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HOW TO DERIVE THE SONORITY SYLLABLE FROM THE PROTOTYPICAL PEAK

by
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More than twenty-five years ago I participated in some very interesting phonological seminars conducted by a brilliant young linguist, phonetician and Nordic philologist; among the central themes of the discussions were phonotactics and the syllable. These topics have interested me ever since, and it is therefore a pleasure to gratefully dedicate this brief presentation just to this not quite as young but still brilliant scholar.

1. Introduction: Five Different Foundations of Phonotactics

The present paper is an elementary and general statement of my current approach to phonotactics. The detailed discussion of the model and its application to Modern Standard Danish will be given in a forthcoming monograph on distinctive features and phonotactics (cf. my earlier treatments in, e.g., Basbøll 1973, 1977 and 1991, and Basbøll & Wagner 1985: chapter 7). If my paper, in its attempt to combine earlier insights from the era of European structuralism with modern phonological principles in a theoretically independent way, has at least some features in common with Jørgen Rischel's many important contributions, e.g. his very suggestive article on prosody from 1964, I would be very happy, but this is obviously not so easily attained.

By way of introduction, I shall identify and label five, clearly different approaches to phonotactics or, more exactly, five different kinds of foundation for that central part of phonotactical studies which has become known under the headline of "sonority", with the possible addition of "scale" or "hierarchy". My presentation may well be so crude as to resemble a caricature, and I want to emphasize that the different foundations are not necessarily those subscribed to by individual authors, but more like extreme or "pure" versions of the different approaches.

The first approach I have in mind might be termed **language-**

specific inductivism , viz.: the phonotactical patterns are identified as generalizations from the clusters attested in a specific language under description. Bengt Sigurd's methodologically important study of Swedish phonotactics (1965), and his Danish pupil Torben Vestergaard's application of his methods to Danish (1968), are cases in point. The main problems with this kind of approach are that truly significant generalizations are very hard to discover, and that it is practically impossible to compare the phonotactics of different languages in any insightful way.

The second approach I have in mind might be termed **cross-linguistic inductivism** , viz.: some "sonority hierarchy" is merely proposed, maybe - and maybe not - formalized by means of an explicit model, and the hierarchy or model is continuously confronted with phonotactical data from different languages and adjusted to agree with more and more specific phonotactical patterns. The hierarchy or model itself is evaluated by perpetually asking the question: "How does it agree with phonotactical data X in language Y?" (sometimes it must simply be acknowledged that certain phonotactical patterns, for example in Georgian, will be at deviance with practically all explicit proposals). This is a quite normal kind of foundation of "sonority hierarchies" which are proposed in the phonetic and phonological literature.

The third approach which I have in mind might be termed **phonetic primitivism** , viz.: "sonority" is considered to be, at least in principle, an objective phonetic property (a "primitive", hence the term "primitivism"), which ultimately should be measurable, e.g. in terms of the distance at which the sound in question can be heard, can be identified, or can be distinguished from some other specific sound. Some of the pioneers of modern phonetics, like Otto Jespersen (1897-99:521), apparently held such a conviction, but it has not been substantiated by later research.

The fourth approach which I have in mind might be termed **nativism** or **innatism** , viz.: the sonority hierarchy (or whatever terminology is used) is derived from some complex formal structures, e.g. metrical trees with strong and weak nodes (cf. Kiparsky 1981, Selkirk 1982). As I see it, the basic problem with such approaches is exactly their foundation: it is difficult to evade the conclusion that such complex structures are not learnable, by means of normally recognized principles of learning, from the input data available to the child, and hence they must be postulated as innate (in some sense to be made precise). This is a

consequence which many modern phonologists working in the tradition of Noam Chomsky do not hesitate to take, whereas other phonologists who also work within "formalist" paradigms do not commit themselves in that respect. Anyhow, this kind of foundation is clearly at variance with the methodological principles I am adhering to, since it cannot be subjected to genuine empirical testing.

The fifth approach I have in mind is the one I am favouring here, namely what might be called (if a term parallel to the others I have used above must be found) **general-phonetic deductivism**, i.e. I shall start from a deductive model which is based upon general phonetic principles. I shall proceed right away in presenting that model, and not explicate or discuss the alternative approaches mentioned above any further here.

2. The Prototypical Syllabic Peak and the Universal Logic of Segment Types

If we ask what is the most central characteristic of the notion "syllable", we will have to distinguish between different "aspects" of this notion; but from every point of view we shall encounter the centrality of the **peak** of the syllable: it is so important that the term **syllabicity** (i.e. "**syllabic** function") has been coined to indicate "peak-ness" with respect to a syllable.

Viewed from the outside, the syllable can function as a unit, e.g. to be counted with respect to stress rules. When one determines the number of syllables, one simply counts *the number of peaks*; in that sense, the peak is central in characterizing the syllable "externally".

Viewed from the inside, so to speak, the central characteristic of the syllable is a "sonority contour" with *a peak in the middle* as a "mountain of sonority", and with segments of decreasing sonority occurring with increasing distance from the peak. This is the central notion of syllable to be discussed in this paper, viz. the "sonority syllable". In the speech chain, the position of the peaks are normally more well-defined than the boundaries between consecutive syllables.

The syllable can be characterized, finally, as the unit of certain prosodies, viz. "accents", such as stress (which also involves the relation between syllables, however), tones, or the Danish "stød". In all such cases, the relevant sequence of segments to which the accents "belong" *include the peak* (they may also include other

segments, the strings in question being e.g. the "nucleus", the "rime", or perhaps the voiced part of the syllable).

Thus it will be safe to conclude that the peak is essential when the syllable is to be characterized in a linguistically significant way. But what kind of segment is the syllabic peak?

To begin with, we all know that one should distinguish between "vowel" in a functional sense (indicating "the peak of a syllable") and "vowel" in a purely phonetic sense (indicating a central oral resonant in the words of Pike (1943), who actually used the term "vocoid" in the sense of a phonetic vowel, in order to avoid confusion with the functional sense just mentioned). In the following, I shall be using the terms "peak" (or "syllabic segment") and "vocoid" in the two senses to be distinguished. The necessity of this distinction can be illustrated by means of examples like Czech *vlk* 'wolf', or the second syllable of English *little*, where a segment (viz. a sonorant lateral) which is not a vocoid (i.e. it is a "contoid" in Pike's terminology) functions as peak, and the final segment of English *low*, where a vocoid functions as non-peak.

The reason why the term "vowel" can be used in both these senses (not to speak of the orthographical sense, of course), is, obviously, that *the normal ("unmarked") case is that a vocoid functions as peak and a non-vocoid as non-peak : the prototypical peak is a vocoid (and inversely)*. In all languages of the world, vocoids can be peaks, whereas in many languages, non-vocoids cannot; inversely, in all languages non-vocoids can be non-peaks, whereas in many languages, vocoids cannot. Furthermore, in the languages which allow non-vocoids as peaks, it is often the case that this situation is restricted to specific syllable types, for example unstressed syllables, cf. English *little*.

Thus, there seems to be good motivation for taking the vocoid as the point of departure for a characterization of the syllable. Let us look closer at the vocoid phonetically. Vocoids are necessarily sonorants, whereas sonorants need not be vocoids (prototypical nasals and laterals are sonorants but not vocoids); speaking in terms of set theory, the set of vocoids is properly included in the set of sonorants. The logical relation (of "extension") between vocoids and sonorants can be depicted by means of the following two Euler's circles:

FIGURE 1 TO BE INSERTED HERE

Furthermore, sonorants (in the acoustic sense used e.g. by

Ladefoged (1971), corresponding to Pike's resonants) are necessarily voiced, whereas voiced segments need not be sonorants: they can be obstruents, of course (e.g. like [v] or [z]). Thus we can add a third outer circle to the figure, representing the set of voiced segments:

FIGURE 2 TO BE INSERTED HERE

Finally, voiced segments necessarily have a vibrating, i.e. non-spread glottis, whereas non-voiced segments can have either a spread or a non-spread (closed, say) glottis. If this class of segments is included into the figure, we have to add a further circle outside the others, indicating segments with non-spread glottis. The figure now comes to look like this:

FIGURE 3 TO BE INSERTED HERE

Our examination of classes of segments in such a unidirectional chain of implication ("vocoid" implies "sonorant", which implies "voiced", etc., not inversely) has now come to an end; and *we can insert no further circles representing generally recognized phonetic and phonological properties into these figures without offending their very logic*. We have to add a final outermost circle, however, to indicate that the "universe of application" for the circles is the set of segments in general (it will make no difference whether we write "segments" in the outermost circle, or whether we leave it unspecified, in the latter case just defining the whole "universe" we are talking about as "segments"; the former option has been chosen for the sake of readability):

FIGURE 4 TO BE INSERTED HERE

Notice that all the reasoning up to now has been *independent of all specific languages, and independent of all considerations involving time* in any sense, in particular of anything regarding the order of segments as manifested e.g. in syllable structure. *Only the logical and empirical relations between segment types have been included*. The figures of this section therefore represent, but do *not* of course exhaust, the **universal logic of segment types**. Notice also that I have not presupposed any specific theory of distinctive features, merely some general (and widely accepted) phonetic characterizations of segment types.

3. Introducing the Time Dimension into the Universal Logic of Segment Types: The Sonority Syllable Model

Now we are coming to the "qualitative jump" of the approach: *we introduce the dimension of time (depicted as an oriented diameter) into the set of Euler's circles* . By that move, the model is being changed from one representing universal relations between segment types (founded both empirically and logically) into one representing the order of segment types in time, i.e. *the model is no longer static but has become dynamic* :

FIGURE 5 TO BE INSERTED HERE

When moving from left to right through the set of circles, the following "order classes" of segments (using the terminology of Sigurd (1965) even though his approach is fundamentally different from mine) are being established: first (in time, or just in order) we meet the segments (the outermost circle) which do *not* have non-spread glottis, i.e. which have spread glottis (like [s] or [ph]); next, we meet the segments which have non-spread glottis but are not voiced; and so on and so forth. Notice that after we have met the vocoids (the innermost circle), we meet the same segments as before but in mirror-image order; thus the general mirror-image character of "sonority" in the syllable follows - by the very rules of logic - from the model proposed. The preceding figure is therefore equivalent to the following sequences of order classes:

FIGURE 6 TO BE INSERTED HERE

All these order classes can be relevant for the description of complicated phonotactical patterns (cf. my detailed phonotactical analyses of Modern Danish). A particular feature of the model is that the most marginal segments in the syllable are taken to be those with spread glottis, typically the voiceless fricatives and the aspirated voiceless plosives (cf. the important phonetic investigation by Frøkjær-Jensen, Ludvigsen & Rischel 1971, and Hutters 1985). According to this maximal version of the Sonority Syllable Model (see below), it is thus no accident, but in fact predicted, that /s/ in many languages is the most marginal segment and can be followed by a voiceless unaspirated plosive in the initial part of the syllable, for example; but contrary to many formal approaches to phonotactics, nothing like "extrametricality"

can be provided as an explanation here (such a term is, at best, a mere name for the phonotactical behaviour of /s/); but the behaviour is in my opinion grounded on general phonetic principles: a spread glottis is typical for pauses, and the prototypical stressed syllable is an isolated monosyllable, viz. one spoken before and after pause. Therefore I consider it to be no accident that the "phonetically homogeneous" (in some respects corresponding to "marked" in theories of distinctive features) value of the phonetic and phonological property in question, viz. "spread glottis", belongs to the margin of the syllable and not its center.

It follows from the very logic of my approach that also non-maximal versions of the model are available: when vocoids are necessarily sonorants, and sonorants are necessarily voiced, then vocoids are also - with logical necessity - voiced, and so forth. This means that any one of the circles can be removed without offending the logic of the approach. This fact has obvious relevance for phonotactical typology (see below). On the other hand, the logic of the model excludes any one of the circles being inserted at a different place (e.g. so that two circles occur in a different order). Regardless of which circle is the innermost one in a specific version of the model, the peak can always be represented by the center of the circles (see below).

Let us finally ask the question: is the maximal version of the Sonority Syllable Model we have been discussing up to now the only (logically and empirically) possible set of concentric Euler's circles having vocoids as the innermost one? Phonetically speaking, there may be one further possibility, viz. that based on the implication that sonorants are necessarily perceptually continuous (an auditive and acoustic property shared by sonorants and fricatives to the exclusion of all kinds of plosives, taps, flaps etc.). The question is whether this phonetic property is also relevant phonologically (so that it could even serve as a distinctive feature). I shall not take any stand on this issue here (it is discussed in my forthcoming monograph referred to in the introduction); I will only point out some consequences of accepting such a proposal (which is definitely a possibility to be considered), which can be illustrated by the following figure:

FIGURE 7 TO BE INSERTED HERE

Notice first of all that this model is inconsistent with the

inclusion of voicedness: it is neither true that voiced segments are necessarily perceptually continuous (cf. the class of voiced plosives), nor that perceptually continuous segments are necessarily voiced (cf. the class of voiceless fricatives). This is in my view a correct result: all attempts to combine voicedness and the distinction between plosives and fricatives into one unique "sonority hierarchy" have failed, as I see it. Notice also that this model allows (since it does not forbid) discontinuous voicing in the syllable, e.g. (in the initial part) a sequence of a voiced plosive plus a voiceless fricative; I do not think such a sequence is possible (for obvious phonetic reasons: it would be utterly problematic to master such abrupt glottis changes, and also very hard to perceive them in a stable way), and I have not seen evidence for its occurrence. Thus there are several reasons why this model is a much less attractive candidate for a sonority syllable model than the one we have been using elsewhere in this paper; but under certain assumptions about phonological properties, it is a logical possibility. I do not want to exclude its relevance altogether for languages which systematically have plosives more marginally than fricatives in the syllable, presupposing they make use of a feature like "perceptually continuous" in their phonology; and if, furthermore, contrary to my general expectations, they have discontinuous voicing in the syllable, this model would be superior to the one we are favouring (but only for such languages with very specific phonotactical characteristics). But for the rest of the paper, I shall concentrate on the set of Euler's circles which include voicing as providing the foundation for the Sonority Syllable Model.

4. The Sonority Syllable Model and the Syllabic Peak

Although the inner circle of the Sonority Syllable Model is constituted by the prototypical peak, viz. the vocoid, it must be emphasized that the notion peak itself has no place in the model as such; this follows from the very logic of the model: it is neither true that peaks are necessarily vocoids, nor that vocoids are necessarily peaks. This is a satisfying result, in my view, since peak-ness or syllabicity is a prosodic notion and therefore different from the segmental phonetic properties that are part of the Sonority Syllable Model. A further argument showing the independence in principle of the peak and the Sonority Syllable Model can be illustrated by the following example: in a sequence like (Danish) *zoologi* 'zoology', the number of peaks (before [l])

can in no way be deduced from the fact that the word begins by a sequence starting with an obstruent phase and ending in a vocoid phase, the model is just silent on this issue; and, quite generally, the model does not predict the number of peaks in a vocoid phase (or in any other phase with higher sonority than the adjacent segments, by the way).

The peak is thus not part and parcel of the Sonority Syllable Model as such; but a natural way to introduce the notion of peak into the model, in agreement with the general understanding of the notion "sonority syllable", is to claim that **the peak is the center of the circles constituting the Sonority Syllable Model (in any of its versions)**, the center being marked by a cross in the figures. The advantage of this statement compared to the introduction of an innermost circle "peak" within the circle "vocoid" is obvious: we avoid offending the very logic of our model by erroneously implying that all peaks are necessarily vocoids; and by the fact that a center is not a circle (but always in the very middle of one) we directly illustrate the difference between the prosodic property peak and the segmental properties in the figures. In cases where a sonorant lateral functions as peak, for example, the innermost circle of the syllable model in question cannot be "vocoid" (but will be "sonorant", typically, or even "voiced"), but of course the peak can still be represented by the center of the circles.

Different languages, and different phonotactical patterns of the same language, may have different conditions with respect to peak: e.g. the peak can exhaust the vocoid of the syllable (in that case there are no glides according to the terminology used here, glides being non-syllabic vocoids), or not. Furthermore, there can be particular restrictions on what type of segments can occur as peaks, perhaps even restrictions sensitive to syllable types, stress, etc. In very many languages obstruents cannot occur as peaks, for example; and I would like to suggest the following general restriction (to be further investigated, of course): the occurrence of a particular segment type as peak in a language presupposes that all contrastive phonetic segment types occurring in that language with a higher degree of "sonority" (according to the model), also occur as peak.

5. The Sonority Syllable Model and the Phonotactical Description of a Language

The Sonority Syllable Model is well suited, in my opinion, to be used as a framework for the phonotactical description of any given language. We can proceed by the following steps:

i) The contrastive phonetic segments (as I call them, corresponding to concrete phonemes or the like) are classified with respect to the phonetic properties of the model, not in terms of abstract phonemic "reductions" or "interpretations", but at a rather concrete level of phonetic/phonological analysis. Questions concerning mono- or bisegmental analysis should be solved at this point (e.g. is [mb] a sequence of a nasal plus a plosive, or a prenasalized plosive?), without using phonotactical evidence of course, otherwise there is a danger of circularity. (Although the foundation of the Sonority Syllable Model is general-phonetic, its application to particular languages involves phonology, naturally.)

ii) The different phonotactical patterns of the language are identified, e.g. with a distinction between foreign and native words, between morphologically complex and simple words, or between stressed and unstressed syllables in a word (some languages have a number of such patterns, others very few or only one).

iii) Restrictions on syllabic peaks (in the phonotactical patterns) are identified (see the preceding section).

iv) Each phonotactical pattern is confronted with the Sonority Syllable Model, and the following questions are answered:

iv) a) What is *the maximal version of the model which is not violated* by the phonotactical pattern in question? In very many cases, the maximal version not violated will be identical to (the maximal version of) the model itself, but e.g. a phonotactical pattern with initial [mgl-] will violate the circle "sonorant" of the model (since the violating sequence has initial (voiced) nasal+obstruent+lateral).

iv) b) What is *the active version* of the model? Most languages surely do not "exploit" all circles of (the maximal version of) the model in all their phonotactical patterns; and if e.g. the distinction between voiced obstruents and consonantal sonorants is never exploited for order relations in the syllable, the circle "sonorant" (which is the one responsible for the distinction in question) is not "active" in that respect.

iv) c) How many segments from each "order class" are allowed in the phonotactical pattern in question? The unmarked instruction would be "pick up at most one member from each order class!", and deviations from that instruction would have to be mentioned separately.

iv) d) Are there further restrictions related to the Sonority Syllable Model (and if so, which ones)? E.g. systematic restrictions demanding the opposite order of that predicted by the model would belong here, but I am not aware of any such restrictions and doubt very much that they occur.

v) What further phonotactical restrictions apply? No one (and certainly not the present author) would want to claim that all phonotactical restrictions relate to "sonority". In my forthcoming monograph on distinctive features and phonotactics in Danish I have described all phonotactical restrictions which are not related to sonority by means of filters of a very simple type, like ***[Fi][Fj]** (a particular instance could be ***[lab][lab]** which would exclude the occurrence of two labial segments adjacent to each other).

6. The Sonority Syllable Model and Phonotactical Typology

When a number of languages are described according to the uniform procedure outlined in the preceding section, a detailed phonotactical typology is within immediate range. I shall suggest the potential of such a typology by adding a few remarks to each of the procedural steps indicated in the section just above.

ad i) The contrastive phonetic segments could be compared across languages (cf. Maddieson 1984, for example), but this point is not specific to the phonotactical approach used here.

ad ii) Different languages could be compared to see which languages have *a phonotactically relevant distinction* between foreign and native words, etc.; and across languages one should seek for relations between the number of phonotactical patterns on the one hand, and other linguistic properties on the other.

ad iii) Restrictions on syllabic peaks in different languages could be compared, and in particular we might ask: are there regularities holding between possibilities with respect to "peakness", and other phonological properties, and if so, what are they?

ad iv) Each phonotactical pattern of the languages to be compared could be confronted with the Sonority Syllable Model according to the following list of questions:

ad iv) a) What is *the maximal version of the model which is not violated* by the phonotactical patterns in question? It would be interesting to compare the different maximal versions which are not violated across languages (keeping the distinction between different phonotactical patterns in mind, of course). Which

circle(s) can be "missing" from the maximal version of the Sonority Syllable Model? (I would suppose that "voicing" would only rarely or never be missing, for example.) Languages where many circles are missing are those which exhibit an "anti-sonority phonotactics", and these cases should be closely investigated.

ad iv) b) What is *the active version* of the model? What are the patterns across languages describing which circles are "active" (e.g. is the one for voicing always active?)? Languages where many circles are not active are those which exhibit an "a-sonority phonotactics" (to differentiate from the cases just mentioned under iv) a)).

ad iv) c) How many segments from each "order class" are allowed in the phonotactical patterns in question? What are the restrictions across languages, and in particular, is there co-variation with other properties?

ad iv) d) Are there further restrictions related to the Sonority Syllable Model (and if so, which ones)? Systematic restrictions demanding the opposite order of that predicted by the model are particularly important to observe since they may be considered falsifications of the model in its strongest form.

ad v) What further phonotactical restrictions apply, in particular: what different types of such restrictions can be found across languages, and can they all be described by means of filters of the very simple type suggested in the preceding section, like ***[Fi][F]** ?

7. The Sonority Syllable Model is Not Innate

In the introduction to this paper, I criticized the complicated sonority models proposed within so-called "formalist" models of phonology for belonging to what I called "innatism", viz. that they in reality (regardless of whether their proponents claimed so explicitly or not) presuppose that the complex structures in question would in some sense be innate, since they apparently could not be learnable according to generally recognized principles of learning. This position (of the existence of complex innate (mental) structures specific to *la faculté du langage*) is logically possible - and it certainly cannot be falsified by any available methods of linguistics - but in my view it is methodologically misguided (given the present "state of the art"): the arguments brought forward by its proponents in principle cannot furnish any real evidence. I must therefore face the following question regarding my own model for the sonority

syllable: do I not also presuppose that those sets of concentric circles must be innate? The answer is no: all that is presupposed in this respect is that speakers are able to classify sound segments into such natural classes as vocoids, sonorants, and so on (which independent evidence concerning natural phonological processes, e.g. diachronic or acquisitional, shows that speakers are in fact able to do), whereas the relations between these classes (depicted by the set of circles) are *the only possible ones*, logically and empirically. Starting from these classes, once the speakers/listeners introduce the time dimension, the Sonority Syllable Model follows. It is as simple as that.

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