

# Phonological Word Structures

## Categorial and Functional Concepts

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### 1 Introduction

Among the levels of grammatical form, phonology has been the last one for which the problems of representing grammatical structures have been discussed intensively. With the rise of non-linear phonology a great number of proposals on various aspects of phonological structure has been made. However, we are still looking for a consistent representation for the complete sound-structure of words. As such it should be established independent from other levels of description (morphology in particular) and at the same time suitable to establish relations to these other levels.

One of the approaches which attempts just this has been developed in Integrational Linguistics (IL). Many issues can be handled easily and with revealing results in this approach, even though Lieb has stated only recently that “Integrational Phonology was developed piecemeal and continues to be the most incomplete part of the integrational theory of language” (1992:141).

In our contribution, we would like to discuss some basic problems of phonological representation understood as problems of explicating the notion of *phonological structure*. In particular, phonological structures are compared to what we presuppose to be a suitable conception of syntactic and morphological structure. We will concentrate on word structure here, putting aside the problems related to intonation structures and accents within larger units.<sup>1</sup> Also, we will not have to say a lot about the important issues of subsegmental structure.

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<sup>1</sup> Much work within Integrational Linguistics has already been devoted to this subject (cf. Lieb 1980, 1983a, 1988).

## 2 Phonological base forms and phonological units

Before talking about structures we have to say something about the entities those structures are assigned to, i.e. *linguistic units*. In syntax, phonology, and morphology linguistic units can be construed in largely the same fashion as sequences of what we call *base forms*.

In syntax the base forms are word forms in the usual sense. Syntactic units then are sequences of such forms, namely those sequences that make up noun groups, prepositional groups, sentences, etc. Similarly, morphs are the base forms of morphology and morphological units (such as stems, compounds, and inflected word forms) are sequences of morphs. So far the conception of syntactic and morphological units looks rather simple. There are certainly some special cases to consider such as ‘mixed’<sup>2</sup> and discontinuous units and variation in the sequential order (*weggehen* vs. *geht weg* “go away”).

Things are somewhat different in phonology. Throughout the largest part of this paper we will consider sounds<sup>3</sup> as the base forms of the phonological system. Then all phonological units should be sequences of sounds. Without going into detail we can say that the problems associated with contiguity and sequencing are by no means easier to deal with in phonology than in syntax and morphology.<sup>4</sup> But even if we put aside these issues for the time being we will have to deal with the so-called *supra-segmentals*, i.e., *stress* or ‘accent’ (predominantly realized as pitch in German) as well as length, syllable-cut, possibly syllable weight, etc. Some of these may be considered as a second type of phonological base form (cf. Lieb 1992:132).

We will concentrate on word-level stress here without pursuing the question of which other types of supra-segmentals could be relevant. Two points are to be noted then: If we regard stress properties (‘itches’) as base forms (i) they do not seem to have an equivalent in morphology or syntax and (ii) they do not show up in the sequential structure of phonological units.

In Lieb’s approach,itches are inherent properties of phonological words with values “<sup>—</sup>” (“high”) or “<sub>—</sub>” (“low”).itches are related to syllables. For every syllable of a phonological word the intonation structure

<sup>2</sup> *Mixed* (as opposed to *pure*) syntactic units contain morphological units as in *auf- und zumachen* (“to open and close”) whereas mixed morphological units contain syntactic ones as in *Guten-Abend-Ticket* (“good-evening-ticket” — a special offer of the German railway company).

<sup>3</sup> We chose to speak of *sounds* here avoiding any commitment in favour of some conception of ‘phoneme’ as well as the vagueness associated with the notion of the ‘segment’.

<sup>4</sup> Consider e.g. vowel harmony or total overlapping (‘blending’) of sounds as exemplified by the velar nasal in German and by nasalized vowels in French.

specifies its pitch as either “—” or “\_”. Being related to syllables is not the same as being a property of syllables. Pitches are neither properties of sounds (e.g. of the vowels figuring as nuclei of syllables) nor properties of syllables. They are entities in their own right although their realization is bound to the realization of syllables.<sup>5</sup>

Further below in this paper, when talking about phonological marking structures, we will offer an alternative approach (section 4.3). It will be proposed to classify syllables with respect to stressability. We believe that this has a number of favourable consequences, one of them being the avoidance of a second type of phonological base form. All linguistic base forms will then play the same role in building linguistic units. Pure phonological, morphological, and syntactic units are equally sequences of base forms and there are no other base forms than those occurring in the units of the respective level. Thus all base forms are proper parts of units (i.e. the subjects of description) rather than elements of the description itself (i.e. structures).

At the first glance this proposal seems to be a return to some form of radical segmentalism which has been much criticized during the past decades and was finally abandoned in favour of prosodic approaches. However, a closer look at popular approaches to word phonology such as lexical phonology or — more recently — optimality theory reveals that supra-segmental structures are derived from underlying representations which are purely segmental in nature. Syllable structure and prosodic structure is assigned by rules (or constraints) based on segmental and extra-phonological — in particular morphological — information.<sup>6</sup> Thus even if the output of the machinery delivers complete phonological word structures, comprising equivalents of our phonological units as well as their functional and hierarchical dependencies, the segment has clearly a privileged status because everything else is derived from it.

A surface oriented phonology as we wish to advocate here draws a distinction between units and structures. The structures, however, may well represent information which cannot be derived from the given sequence of base forms. E.g. we may assign stress properties to some syllable independently from the internal structure of that syllable or from other syllables in the given word form. As an empirical result it may or may not turn out that stress properties are dependent on some of these structural factors. Therefore the approach outlined here as well as Lieb's approach can be claimed to be non-

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<sup>5</sup> To our knowledge, the first definition of 'pitch' in this sense is given in Lieb (1980).

<sup>6</sup> For German cf. among others Wiese (1988), Hall (1992), and several of the contributions in Eisenberg et al. (1992).

segmental in the sense that prosodic information is introduced independently from 'segmental' information.

In our approach to word structure we need to take into account the overall set of phonological units given in (1).

*Phonological units*

- (1) a. the unit sequences of base forms, i.e. sounds;
- b. the sequences of sounds which are syllables;
- c. the sequences of sounds which are feet;
- d. those sequences of sounds which figure as sound sequences of phonological words.

We believe that these four types of phonological units are sufficient to describe the phonological word structure of a language like German. We do not mean to imply that all languages can be handled with this set of units<sup>7</sup> although we are confident that the approach can be taken over to most other languages. In particular we shall argue against sub-syllabic constituents such as onset, rhyme, coda, etc. assumed in a number of current accounts (section 3).<sup>8</sup> At this point we are not even sure whether or not phonological words<sup>9</sup> should be included here (see section 4.3).

### 3 Phonological constituent structures

#### 3.1 *Remarks on structure*

Without going into detail we have to provide some background on the concept of grammatical structure in Integrational Linguistics. In particular we would like to emphasize the following points:

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<sup>7</sup> While Lieb's approach has been developed in particular with the aim of covering all natural languages including tone languages, our approach has evolved mainly from descriptive work on the word structure of German.

<sup>8</sup> We also do not include 'complex segments' such as diphthongs and affricates although this issue would need some in-depth discussion (cf. Ramers and Vater 1995 for a concise synopsis of the arguments). Currently we believe that such 'complex segments' should be treated either as sequences of base forms which do not form a unit of their own or as (complex) base forms.

<sup>9</sup> A *phonological word* here is a sequence of sounds corresponding to a word form (in the traditional sense) together with its (possibly incomplete or *weak*) phonological structure. This is quite a different concept than the 'phonological word' as a prosodic unit as envisaged by Nespor and Vogel (1986) and their followers.

- i. Constituent structures are employed — intuitively speaking — to express the hierarchical organization of units. They are not meant to express the functional dependency of grammatical units within some expression. This is entirely left to the devices of grammatical relations.
- ii. Aside from constituent structures, Integrational Linguistics employs marking structures and intonation structures. Marking structures express information related to the lexical and paradigmatic organization of units (e.g. inflectional ‘features’). So far IL has not employed a marking structure in phonology. In section 4 we will propose a marking structure for phonology. As one of the results the intonation structure becomes dispensable (at least within phonology) and we have to deal with only one uniform set of phonological base forms.
- iii. All concepts used for the specification of those structures should be strictly categorial in nature. While some other approaches (inadvertently or even purposefully) mingle categorial and functional entities, these have to be carefully separated in Integrational Linguistics, be it only for the reason that functional concepts are systematically applied besides categorial ones. More specifically, in IL grammatical relations are established between units<sup>10</sup> (typically between constituents) and this is bound to lead into circularity if the units themselves are defined in terms of such relations.

However, anybody who has ever worked within some structuralist framework is probably aware of the difficulty to decide on where to use categorial and where functional notions (and to distinguish both within any theory that is not entirely formalized). This problem is pertinent to phonology in particular and it is instructive to ask why this is so. In syntax, at least some rather concrete notions such as ‘subject’ and ‘object’ are easily identified as functional and in most approaches they will be distinguished at least implicitly from categorial concepts such as ‘NP’, ‘nominative’, or ‘accusative’. In phonology on the other hand, most authors do not even realize that there could be a problem with clearly functional notions such as ‘onset’, ‘nucleus’, ‘coda’ and ‘rhyme’ as constituent categories. We are convinced this is not a mere accident but a result of the combinatorial regularities governing syntax on one side and phonology on the other (with morphology ranging somewhere in between).

Consider an expression like *den ganzen Tag* (“the whole day”) in German. From its inherent properties (its constituent and marking structure) we can assert without much room for any ambiguities that it is an NP with mor-

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<sup>10</sup> For instance the syntax-semantics interface crucially relies on syntactic relations such as ‘complement’, ‘modifier’ etc.

pho-syntactic markings such as definite, singular, accusative, masculine. However, this expression can have a number of different functions e.g. as an object (*sie benötigt den ganzen Tag* “she needs the whole day”), as an adverbial (*sie arbeitet den ganzen Tag* “she works all day long”), or as the complement of a preposition (*durch den ganzen Tag* “through the whole day”). Conversely a grammatical function such as being an object can be served by categorically well-distinguished expressions such as NP’s and sentences. This many-to-many relation between form and function is at least one of the most striking facts forcing us to distinguish categorial from functional concepts.

On the other hand, many sequences of sounds can serve only one particular function within a phonological structure and some phonological functions require a very specific type of sound in some position. For example, in many languages (including German) sequences of obstruent+sonorant like [tr], [fl], [ʃm], [kn], etc. can only occur in the pre-nuclear (or ‘onset’) position within a syllable while the reversed sequences of sonorant+obstruent are restricted to post-nuclear (‘coda’) positions. Furthermore, in many languages the nucleus of a syllable must be a vowel and vowels are not too frequent in other than nuclear positions.

While there are certainly some polyfunctional units in phonology, the constructive principles here seem to result in some state of affairs which comes at least much closer to ‘one form – one function’. This can be attributed at least partly to the articulatory and auditory constraints governing the distribution of sounds. However, to give up the distinction between categorial and functional terms in phonology would only be justified if their relation was strictly 1:1, which is clearly not the case. Note that not only ‘consonantal groups’ such as [mpf], [lk], etc. can figure as ‘codas’ but also simple consonants. Almost all of these (with the notable exception of the velar nasal) can also figure as onsets in German. The vocalized *r*-sound [ɐ] can figure as a coda (e.g. in [bi:ɐ] *Bier* “beer”) but also as a nucleus (as in [hʊn.dɛt] *hundert* “hundred”). Some nuclei (such as in [hɔʃŋ] *hoffen* “to hope”) are even clearly consonants otherwise found in onsets and codas. We are therefore convinced that it is well worthwhile to take a step aside from the mainstream of prosodic phonology in maintaining a clear-cut distinction between categorial and functional concepts.

### 3.2 *Simple constituents*

Prototypically simple phonological constituents are unit sequences of base forms, i.e. sounds.<sup>11</sup> In this section we shall discuss which constituent categories should be assigned to these ultimate constituents. If the unit sequences are classified into the constituent categories C (consonant) and V (vowel), we get a partial constituent structure corresponding to the CV-tier which has been proposed in many accounts more or less following Clements and Keyser 1983 (for German e.g. Wiese 1986, 1988, Vater 1992).

Except for our basic requirement that constituent categories be defined in strictly categorial terms, based on inherent properties of the respective units (or extensionally, if all else fails), there are certainly no strict guidelines leading to the establishment of a particular set of constituent categories. With respect to the definability of the categories C and V we would like to point out that the phonetic foundation of a clear-cut distinction between consonants and vowels is rather shaky to say the least (in particular with respect to glides or semi-vowels and some *r*-sounds). On the other hand, we find a number of sound classes which can not only be defined very safely in phonetic (namely articulatory or acoustic) terms but also play an important role — by no means secondary to the consonant vs. vowel distinction — for syllable structure.

Furthermore, a phonetically based distinction between consonants and vowels does not take us very far with respect to syllable structure: For simple cases such as German [dʁas.tʃ] (*drastisch* “drastic”) or [ʔa.po.te:kə] (*Apotheke* “pharmacy”), syllabification and syllable structure can easily be specified based on some reasonable feature specification of the base forms and without any reference to the consonant vs. vowel distinction and in particular without mapping this distinction onto the constituent structure. In other cases, however, we have to recognize that a phonetic consonant vs. vowel distinction does not help to establish correct syllable structures. Consider a form like [vɔːl̩n] *wollen* (“to wish”). In standard pronunciation this form contains only one vowel although it is bi-syllabic. Thus, the C-V distinction does not help to differentiate its structure from the monosyllabic [kœln] *Köln* (“Cologne”). Likewise the vocalized *r*-sound in German is phonetically clearly a vowel in typical realizations of the bisyllabic form [ʀoːɐ̯] *roher* (“raw”) as well as of the monosyllabic [ʀoːɐ̯] *Rohr* (“tube”).

<sup>11</sup> The *unit sequence* of a base form is the one-place sequence containing that base form and must be distinguished (at least formally) from the base form itself. For phonology see Lieb (1980:137ff.), (1992:139ff.); for morphology and syntax see in particular Lieb (1983), (1992), (1993).

In other words, a syllable need not have a vocalic nucleus and it may contain other vowels in addition to the one which forms the nucleus. In the literature this has been mainly discussed with respect to diphthongs.<sup>12</sup> It is usually assumed that the first vowel of a Diphthong figures as nucleus. This is sometimes sought to express by specifying the first vowel as [+syllabic], the second as [-syllabic] (e.g. by Wurzel 1980:918ff.). Wiese (1986) and others are certainly correct in criticizing this approach with the very argument that 'syllabic' is not a categorial but a functional property of sounds. However, Wiese's proposal to assign the first vowel of the diphthong to a V-position on the CV-skeleton and the second to a C-position should fall prey to the same argument if we regard the CV-tier as a partial constituent structure.

While a categorial differentiation of 'vocalic' and 'non-vocalic' vowels based on their inherent phonetic properties is not inconceivable,<sup>13</sup> it is certainly not very desirable to be forced by the descriptive model to draw such a distinction. At least for German it seems preferable not to duplicate the critical vowels [i] and [u] but to specify the relevant differences in functional terms as outlined below (section 3.3).

We come to the conclusion that the classification of the phonological unit sequences into C and V is either redundant (given the appropriate feature specifications of the corresponding sounds) or based on functional considerations. We therefore end up with only one constituent category for the ultimate constituents of the syllable — or with none at all.<sup>14</sup>

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<sup>12</sup> Although various representations have been proposed for the diphthongs of Modern Standard German (including mono-phonemic solutions), the received position seems to be that they consist of two adjacent vowels (see e.g. Wiese 1986:3.2, 1988:62ff.). Certainly the two vowels forming a diphthong, although they are both real vowels as far as their feature specification is concerned, do not have the same function within the syllable.

<sup>13</sup> It is well-known that the articulation as well as the perception of sounds is context-dependent to a large degree. This seems to be the ultimate reason for the common use of functional terms when sounds are arranged into higher constituents. Although the production and perception of syntactic units may also sometimes depend on the context, the difference remains a qualitative one. This should be expected, be it only for the reason that simple syntactic units (word forms), unlike sounds, can always stand alone.

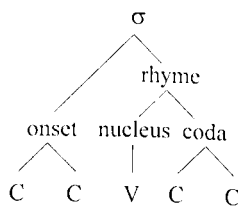
<sup>14</sup> It is then a matter of the formal specification of the model (and of the convenience to be able to talk about constituent structures without naming the actual sounds) whether or not to introduce a 'prosodic skeleton' of segmental positions (usually labelled 'X') between the melody tier and the higher constituents of the syllable.



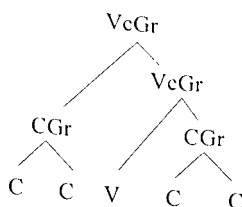
3.3 Syllables

Our discussion of the syllable and its constituents starts from the representation in (2a). However, our criticism applies to all similar models of the syllable which employ constituents such as onset, rhyme, etc.<sup>15</sup> As shown earlier these are functional notions and therefore should not be considered as constituent *categories*. For this reason Lieb has always avoided them and applied CGr (consonantal group) and VcGr (vocalic group) instead. He also avoids 'syllable' as the name of a constituent category. We will come back to this later. Thus in Lieb's approach, (2a) would be replaced by something like (2b), where CGr and VcGr appear independently of their respective function (cf. Lieb 1992:144f.).

(2) a.



b.



While following Lieb in considering the usual labelling of constituents as inadequate, we would, however, go even further and abandon any hierarchical structure between the tier of phonological unit sequences and the syllable. It is of course not possible to recapitulate all arguments that have been put forward in favour of hierarchical constituent models of the syllable here. We will therefore restrict ourselves to some brief comments on the most common types of arguments found in the literature with respect to that problem.

Inherent structural properties are essential to define any constituent type as a category. As pointed out already in section 3.1 this prerequisite is problematic at least when it comes to establishing onset and coda as distinct categories. Likewise, it is not easy to establish a categorial notion of nucleus. But as we will see, this is only a secondary argument against this constituent. Therefore, if we wish to stick to a strictly categorial concept of constituency, we end up with only two possible sub-syllabic constituent categories, namely consonantal groups (which can figure as onsets, codas and possibly as rhymes) and vocalic groups (figuring as rhymes).

<sup>15</sup> It is not possible here to go into the different 'moraic' models of the syllable. However, by and large our line of arguments should be applicable to these models as well, at least to the extent that moras are treated as constituents.

Most arguments in favour of some constituent are related to syntagmatic relations and well-formedness conditions in the widest sense. More specifically, either a particular syntagmatic relation (such as government or agreement) is found to have its domain restricted to a particular constituent or a particular constituent is figuring as the target of such a relation. While the concepts of government and agreement are clearly borrowed from syntax, there is little doubt that we find a number of relevant syntagmatic relations in phonology as well. We might even characterize syntagmatic relations such as assimilation with well-known concepts such as government and agreement. However, few of the relevant phenomena seem to deliver any natural criteria for the constituent structure of the syllable.

The only phonological unit which can clearly be identified as the domain of a large number of phonological well-formedness conditions is the syllable. No reference to onsets, nuclei, codas or rhymes is required to specify those syntagmatic restrictions on syllables constituting the so-called 'sonority sequencing principle'. We can reduce this principle to a number of restrictions requiring all voiced sounds, all sonorants, etc. to form contiguous blocks within the syllable (Butt 1992). These blocks clearly run across the boundaries of all sub-syllabic constituents. The same can be said for almost all assimilation phenomena. Assimilation is probably best understood in terms of sub-segmental constituents or features spreading to one or more adjacent positions (see Browman and Goldstein 1992, Goldsmith 1979, and further remarks in section 4.2). In general, adjacency seems to be more important for assimilation phenomena than any sort of phonological or morphological constituency. For example, while it is true that nasals in German seem to be subject to place assimilation only in codas, the assimilation itself can spread over all types of boundaries including morpheme and syllable boundaries (e.g. [ha:k<sup>n</sup>ŋ] *Haken* "hook", [aŋ.kɔm] *ankommen* "to arrive"). Likewise labialization can spread over an entire syllable ([ky:m] *kühn* "bold", [hum] *Huhn* "chicken").

Admittedly, some phonotactic restrictions do seem to operate on the domain of the coda. In German, e.g. obstruents are always voiceless in codas (which leads to the well known phenomenon of final devoicing). Also, many languages, including German, seem to exhibit some significant interaction between nuclei and codas to the effect that the syllable weight is balanced. However, even such observations do not seem to deliver conclusive arguments in favour of some particular constituent analysis: While Wiese (1986, 1988) argues that the nucleus itself is always balanced to the same weight by

assigning two positions on the CV-tier,<sup>16</sup> Vater maintains that the C-position should be regarded as part of the coda at least when occupied by an actual consonant.

We come to the conclusion that the descriptive versatility of a phonological model is not much enhanced by introducing onsets, codas, and rhymes as constituents. Note that the nucleus remains a constituent even in a flat model of the syllable as long as we regard only one sound as the nucleus of any given syllable. However, in our account *nucleus* is not a constituent category but a grammatical relation that holds between a syllable and some sound within that syllable.

Let us now briefly turn to the question of how the nucleus is identified. As far as we can see, the nucleus should always be exactly one sound (there is no convincing evidence for complex or multiple nuclei, the former would certainly be a suitable argument in favour of some complex constituent below the syllable). There are some categorial conditions on a segment's ability to figure as nucleus (just as in syntax there are some categorial conditions on a syntactic unit to figure e.g. as a subject). Although these conditions are language dependent, it can be said for most languages that a nucleus should be a *static* (or 'continuant') sound and it should be voiced (in German a nucleus must be a sonorant). Certainly within many syllables more than one sound satisfies those conditions. Which one is the nucleus can typically be determined by looking at the sequence of sounds that forms the syllable.<sup>17</sup>

There are, however, some cases where the nucleus cannot be determined by reference to its segmental context only. Consider the sound sequence [hɛlm]. To begin with, in German standard pronunciation as produced even by trained radio speakers, this sequence can be monosyllabic (*Helm* "Helmet") or bisyllabic. Furthermore, there are two bisyllabic forms (*Helmen*, the dat/pl form of *Helm*, and *hellem* "light", an unrelated adjectival Form). It seems that these three forms are pairwise distinct even on the phonetic level in colloquial speech. However, there is no satisfactory way to

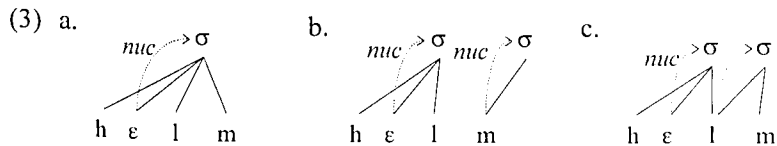
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<sup>16</sup> This is accomplished by assigning one V and one C position to the nucleus which are either 'linked' to *one* (long) vowel, to two vowels (i.e. a diphthong), or to a short vowel and the following consonant.

<sup>17</sup> Usually the assignment of a nucleus is accomplished by determining the sound that ranks highest on a so-called 'sonority scale'. This method is questionable at least because the phonetic and phonological significance of 'sonority' is by no means clear (cf. Butt 1992). In any case, however, the nucleus cannot be determined without reference to its phonological context within the syllable. While the proper method to define and determine the nucleus of a syllable lies beyond the scope of this paper, this again demonstrates that *nucleus* is a functional rather than a categorial concept.

express this distinction on the segmental level. Traditionally, and in accordance with some pronunciation dictionaries, the distinction has often been represented by presence vs. absence and by the position of an additional schwa ([hɛlm], [hɛləm], [hɛlmən]). While the forms with schwa might be acceptable in modern standard pronunciation (though marginally), we cannot accept a solution, which regards these as the ‘underlying’ forms for the various surface forms without schwa. Such ‘underlying forms’ are nothing but phonological deep structures and the actual surface forms are then derived by so-called ‘realization rules’. We would maintain that such a descriptive apparatus is not in accordance with the basic aims of surface grammar.

The proper solution might be rather to differentiate the forms in question not on the segmental level but on the level of syllable structure in terms of constituent structure *and* grammatical relations. Straightforwardly, then, *Helm* (3a) is a monosyllabic form with [ɛ] (the only vowel) forming the nucleus (if a syllable contains only one vowel it will always be the nucleus). *Helmen* in its standard colloquial form (3b) is bisyllabic with the syllables [hɛ] and [m]. There is no vowel and no second nasal in the second syllable. It consists only of one sound [m], which therefore must be the nucleus (given that we require a nucleus for every syllable). The adjectival form *hellem* (3c), on the other hand, consists of the syllables [hɛ] and [lm]. There is only one [l] in the segmental sequence but this segment belongs to both syllables — it is ‘ambisyllabic’. Apparently, this [l] is the coda of the first syllable as well as the nucleus of the second.<sup>18</sup>



It seems that we can determine the nuclei of the syllables in a given word form with respect to (i) its sound sequence and (ii) its syllable structure (i.e.,

<sup>18</sup> We may ask also whether the second syllable in *hellem* has an onset. If we take the onset (in functional terms) to be the sequence of tautosyllabic segments before the nucleus, this is clearly not the case. However, in German ‘naked’ syllables such as the second syllable of *gehen* have a special distribution and with respect to this factor the second syllable of *hellem* doesn’t seem to be naked. We might therefore define the notion of *onset* such that it includes sonorant consonants at the beginning of a syllable even if they are nuclei. Likewise in *Helmen* [m] would be an onset. Given a suitable definition of *coda* it might also be a coda such that one sound figures as onset nucleus and coda simultaneously. Such considerations would probably be excluded in a hierarchical constituent model with onset, nucleus and coda as constituents.

the assignment of sounds to one or more syllables). However, although in German there seems to be no case where the nucleus cannot be determined on this basis, we may still want to provide for structures where only the placement of the nucleus *ceteris paribus* carries a lexical distinction.<sup>19</sup>

### 3.4 *Feet and phonological words*

In this section we shall discuss the question of whether there are any phonological constituent categories relevant to word structure beyond the syllable. In earlier work Lieb employed a constituent category 'phonological word form' for units with more than one syllable (e.g. Lieb 1980). This category has been abandoned as a constituent category without replacement in more recent work (Lieb 1992).<sup>20</sup> Thus all phonological constituent structures assigned to units stretching over more than one syllable are so-called *weak structures*. *Phonological words* ('structured phonological units') are either syllables or sequences of syllables. In addition they may contain unsyllabified sounds.

Following many recent approaches, we would like to propose a phonological constituent category *foot* ( $\varphi$ ). It seemed to be inevitable indeed to give up the phonological word as a phonological constituent. However, it does not follow that we end up with syllables as the highest constituents in phonological structure. Much evidence collected during the recent years indicates that there is a phonological patterning of syllables independent from although not unrelated to the structure of phonological words.<sup>21</sup>

The major difference between phonological word and foot as a possible constituent category lies in the fact that a foot has a specific rhythmic pattern. In a given language there is only a small number of such patterns corresponding to different types of feet. We believe that only two types of feet, viz. the trochee and the dactyl (see below) are properly established in Modern Standard German. These patterns are repeatedly used in a language and have considerable effects on the construction of word forms.

A phonological word, on the other hand, may embrace more than one foot and the foot boundaries need not coincide with the word boundaries. We can enumerate the possible phonological constituents within a word. But as

<sup>19</sup> In a similar fashion as in syntax, the two possible readings of *Er leidet unter seiner Nachbarin* ('He is suffering under/from his neighbour') are distinguished solely by different syntactic relations (object vs. adverbial) between the verb and the prepositional phrase.

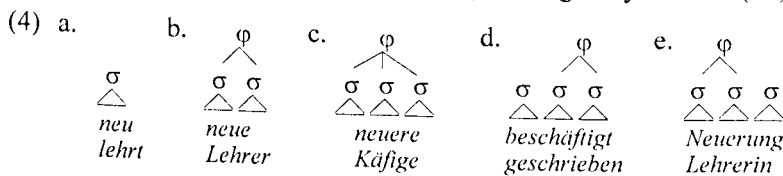
<sup>20</sup> The unit corresponding to a 'phonological word form' in the sense of Lieb (1980) would now be called a *phonological word*.

<sup>21</sup> For German see e.g. Giegerich (1985), Uhmann (1991), Eisenberg (1991), Féry (1996).

words are lexical units, we can not establish sufficient conditions for some phonological object to be a word without leaving the domain of phonology. A lexical word as well as the forms comprised in its paradigm is structured by phonological *and* morphological regularities. Based on the given lexical material (which is often idiosyncratic) morphological rules may produce forms conforming to certain preferred prosodic patterns but they need not do so.

Typologically German falls into the class of so-called 'stress-timed' languages and as such it depends on a rather regular alternation of stressed and unstressed syllables. The trochee and the dactyl have evolved as the predominant patterns and many types of words are constructed accordingly. One important class of facts relevant here is comprised in so-called 'prosodic morphology'. For German we can find e.g. that the plural forms of nouns in the native vocabulary have to end in a trochee. The same is true for the forms of some other categories such as the subjunctive of present tense, preterite, inflected forms of the adjective in the positive etc. Similar statements can be made with respect to the dactyl. Also we find some distributional constraints in morphology (e.g. for derivational suffixes) which are best handled by reference to foot structures.<sup>22</sup>

It may well be that in addition to the trochee and the dactyl other types of feet have to be acknowledged for German. However, we do not follow the mainstream view that within a phonological word every syllable has to be an immediate constituent of a foot. Instead we follow Lieb's (1992) proposal in allowing phonological words (as well as morphs) to have *weak* constituent structures. In our view then, lexical units (morphs and word forms) may contain unsyllabified sounds as well as 'unpedified' (or unfooted) syllables. The latter is the case for the examples (4a), (d) and arguably also for (4e).



Typical monosyllabic forms such as (4a) can be assigned a strong constituent structure although they do not contain a foot. Here the boundaries of the word coincide with the boundaries of the syllable.<sup>23</sup> (4d), on the other hand,

<sup>22</sup> See Hurch *forthc.* for an overview of prosodic morphology and for instance Eisenberg *forthc.*, Neef (1996), and Raffelsiefen (1996) for some pertinent phenomena in German.

<sup>23</sup> We have to leave the question open here whether some monosyllabic units could be regarded as incomplete feet. For phonological words this does not seem to be necessary but there are e.g. some stems that need to occur always in a particular position of a foot.

is a weak structure. An unpeditied syllable followed by a trochaic foot (the latter being similar to (4b)). Whenever a form like (4d) occurs within some larger context, the unpeditied syllable will tend to adjoin to the preceding syllables to form another foot. This 'pedification' will essentially be the same within words and within larger syntactic units as exemplified by ... *hat den Aufsatz abgeschrieben* vs. ... *hat den Aufsatz neu geschrieben*.

In a similar fashion, a weak structure might be assumed for forms like (4e). Depending on the phonological context the last syllable of this word form can either be adjoined into the foot on its left to form a dactyl (as in ... *als Lehrerin angestellt*) or form the left branch of the following foot (as in ... *als Lehrerin beschäftigt*).

Similar to syllables, one of the immediate constituents of a foot has a specific function and may be described as its nucleus. In trochees and dactyls the nucleus is always the first syllable and, just as a sound has to satisfy certain conditions to figure as the nucleus of a syllable, a syllable must satisfy certain conditions to be the nucleus of a foot. In particular it must be a stressable syllable such that the nucleus of a foot can bear primary or secondary word accent.

The nucleus of a foot can be determined in a similar fashion as the nucleus of a syllable with respect to the constituent structure of the given expression and to certain properties of the syllables or sounds involved. The relevant properties of sounds and syllables can be construed as *marking categories*. Thus the last section of this paper will be devoted to the role of phonological marking structures.

## 4 Phonological marking structure

### 4.1 Marking structure and paradigm

As pointed out already, Integrational Linguistics does not employ a marking structure in phonology. Lieb (1992:152ff.) states in passing: "Lack of marking structures in phonology is due to absence of paradigms; in the sound system, the role of paradigms is, in a sense, taken over by the feature composition of base forms, in particular sounds."

We shall argue, that indeed phonological unit sequences (sounds) can be arranged in a fashion which at least closely resembles syntactic or morphological paradigms. Furthermore, even if the concept of the paradigm is not

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Consider the root of a word like *Botschaft*. Here it is the left branch of a trochee the right branch being provided by a derivational suffix. But whenever this stem occurs on its own (*Bote*) a 'dummy' schwa-syllable has to be added to supply the right branch of the foot.

employed (which seems most suitable for the level of the syllable), this does not mean that there cannot be such thing as a marking structure.<sup>24</sup>

Let us take a brief look at inflectional paradigms in syntax and their relation to marking structure. In Integrational Linguistics, such paradigms are construed as binary relations between unit sequences of phonological words (i.e., syntactic base forms) and sets of syntactic categories called *unit categories*. As an example, consider the preterite paradigm of a strong verb such as *laufen* ("to run") in (5a) with the unit categories  $unm_a/adr$  (unmarked/addressee) and  $unm_{pl}/pl$  (unmarked/plural). (5b) gives the general scheme for the preterite paradigm of this type of strong verb. Such a paradigm can be regarded as an  $n$ -dimensional space where each cell is occupied by one form which belongs into one category on each dimension.<sup>25</sup>

(5) a.  $\{(lief, \{unm_a, unm_n\})$  b. 

	-	adr
-	-	-st
pl	-en	-t

  
 $(liefst, \{adr, unm_n\})$   
 $(liefen, \{unm_a, pl\})$   
 $(lieft, \{adr, pl\})\}$

The complete paradigm of verbs in German will certainly have some additional dimensions to comprise other forms such as present and subjunctive. It is by no means clear, however, which forms should be included in a given paradigm. A *lexical word* is a paradigm together with a lexical meaning, i.e., the paradigm is so to speak the formal part of a lexical word. And every form within a paradigm (e.g., *lief*, *liefst*, etc.) has the same lexical meaning. Inflectional paradigms collect units of the 'same word', where 'sameness' should have a syntactic as well as a semantic aspect. However, while the semantic aspect is obvious (as long as we have some suitable definition of 'sameness' with respect to lexical meanings), the syntactic aspect seems to be poorly understood. Within the paradigms assumed in typical accounts the units show considerable diversity in their syntactic behaviour. Thus, questions such as whether periphrastic forms and infinite forms (in particular, participles and pure infinitivals) should be counted as members of the verbal paradigm or whether comparative and superlative together with positive forms belong into one adjectival paradigm are prolific sources of a continuing debate.

<sup>24</sup> Absence of proper paradigms is also possible in syntax. This would be the case for an ideal isolating language. Here every word has exactly one form. The *improper paradigms* of such a language (if for formal reasons and for the sake of generalization we still wish to speak of paradigms at all) would each comprise exactly one form.

<sup>25</sup> Cf. Lieb (1992a) and Wunderlich (1992) for recent discussion of this conception of *paradigm*.



Regardless of how these questions are resolved, the unit categories employed to establish the inflectional paradigms of a given language will typically not be sufficient to express all relevant morpho-syntactic information. In particular, there are some syntactic categories (such as the gender categories masc/neut/fem for German nouns) which apply to all the forms within the paradigm of a given word differentiating it from other words. Using the terminology employed in earlier work of Lieb (cf. Lieb 1975), we shall call this type of marking category a *paradigm category*.

4.2 *The internal structure of sounds*

Is there really nothing in phonology which resembles the paradigmatic relations between units in syntax and morphology? To begin with, we might arrange pairs or suitable sets of features to arrange sets of sounds in a multi-dimensional space in the same fashion like syntactic or morphological units are arranged in paradigms.

(6) a.

	-	voiced
labial	p	b
apical	t	d
dorsal	k	g
glottal	ʔ	

b.

	-	round	back
close	i	y	u
mid	e	ø	o
open			a

Such structures (as exemplified in (6a) for the plosives and in (6b) for the vowels of Modern Standard German) clearly represent paradigmatic relations between sounds. It is not surprising that some properties of syntactic and morphological paradigms can be found here as well. For example unmarked categories typically show more internal differentiation than marked ones.

The question remains, however, whether the phonological 'features' should establish unit categories (arranging groups of sounds into phonological paradigms) or paradigm categories (relating possibly improper phonological paradigms). Clearly there are two extreme and several intermediate solutions. On the one hand, all sounds could be arranged into one single phonological paradigm. All relevant phonological features would establish unit categories. The result would look like one of the well known phonological charts (such as the one provided in IPA 1949:10). The other extreme would be to regard every sound as forming its own (improper!) paradigm. All features would then establish paradigm categories. As both solutions can rely on isomorphic classification systems, they are in fact substantially equivalent.

The more interesting solutions might be those which group some sounds into phonological paradigms such that there is some number of paradigms structured by unit categories and differentiated by paradigm categories. This

should integrate well into the concept of grammatical structure established in Integrational Linguistics. Certainly, like in syntax and morphology, we will then have to ask for the criteria that lead to the establishment of a particular set of paradigms. This seems to be even harder in phonology because sounds are not associated with lexical meanings. Still in an indirect fashion lexical meanings might provide some criteria. Clearly there are some sets of sounds which vary systematically within syntactic and morphological paradigms. Thus we might assume phonological paradigms comprising the pairs of voiced/unvoiced obstruents or of back and corresponding front vowels for German. We would then find sets (small ones though compared to syntax or morphology) of paradigms with an identical structure.

However, further investigation of sub-segmental structures and their influence on phonotactics is likely to shatter the idea of sounds or 'segments' as phonological base forms. The ultimate base forms of phonology might turn out to be such things as speech gestures rather than sounds and the question of phonological paradigms would have to be resolved primarily on this sub-segmental level.<sup>26</sup>

#### 4.3 *Marking structure and word-level stress*

As mentioned already, we propose to represent the basis of word-level stress in terms of marking structure on the constituent level of syllables rather than in a separate intonation structure. Clearly, there must be a strong connection between word-level stress and the foot structure of a word. In fact the majority of phonological words in German comprise exactly one foot and in this case the nucleus of that foot is also bearing the word-level stress.

We are left with two rather hairy questions then: (i) How is the nucleus of a foot determined and which categorial properties of syllable play a role in this and (ii) how is word-level stress represented and assigned in phonological words containing more than one foot? A general answer to these questions as well as a descriptive account of word-level stress in German is beyond the scope of this paper. In the remaining paragraphs we shall merely illustrate some of the representational aspects involved here.

As pointed out above, we do not assume that all grammatical relations can be determined on the basis of the grammatical units and structures involved. But typically we do find some rather strong dependencies between grammatical structures and grammatical functions. With respect to the nu-

<sup>26</sup> Unfortunately, the move to sub-segmental units as phonological base forms would tie the model to an articulatory rather than an auditory basis. Lieb (1988) argues in favour of an auditory basis but demonstrates convincingly that articulatory concepts can be employed to characterize auditory entities on the 'segmental' level.

cleus of a foot, we can safely say that in German not every syllable can figure as the nucleus of a foot. We can categorize the syllables by a pair of marking categories with respect to stressability. Clearly, all syllables whose nucleus is not a full vowel never bear primary or secondary word level stress and can therefore be classified as non-stressable. Conversely, most syllables with a full vowel figuring as nucleus can be found in stressed positions and are therefore stressable.<sup>27</sup> There seems to be no reasonable way to combine stressable and non-stressable syllables into paradigms, i.e., there is no unstressable counterpart of a stressable syllable or vice versa. Thus we regard stressable/non-stressable as a pair of paradigm categories.

Stressability imposes a considerable constraint on the possible foot structure of phonological units, words in particular. For a large number of bi- and tri-syllabic word forms in German there is only one possible pedification, because there is only one stressable syllable (7a-c). The most typical resulting prosodic structures are the trochee (7a) and the dactyl (7b). These can be regarded as the prototypes for the prosodic structure of German word forms which are carried over to a large number of word forms with more than one stressable syllable. This results in the basic rule of word-level stress in German which simply says that the last stressable syllable in a word bears the word level stress. This rule does not hold for all but for a considerable percentage of the word forms in German including those in (7d) (see Eisenberg 1991 for details).

- (7)    a. *aber*        b. *neueres*      c. *Gewinde*    d. *Wacholder*  
           *laufen*        *ebenes*        *begießen*     *Forelle*  
           *Schaufel*      *laufendes*    *gelingen*     *Hornisse*

But clearly the exceptions to that basic rule are too numerous to be simply neglected. We have to ask which other rules might govern pedification and word-level stress and we have to be able to express such rules in terms of grammatical structures and functions.

Obviously not only phonological but also morphological factors must be taken into account for the assignment of word-level stress. This is the case in particular with respect to compounds but also for some derived forms and possibly even for some inflectional forms. However, it may well be the case that on the phonological side besides stressability other marking categorizations have to be taken into account, possible candidates being syllable weight (cf. Giegerich 1985, Wiese 1988, 1996) and syllable cut (Vennemann 1991).

<sup>27</sup> There may be some other structural properties of syllables resulting in non-stressability. E.g. syllables whose onset is ambisyllabic or empty (hiatus) are typically non-stressable.

Let us finally turn to those phonological words which are not feet. Starting with the simplest case, in phonological words consisting of two or more feet we might regard one of these feet as the nucleus of the phonological word thus adding one more level of structure analogous to the levels of syllables and feet. We can then represent such forms as [ka.ta.stro:.fə] *Katastrophe* ("catastrophe") and [gro:.bi.a.nə] *Grobiane* ("rough guys") in a straightforward fashion. We could now identify the syllable bearing primary word-level stress as the nucleus of the foot which is in turn the nucleus of the a phonological word. All other syllables that are nuclei of feet bear secondary word-level stress. Because there seems to be no convincing evidence for more than two distinguished levels of word-level stress in German, we do not see any justification for further prosodic units within the word such as 'foot groups'.

Remember, however, that phonological words can have weak structures. Thus we have to take into account words containing unpedified material where word borders do not align with foot borders. In particular, we are now facing the problem that an unpedified syllable may bear the word-level stress (consider such words as [po.li.'tsaj] *Polizei* "police"). One solution could be to allow for feet containing just one syllable. The last syllable of *Polizei* would then be such a foot and this in turn would figure as the nucleus of the phonological word. Although we do not want to rule out such a solution, we would like to avoid non-branching constituent structures if we can, because it is not clear what sort of thing a monosyllabic foot might be as opposed to simply a syllable. In such a situation we suspect that once again something functional is being expressed in the constituent structure.

What we see here is that an additional level of *phonological* structure above the foot is in fact not called for. The phonological word is a different type of linguistic entity than a sound, a syllable or a foot: The latter can be established *within* phonology (or phonetics for that matter) as classes of sound events with certain articulatory, acoustic or auditory properties. Phonological words on the other hand are the phonological forms of syntactic entities. They do have a (weak) phonological structure but they are not phonological units in the proper sense.

Primary word-level stress then cannot be a categorial property of phonological units such as syllables. It is best construed as a relation between a phonological word and one of its syllables. Just as with the other nucleus relations we have investigated, certain categorial conditions will play a role here: To be the nucleus of a phonological word (i.e. to bear primary word-level stress), a syllable must be stressable, and if there are any feet within the phonological word it must be the nucleus of one of the feet.

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