidence that peripheral syllables refuse to bear primary stress. For such cases it has been argued (already in Liberman & Prince), that peripheral syllables can be excluded from the foot parse.

A familiar example is Classical Latin, which has a QS foot, which flatly ignores the rightmost syllable. Thus stress is placed on the penultimate syllable if this is heavy and on the antepenultimate syllable in all other cases.

The idea has been around that extrametricality is limited to the right edge, but this is not true. An example demonstrating left-edge extrametricality is discussed in Hualde (1999). This implies that we need an Edge parameter that is dependent on the Extrametricality parameter.

We also need another parameter that is only relevant if extrametricality applies. In most cases, we make syllables extrametrical, but it also appears necessary to sometimes just mark a peripheral segment as invisible, which is sometimes limited to either a vowel or a consonant.

Inkelas (1989) views extrametricality as one instance of a mismatch between prosodic and morpho-syntactic structure. Today, one would say that there is a "misalignment" between both dimensions (cf. Section 5).

In Section 3.1 I referred to **catalexis**, another kind of misalignment. In this case, however, the prosodic structure partly hangs over the morpho-syntactic word edge, with half of the peripheral foot hanging in the air. The mechanism has been proposed in Kiparsky (1991), but has precedents in Giegerich (1985). Cf. Kager (1995) for a discussion and further application.

A special form of extrametricality applies to feet. This is called **late extrametricality** in Zonneveld & Trommelen (1999). The typical case here is that a final **non-branching** foot is declared not to carry primary stress. Such cases arise in QS systems since otherwise the final syllable would not form a foot by itself. A case in point is Dutch, which has regular antepenultimate stress if the final syllable is heavy (van der Hulst 1984). In binary word tree approaches these cases were handled with a special way of S/W labeling, called the LCPR; cf. Hayes (1980) for further details.

Hayes (1995) proposes to apply general foot extrametricality in certain cases, but these also seem to be analyzable in terms of (early) syllable extrametricality (cf. Jacobs 1990).

3.5. *Exceptions*

A well-known division among stress systems is that between fixed and free stress. Fixed stress refers to complete predictability on the basis of phonological factors, such as word edge and syllable weight. Systems falling into this category usually have exceptions resulting from loans. These must be somehow marked in the lexicon, but limited marking does not affect the predicate "fixed".

Free systems are those in which morphemes contain one (or zero) lexically marked (i.e. "accented") syllables. These are the lexical accent systems discussed in Section 3.2. The location of these lexical accents is as unpredictable as the distribution of heavy syllables (from which these marks often are a historical reflection), but once the morphemes are strung together to form a word, rules takes over.

It has also often been said that languages like English have a free stress system, but that is really another kind of case. English stress is foot-based, but foot formation is dependent on lexical idiosyncracies, morphological structure and word class. Hence the system is a grammaticalized version of the fixed type.

Marking exceptions in foot-based systems is not an easy matter, since only exceptions of a certain type are possible. In bound systems exceptions do not violate the "three-syllable window". Various trends in exception marking have been proposed, the most popular being that lexical representations are provided with bits and pieces of the ingredients out of which metrical representations are constructed. So we find premarked "heads", pre-marked feet, pre-marked foot-boundaries and pre-marked extrametricality or catalexis.

4. *Other (sometimes parallel) developments*

4.1. *Grid-only theory*

In Section 2.2 we noted that the original Liberman & Prince theory contained built-in redundancies. The major trend was to eliminate the grid, but Prince (1983) explores the other logical possibility, arguing that the independent evidence for foot structure is rather limited.

Thus he translated footing into "perfect gridding" and word tree construction into "end rules". The latter proposal implied a "flat" view on the prosodic word organization. By allowing that Perfect Gridding could be specified as "peak first" or "trough first", Prince could mimick the effect of trochaic or iambic parsing. QS systems were represented by projecting heavy syllables on the grid and letting Perfect Gridding apply to stretches of light syllables. This approach, in fact, is comparable to the (later developed) bimoraic footing idea (cf. Section 3.1), since it suggests that heavy syllables are "metrical islands", placed outside the algorithm that distributes rhythm to light syllables.

Prince's article renewed the interest in evidence for foot constituency. Halle & Vergnaud (1987) provided examples of stress shifts, the direction of which could only be understood if foot boundaries are part of the metrical structure (cf. Dresher 1990 for a critical note and Kenstowicz 1991 for further support).

Prince (1983) is an important and influential article even though foot boundaries were restored. This influence was partly notational (cf. Section 4.2), partly terminological ("End Rule") and partly substantial (the "island" treatment of heavy syllables, the flat word structure).

4.2. *Bracketed grid theory*

Even though Halle & Vergnaud (1987) pleaded for the return of foot boundaries, they were so charmed by the return of the grid suggested in Prince (1983), that they decided to **add** the foot brackets to the grid, rather than returning to the graphical shape of trees:

```
(12)               x
         (x    x    x  )
         (x  x)(x  x)(x  x)
          Apa  lachi  cola
```

In my view, representations like (12) are fully equivalent to trees, but they have the definite advantage of being easier to handle on a word processor. Next to (12), tree notations that were and are in use replace the use of S/W labels by graphically marking heads with a "dot" or "small circle". Hammond (1984) proposed this notation and termed it "lollipop-notation". Usually heads are also dominated by a vertical line. A similar notation is proposed in Dependency Phonology (Anderson & Ewen 1987).

On the substantial side, Halle & Vergnaud (1987) essentially argue for the standard foot typology, i.e. they do not follow the lines leading to bimoraic accounts of QS systems that we discussed in Section 3.1.

4.3. *Bracket-first theory*

Halle & Idsardi (1994) and Idsardi (1992) propose a new algorithm for constructing bracketed grids. The basic idea is that the algorithm starts out placing left- or right brackets in the string. Further steps fill in the pairing of brackets and heads.

I am inclined to be sceptical about this approach since the manipulation of brackets seems to imply a conception of phonology that is preoccupied with the notational system and not so much with its "semantics", i.e. the content of the theory.

Still (but this may very well be a coincidental effect), it could be argued that the bracket-first approach has a unifying effect on marking exceptions since it reduces marking extrametricality and foot structure to the same device, viz. inserting a bracket.

On the other hand, an apparent disadvantage of the approach is that it capitalizes on a procedural aspect of phonology, i.e. constructing representations. In the next section, we will see that certain current trends in phonology are based on the idea that the only thing that matters is stating what a well formed representation looks like, it being irrelevant "where the representation comes from" or how it was constructed (and by whom).

5. *Optimality theory*

Optimality theory (Prince & Smolensky 1993, McCarthy & Prince 1993a, b) is not about phonology per se. It is a new conception of how grammar works. Most of its applications so far are in phonology, but OT work in syntax is also available. A fair discussion of this approach deserves a separate contribution, so I will limit myself to a few illustrations.

The central idea is that the grammar consists of a (universal) list of constraints. This list is ordered, partly universally and partly language-specifically. The last fact forms the basis for variation among languages.

Constraints state what the output of grammar must look like, but because they are ordered and potentially conflicting, outputs need not conform to all constraints. On the basis of the ranked list of constraints, the grammar selects optimal forms from a pool of candidates which are freely generated on the basis of the input or lexical forms. Free generation involves providing input forms with all conceivable syllabifications, metrifications and other matters that need not concern us here. The optimal output is the one of which the first violation concerns a constraint that is lower than constraints that are violated by every other candidate (ignoring constraints that are violated by all candidates). The following example may illustrate this.

There is a constraint which states that heavy syllables must be heads. We will call it **weight**. If this constraint was universally top-ranked, all languages would be QS. Since this is not the case, there must be another constraint with which Weight potentially conflicts. If this constraint outranks Weight, the language is QI. What could this constraint be? Recall that in QS languages heavy syllables "disturb" a nice two-by-two parsing, leading to stress on adjacent syllables. Let us therefore assume that there is a constraint that militates against such clashes.

By ordering Weight and NoClash in two ways we now produce two types of languages:

(13) a. QI NoClash » Weight
b. QS Weight » NoClash

It will be clear that a parametric system can easily be translated into a constraint-based system if we declare both settings to be separate constraints.

In this respect the example in (13) is more interesting since it might be

argued that the two constraints are not exactly opposite, but rather independent and overlapping.

Even typical procedural parameters like "direction of footing" can be accomodated in a constraint-based approach. The relevant constraint type states that feet must be on the left or right edge of the word. Clearly, if the complete word must be footed, only strictly peripheral feet succeed in not violating the constraint, but on the assumption that violation is minimal, (14a) does better than (14b):

(14) Foot-alignment: feet must be on the left edge
a. (σ σ)(σ σ)(σ σ) σ
b. σ (σ σ)(σ σ)(σ σ)

To describe a left-directional language, Foot-Alignment (left) must dominate Foot-Alignment (right).

Another application of OT involves extrametricality (which OT proponents now limit to the right edge, but that is an independent issue). It is well-known that extrametricality is suppressed if the word would become to small to foot. Thus, we may see this as a case in which extrametricality (as a constraint) is outranked by a constraint that requires (content) words to have a foot. This idea of overruling extrametricality by "something higher" was already implicit in the parametric approach and since the ranking in this case is taken to be universal it does not support the specific conception of language-specific ranking that is the hallmark of OT.

OT applications to stress can be found in Hewitt (1992), Hung (1993), Kager (1994), Kenstowicz (1995) and McCarthy & Prince (1994), van de Vijver (1997), Revithiadou (1998), Elenbaas (1999). Burzio (1994) proposes a constraint-based theory that shares important features with OT such as violability and ranking of constraints; cf. also Burzio (this volume).

One point that must be borne in mind is that OT does not solve and is not intended to solve, issues of representations. For example, when one wants to provide an OT analysis of ternary patterns, one must first decide on what type of foot is needed to represent such systems. Then, constraints can be formulated which pick out the appropriate representations from the candidate outputs.

OT is an important development in the field in proposing solutions to old problems in a strikingly simple way. The idea to reflect the "competing forces" that operate on language directly in the design of the grammar is appealing. OT is also incredibly popular and some of the factors that determine its spread would be interesting to study in the context of a treatise about "fashion" in science. At present, the theory is in the expanding phase. Every new analysis adds new constraints to the universal inventory, with a concomitant loss of explanatory power. Deviating surface patterns are too easily declared to adhere to a novel constraint. This leads to situations in which the very thing one wants explained is presented as an explanantion itself.

6. *Summary*

In this overview I discussed several aspects of metrical theory, focusing on **representational** issues. I ignored **derivational** matters, i.e. the mapping of one level to the next. For instance, we did not consider the interaction between stress and level-ordered morphology.

Our discussion of representational issues dealt with **constructional** and **notational** points, which must be separated. Constructional issues are dependent on a procedural view on grammar and such a view is not the only and perhaps not the preferred one. Notational issues, which unfortunately most easily catch the eye of the casual observer, are in themselves irrelevant, although it stands to reason that one adopts notations that are user-friendly. What matters most is being explicit on what the notation is meant to express, i.e. the theory that one proposes of how phonological representations are organized, what the primes are and how these form well formed constellations.

Starting with Vergnaud & Halle (1978), metrical phonology has been concerned with a broad range of languages, sometimes perhaps languages of which too little is known. This is partly due to the fact that grammar sections on stress often contain only the traditional holistic statements and no systematic stress markings, and partly to the "typological" flavor that many metrical studies on stress have. Despite this drawback, metrical theory has made enormous advances since its inception and I regard the issues discussed in Section 3 as representative of the refined theoretical debates that take place.

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