What does Phonology tell us about Stress and Rhythm?
Some Reflections on the Phonology of Stress

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ABSTRACT

In both non-linear and non-derivational phonology, stress plays a central role in the general architecture of the theoretical model. However, while word stress is normally considered, little, if any, attention is devoted to phrasal stress as well as to linguistic rhythm. The phonological study of stress is based on an abstract and ideal view of language, which is far away from the effective production and perception of speech. We devote a special attention to the notion of foot, as dealt with in phonology as well as in phonetics, trying to show the differences and the similarities between the metrical foot and the rhythmical foot. The inadequacy of some theoretical assumptions of metrical phonology and OT is discussed.

1. INTRODUCTION

A glance at the most important journals of phonetics in the past fifty years will show that stress has traditionally been a research topic in phonetics. It is, however, also an important notion in phonological theory and its position in the centre stage of research has grown as scholars have come to consider the prosodic aspects of language increasingly important. In fact, the importance of stress can easily be dated in phonology, since it is clearly related to the arrival and diffusion of the non-linear frameworks in generative theory. Although the study of stress has been pursued from the beginning of generative theory, the attention devoted to stress achieved its climax in non-derivational phonology, not only in *Metrical Phonology* (see §§ 2-5), but also in *Optimality Theory* (see § 6).

The reader may well ask why we have decided to present a brief evaluation of recent phonological proposals about stress in a symposium which is held in a congress, or, to be more precise, in THE congress of phonetics. This endeavour should not be perceived as a provocation, but rather as an invitation to reduce the still quite profound gap that exists between phoneticians and phonologists. In this congress other scholars discuss the crucial aspects of stress and rhythm from a phonetic point of view with special reference to new empirical data; we, instead, would like, more modestly, to present a critical sketch of the basic notions and procedures employed in recent theoretical phonology in an attempt to give some suggestions for future experimental research. We are perfectly aware of the fundamental difference existing between phonetics and phonology, but, at the same time, we believe that the two subjects are closely related, so that just as phonetic analysis should be guided by phonological hypotheses, phonological analysis should be grounded on phonetic results.

Our comments will basically refer to stress. Before starting, however, let us consider how stress analysis was presented at the dawn of generative phonology, where stressed and unstressed syllables within an English word were almost completely predicted by simple formal rules in *SPE*. Here the notion of stress was not only strictly interwoven with the notion of rule (see [1]), but stress was also considered as a distinctive feature, i.e. as a property of a segment, which could be marked as [+stressed] or [-stressed], just like [+coronal] or [-coronal]. Nowadays we know that stress should not be dealt with as a segmental feature, since its scope is wider than the single segment and, in fact, the focus on prosody in phonology kept pace with the discovery of the syllable and with the way in which stress, like tone and rhythm, is manifested in and associated with the syllabic unit. Indeed it is not gratuitous that prosodic phenomena were already known in the traditional literature of linguistics as 'suprasegmentals'.

The scope of the phonological analysis of stress is normally limited to the word. This means that only lexical stress is investigated and although speakers do not speak word by word but in phonetic chains, there is no room for higher and wider domains. Scarse, if any, consideration of phrasal stress (or rhythmic structure) is shown in the work produced within the generative framework. In texts considered the milestones of metrical theory, almost all the analyses concern word accent. For instance, the fourth chapter of Goldsmith's *Introduction* [2] is totally devoted to metrical structure, but does not contain any reference to or comments on phrase accent and rhythm; the *Handbook of Phonological Theory* [3] contains two papers on stress, but none on rhythm; the same picture can be found in the *Reading* edited by the same author some years later (cf. [4]), as well as in the broad handbook written by Kenstowicz [5].

2. METRICAL THEORY

The derivational structure of the standard generative phonology was, as is well known, challenged from the middle of the Seventies when some Ph.D. Theses discussed at M.I.T. critized the basic assumptions behind

SPE, thereby opening up the way to the non-linear season in phonology. However, although non-linear models of phonological representations developed as a result of the banning of the strict linearity pursued in *SPE*, it is worth noting that they should be viewed as a continuation of the previous model, for, as Goldsmith ([2], p. 2) writes, "the original justifications for the theoretical changes in the model of phonology that led to autosegmental phonology and metrical phonology were based on arguments that made, and still make, perfect sense within the very theoretical heart of generative phonology".

Subsequent to Goldsmith [2], the basic goals of phonological theory within the autosegmental framework can be summarized as follows:
- to formulate general phonological principles which can be applied to a wide range of natural languages;
- to find connections to other fields of linguistics, and especially theories of speech production and perception;
- to better understand the historical development of language.

The second goal is relevant to our case since we need to ask: a) whether this goal has been achieved, and, in particular, whether metrical theory has taken into account the experimental research which has been done in the last twenty years in the domain of phonetics; b) whether recent studies carried out by phoneticians have considered the hypotheses proposed within theoretical phonology.

The answer to both the pending questions will probably be negative: phonetics and phonology proceed on parallel paths but their destiny seems to be to never meet. We know that the phonological point of view is, by definition, abstract and so is not much concerned with the physical correspondence of stress contrast. However, once again, we would like to state the need for a suitable exchange of proposals and results between phonetics and phonology, since both disciplines could profit from a reciprocal dialogue.

3. METRICAL AND RHYTHMICAL FOOT

Metrical theory is one of the modules that developed within non-linear generative phonology in the last quarter of last century. The first developments go back to Liberman [6] and Liberman and Prince [7], when the theoretical notion of metrical foot was proposed. During the Eighties new developments closely related to the metrical grid and to a parametric account of accent systems appeared (see [8], [9], [10]).

In phonology, foot is a term which has two basic sources, poetry and phonetics. As far as poetry is concerned, the term is classical, going back to the classical poetry of Ancient Greek and Latin, where the contrast between long (heavy) and short (light) syllables plays a central role. An interesting correspondence between the metrical organization of verse lines and the stress patterns of words in natural languages can be noticed: the most salient element in both structures is located at the end or close to

the end of the domain, i.e. verse line on the one hand, word on the other. The metrical organization of verse lines shows an ordered alternation of more salient syllables with less salient ones and the grouping of one more salient syllable with one or more less salient syllables forms a foot. Since the periphericity (or near-periphericity) and the alternating pattern are properties common to both poetry and stress systems, the basic notion of verse organization, the foot, was proposed in the analysis of accentual patterns too. However, unlike the poetry of Classical languages, which were mora-timed languages, the modern notion of foot centers around the contrast between stressed and unstressed syllables, both in poetry and in the metrical account of stress.

As far as phonetics is concerned, *foot* was a traditional term in the area of research called 'timing'. In this context, foot is the core unit of the so-called stress-timed languages, and refers to the rhythmical structure which is made up of a stressed syllable and the unstressed ones which follow until the next stressed syllable. Metrical theory retains this central idea of foot, since *Initial Head* is normally assumed not only for stressed-timed languages such as English or German, but also for syllable-timed languages such as Spanish or Italian. This setting of the *Head* parameter means that the strong syllable always occupies the initial position in a foot, while the weak syllables will follow. However, the scope of the two notions is different. It is narrow for the metrical foot and wide for the rhythmical one. As a matter of fact, there is no limit to the number of unstressed syllables in a phonetic foot, while only one weak, i.e. unstressed, syllable can follow the strong one in the metrical foot, thereby giving rise to a binary structure. This is the first mismatch between phonological theory and phonetic analysis, since there can be no doubt that long sequences of unstressed syllables may occur in speech.

4. THE BINARITY CONSTRAINT

Metrical theory obeys the binarity constraint of generative grammar which holds to all the modules proposed within non-linear phonology. In the case of a long sequence of unstressed syllables, the theory predicts that the *Alternation Principle* assigns rhythmical prominence every two syllables, starting from the most prominent syllable, identified as the one receiving the label *Strong* throughout the metrical tree. The reasons for adopting binarity are basically empirical and are based on typological and acquisitional data; for instance, we know that the trochaic rhythm normally emerges in children before the dactylic one. Moreover, binary metrical trees perfectly match the syntactic structure, where branching from only one to two nodes is allowed. This means that the relationship between phonological structure and syntactic structure is conceived and drawn up as strongly symmetrical. All systems are assumed as alternating, even if the postulated binary constituents do not find any empirical correspondence in some natural languages. As Laks [11] correctly points out, why should we save a

series of secondary accents in any language, at any cost, when they have no translation in the surface?

In my opinion, to impose a binary structure on all metrical feet and on all languages is a very strong limitation which does not find any correspondence within the realm of phonetics. Consider for instance a word like *príncipe* in English or *lámpada* ('lamp') in Italian. The most natural way to represent these phonetic strings in both languages seems to me to be a dactylic structure, with an initial head and two following complement syllables. Standard theory, however, by assuming the binary trochee as default and the final syllable as extrametrical, i.e. invisible to the metrical parsing (cf. [5]. p. 56), did not allow ternary feet for a long time, even though some scholars had already argued that the universal foot inventory should incorporate ternary feet (e.g. [9]). Only a few years ago was the binarity constraint relaxed and then the dactylic foot was able to enter the foot inventory.

The different foot width reflects two basically different assumptions. On the one hand, the metrical foot is an element of *Universal Grammar*; as such, minimal variation is allowed, while general principles such as binarity are taken for granted. On the other hand, the rhythmical foot is a notion that has developed within the prosody and poetry of Germanic languages, and especially of English, and so is dependent on stress timing. In both cases, the application of this notion to the prosody of syllable-timed languages such as Italian or other Romance languages does not seem to be a profitable perspective, particularly if stress is contrastive (see further on).

5.   FINAL AND LEXICAL STRESS

Another critical pattern for metrical theory has been the representation of words with a final stress; for instance, *tatoo* in English, *città* ('town') in Italian. Since the binary trochee is assumed as default in both languages, the two syllables of the word cannot belong to the same foot, but need to be considered as daughters of non-branching nodes. In this case, the foot is considered *degenerate*, that is, faulty or defective, since it consists of only one syllable (cf. [2], [5]); in other words, the head is present, but its complement is missing. Despite the difficulties relative to the representation of words with final stress in languages that are considered left-headed and bounded, generative theory has tried to explain them with reference to the *Exhaustivity Principle*, which requires all syllables to be parsed at the metrical tier (see [10], p. 86 for a 'soft' presentation of this constraint).

In our opinion, there is nothing particularly 'wrong' or 'faulty' with the rhythmical structure of words with final stress in English or in Italian, as is clearly shown by the fact that speakers normally use these words without applying any repair strategy in order to restore a trochaic pattern. In fact, if we do not group the two syllables of the word together in the same foot, we go against naturalness and the intuitions of speakers.

Once again, given that the theory hinges upon the general principle of *Uniformity*, where an algorithm for the assignment of stress is at work in any language, a metrical structure aiming at representing the output in terms of phonetic constituents is assigned a low, if any, phonological value. However, the *Uniformity* principle cannot account for the stress patterns in languages with lexical stress. This is exactly the case for Italian or Spanish. In these languages, stress cannot be predicted on the ground of simple rules, so no algorithm will be able to capture the overall accentual phenomenology, unless some specific constraints and *ad hoc* devices are postulated, with the undesirable outcome of lowering the power of the prosodic algorithm itself.

The above empirical problems deriving from the application of metrical theory are not the only ones. We could also raise the question of whether lexical accent languages can be dealt with in a theory that assumes only left-headed, bounded, binary feet. On the ground of what we have seen, the answer should be negative, since it seems that for these systems we simply need the lexical marking of stress. However, we do still believe that both bounded and unbounded systems share some general properties relating to general, probably universal, constraints holding in prosodic structure. Moreover, we still recognize the relevance of metrical analysis in so far as it is an analysis which groups syllables and assigns their relative prominence.

5.   OPTIMALITY THEORY

One of the most important changes in metrical phonology with respect to the previous framework has probably been the use of constraints instead of rules. The phonological lexicon no longer rotates around the idea of rule, but around one of constraint. The metrical account of stress has abandoned linearity, cyclicity and features, in favour of a conception of stress as an epiphenomenon, i.e., the phonetic manifestation of a hierarchical underlying organization of the sound chain. The metrical tree and the grid are the formal instruments for the assignment and representation of rhythmic structure.

Optimality Theory (henceforth OT) pursues the same road, with two important differences: first, the constraints are now assumed as crucially violable, although violation is minimal; second, the constraints can conflict with each other, and, therefore, the phonological system is assumed to be intrinsically dynamic. The matching between input and output is achieved *via* GEN and EVAL. The GEN(erate) component, with reference to a given input, produces many candidates, which compete with each other, while the EVAL(uate) component evaluates the candidates with reference to an ordered set of constraints belonging to *Universal Grammar* and to the particular language. The candidate which gives the best satisfaction of the constraint ranking is the optimal one, i.e. the winner of the competition.

Because of its general principles, OT appears, at first glance, to be a good model for capturing the undeniable variability found in languages. In the case of stress analysis, it is also worth underlining the fact that the possible objections to OT will be the same as those which may be advanced against the architecture of the theory in general, for instance, the hypertrophy of GEN, or the arbitrariness of constraint ranking. For a critical survey on OT, the reader is recommended to see the interesting volume edited by Roca [12], where part of the debate on the topic is presented in depth. Another feature OT shares in common with non-linear phonology is the primary relevance assigned to prosody. In the seminal paper by Prince and Smolensky [13], a large section is devoted to the interaction between syllable weight and metrical structure.

Let us now examine briefly the basic constraints which are normally used in the analysis of stress (see [14]). The first constraint is the one accounting for binarity, i.e. *FOOT BINARITY*. Recently, a relaxation of this constraint has been proposed. Both metrical theory and OT have, therefore, had to abandon strict binarity and to recognize the occurrence of ternary feet alongside binary feet for many natural languages. Both theories now allow three syllables as the maximum size. Structures made up of more than two unstressed syllables are still not allowed but, as we have already seen, long sequences of syllables where no acoustic cue for stress is present are quite often found in speech chains. Consequently the gap between theory-based predictions and real phonetic data should be reconsidered.

One way in which a greater match between theory and data can be obtained is with the constraint *CLASH, which is assumed in order to avoid two adjacent stressed syllables. Here, a change in the stress position or the deletion of one of two adjacent accents is postulated, and both the possibilities predicted by the theory can be found empirically in speech.

As OT has developed, there has been a search for the progressive reduction of the gap between input and output. In fact, some recent OT models deny an underlying structure that is different in any way from the surface structure (cf. *Output-Output Correspondence*). As abstractness is intended to be avoided, one possible outcome of this position could be to move towards an approach which is closer to phonetics. The signals available in OT literature are, however, ambiguous: sometimes, the candidates discussed in the *tableaux* are very far from the phonetic form, while the complex formalism adopted seems to capture only a part of the relevant cognitive events that act at the phonological level of language. Even so, the reference to acoustic parameters and to physical models is becoming ever more frequent.

It is probably too early to draw up a balance sheet on the research produced within this framework, but let us hope to achieve the revolution bringing phonology nearer to phonetics through OT.

As a final remark, we would like to promote a close interaction between phonology and phonetics albeit from their different starting-points. From a phonological point of view, stress has been considered and still has to be considered as an abstract property of phonological systems. Phonetic cues convey stress and, as such, are related to accent, i.e. they are the indexes of the structural and abstract property which is word accent. Although a certain tension between theory and data is inevitable, as phonologists our goal should be to try to account for the linguistic data, while as phoneticians we should aim at capturing the cognitive value of facts caught in the *mare magnum* of *realia* we can record, visualize and measure with our experimental tools.

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