0 Preface

The first publicly circulated version of this thesis (Version 1.4) was defended at the Hungarian Academy of Sciences (HAS) Institute of Linguistics in September 1986. An extended Version 2 was submitted to the HAS Scientific Qualifications Committee in August 1988, and was formally defended in September 1989. The present edition in *Linguistica: Studia et Dissertationes* differs from this version in two main respects. An English version of the official Summary *Kandidátusi Értekezés Tézisei* replaces the old Introduction, and the section on implementation reflects the system that was running at Xerox PARC at the time of the formal defense.

To leave the material in the thesis in manuscript format for all these years would have required more patience than the author can lay claim to. The abstract analysis of feature systems in chapter 2.1 forms the basis of the more detailed analysis in Kornai 1993. The analyses of Hungarian vowel harmony in 2.1 and 2.7 have been published in Kornai 1987 and Kornai 1991. Part of the material on syllable structure in 2.4 can now be found in Kornai 1990, and a more extended version of the material in 2.5 on postlexical phonology is in Kornai and Kálmán 1989. The analysis of lexical categories in 3.1 and 3.2 has been published as Kornai 1985. Except for chapter 4, which describes the morphological rules in detail and discusses a two-level implementation, almost all the material has been published elsewhere. What is, then, the purpose of the present edition?

First, it is hoped that by bringing the parts together in a convenient monographic format the reader can use the volume as a reference work detailing nearly all aspects of the inflectional and many aspects of the derivational morphology of Hungarian. Since the rule system developed for the thesis has been extensively tested on over twenty thousand stems covering virtually the whole lexicon of contemporary Hungarian, future models of Hungarian morphology can, if nothing else, learn from the mistakes of the present one. Second, it is hoped that the overarching plan of this work, as presented in chapter 1, might still have some relevance for theoretical linguistics.

In a fast moving field like generative grammar authors seldom get a chance to contemplate whether the topics they chose to investigate and the methods they applied a decade ago would still make sense. In the eighties the author was lucky enough to pick a problem domain, morphology, that was just about to come in from the cold, and a technical framework, autosegmental theory, that has since grown from an esoteric branch of Africanist phonology into a mainstay of generative grammar. In the nineties some of the fundamental judgement calls made in this work, in particular the unashamedly procedural mode of description and the unbridled minimalism/reductionism that are the common threads binding it all together, came under renewed attack. Whether the work stands up against these lines of criticism will have to be decided by the reader.

1 Introduction

Aside from a few isolated attempts, such as Kiefer 1970, morphology played a very limited role in the early development of generative grammar. The basic reason for this was that the standard generative model (Chomsky 1965) treated sentences as strings of morphemes: both base (rewriting) and transformational rules operated on morphemes. This one-step model (originating in the work of Harris 1946, 1951) was gradually replaced by a two-step model in which sentences are treated as strings of words, and words are treated as strings of morphemes, much as in traditional grammar.

In order to (re)introduce 'word' as an explanatory category, the class of possible models had to be delimited so that the division of labor between rules of syntax, on the one hand, and rules of phonology/morphology on the other, become clear. This is accomplished by the Lexicalist Hypothesis (Chomsky 1970), now usually called the Lexical Integrity Hypothesis (LIH). Although the LIH exists in many versions (see Scalise 1985), for our purposes it will be sufficient to state the following basic requirements, which are common to nearly all versions of the LIH:

(1) Rules of syntax (and semantics) cannot make reference to the phonological content of words.

(2) Rules of syntax (and semantics) cannot modify the phonological and morphosyntactic features of words.

Thus, in addition to forbidding rules like Affix Hopping (Chomsky 1957), the LIH also forbids the derivation of word-forms by syntactic rules. But if syntax can not derive word-forms, each and every word-form must be supplied by the lexicon. According to the traditional view of the lexicon as a list, this would mean that every (paradigmatic) form of a word must be listed. Given that such forms often number in the thousands, listing them all appears to be impractical, if not impossible.

But the traditional file-card based technology of lexicography has gradually been replaced by a computer-based technology that can handle several orders of magnitude more data, and the reason why generative morphology avoids listing all word-forms is not a practical but rather a theoretical one. It is the *Principle of Brevity*, stated by Chomsky and Halle (1968:12) as follows:

> "Regular variations (...) are not matters for the lexicon, which should contain only idiosyncratic properties of items, properties not predictable by general rule."

Listing all word-forms (and in particular, all paradigmatic forms) thus contradicts the Principle of Brevity, while the LIH, apparently, requires exactly this.

Generative morphology resolves this contradiction by treating the lexicon not as a static list but as a dynamic (generative) component of the grammar. The LIH requires only that syntax

must get fully formed words from the lexicon, but does not require that such forms be stored in the lexicon. On the contrary, the Principle of Brevity demands that no form that can be produced by a regular operation should be stored. Thus we must distinguish the output and the content of the lexicon. The output of the lexicon is the set of well-formed words. If we treat compounding or recursive derivational processes as productive, this will be an infinite set, which makes it impossible to think of the lexicon as a list. The content of the lexicon, however, will be reduced to the list of irreducible elements (morphemes) and the rules operating on them (suppletive and other irregular forms are also included here).

Therefore, the fundamental goal of generative morphology is to characterize the basic elements and operations of the lexicon — the contributions of the present dissertation to this goal are discussed in 1.2 – 1.4.

1.1 The methods of the investigation

We have seen above that the LIH and the Principle of Brevity, taken together, will naturally lead to a generative view of the lexicon. Given that traditional grammar makes as sharp a division between phonology and morphology as is made by the LIH between morphology and syntax, it seems possible to gain a better understanding of the structure of the lexical component by enforcing more principles of separation than just the LIH. This is the method of 'natural' generative phonology, where the most important principle of separation is the Morphophonemic-Allophonic Principle introduced by Koutsoudas et al. 1973. More recently, research in 'natural' morphology (Dressler 1985) attempts to isolate a third, morphophonological component between phonology and morphology.

The basic method of the present investigation is exactly the opposite of the strategy of natural phonology/morphology. My fundamental assumption is that phonology and morphology form an indivisible unit which I will call 'the lexicon' or just 'morphology'. This assumption seems to be contradicted not only by the obvious difference in the size of the basic units (phonemes vs. morphemes) but also by the different nature of the typical phonological operations (e.g. assimilation or deletion) and the typical morphological operations (e.g. affixation or compounding). Therefore it is necessary to discuss briefly why 'mainstream' generative grammar treats phonology and morphology homogeneously.

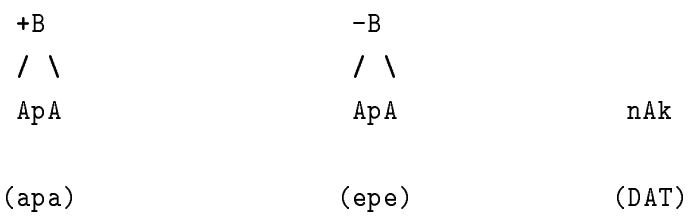
Jakobson pointed out that we find a number of rules (such as the rule of word-final devoicing in Russian, see Halle 1959) that are morphophonemic and allophonic at the same time. With the introduction of context-sensitive rules (Chomsky 1956), the homogeneous formal treatment of phonological and morphological rules became possible and necessary, since there was no separate morphological component at the time. The principle of cyclic rule application made clear that each morphological rule (affixation) triggers phonological rules such as stress shift. Furthermore, Lexical Phonology (Kiparsky 1982) provided a unified treatment of cyclic rules and the phonological processes taking place at morpheme boundaries and showed that the rules

of phonology and morphology are arranged in the same stratal structure.

The most important argument in favor of a homogeneous treatment of phonology and morphology was provided by the fundamental transformation of phonology in the last decade. This transformation started with the introduction of a separate tier for tone (Leben 1973, Goldsmith 1976). This was followed by tiers for harmonizing vowel features (Clements 1976), for aspiration (Thráinsson 1978), for nasalization (Hyman 1982), for syllabicity (Clements and Keyser 1983) and so on. The multi-tiered representations thus formed made it possible to treat the infixing morphology of Semitic languages by purely phonological means (McCarthy 1979) and to reduce reduplication to concatenative affixation (Marantz 1982). With the aid of multi-tiered representations, other processes, hitherto assumed to be purely morphological, also became amenable to a treatment in terms of phonologically motivated operations.

The methodological basis of the present dissertation is the principle of parsimony (Occam's razor). Thus, when we seek a characterization of the basic elements and operations of the lexicon, we seek an answer to the following questions. What are the fundamental units that *must* be stored in the lexicon? What are the operations which are *indispensable* for the task of generating every word-form? Starting from the phonological form of words we can argue that the words can be decomposed into syllables, the syllables can be decomposed into phonemes, and the phonemes can be decomposed into distinctive features. The distinctive features are atomic, and thus will necessarily be part of the lexicon. Starting from the meaning of words, the minimal units having both phonological and semantic content are (by definition) the morphemes, so the lexicon will have to contain these too.

However, the question whether morphemes are built from phonemes or directly from features is arguably open: for instance, in Hungarian, backness is a property not of the individual vowels, but of the whole morpheme (see Hetzron 1972). Autosegmental phonology expresses this fact by locating backness on a separate tier. For instance, the segmental content of *apa* 'father' and *epe* 'bile' will be *ApA* in both cases, where *A* is the same *a/e* archiphoneme that we find in the dative suffix *nak/nek*. In the full representation of these morphemes, both the segmental and the backness tiers are present, together with the association lines between them:



As can be seen, the dative morpheme is not associated to the +B or –B feature — the basic rule of vowel harmony says that the *A* of *nAk* has to be associated to the backness feature of the stem. Therefore association (and also delinking) will have to be listed among the fundamental

operations, the more so because they appear in the description of other phonological processes (such as assimilation or compensatory lengthening) as well. Similarly, a theory of the lexicon can not do without the operations of feature insertion and deletion. The use of these operations and of concatenation has been extensively justified in autosegmental phonology already in the description of tone languages, so the present dissertation could take these to be given.

For the reasons sketched above, I could not take it for granted that phonemes are primitives. With the introduction of a root tier, autosegmental phonology made it possible to identify a phoneme with the set of features associated to a root node, and to treat the (traditionally problematic) affricates and diphthongs as well as the long (geminate) phonemes in a homogeneous manner together with short phonemes (Clements and Keyser 1983). Accordingly, I did not permit rules that operate on phonemes rather than directly on features. With the introduction of a morphemic tier (McCarthy 1979), parentheses, and in general segmentoid boundary markers also become eliminable (for the syllable boundary see Kahn 1976, for boundary markers of various strength see Mohanan 1984).

The central aim of the dissertation is to show that Hungarian morphology can be described with the extremely limited inventory of representations and operations outlined so far. Since the most powerful tools of the standard theory (such as transformations, curly brackets, and Greek letter variables) were already eliminated from autosegmental theory, the dissertation concentrates on the remaining two strongest tools, namely diacritic features and feature changing rules. Since my aim was to limit the number of tools available, the choice between alternative analyses was always dictated by the criterion of using the least number of *ad hoc* tools.

The method employed in the investigation of the meanings of words and morphemes was also dictated by considerations of parsimony. Although we do not know precisely what features distinguish the meaning of one morpheme (or word) from the meaning of another one (or, to put it differently, our decisions in these matters will greatly depend on the theory of lexical semantics we adopt), we can assume without further argumentation that the number of the ultimate features is finite (less than the number of elements that have to be listed in the lexicon). Since some operations that will insert features in larger structures (and further transform these structures) will be necessary for phonological purposes anyway, the dissertation employs the same operations in the investigation of meaning as well. The morphosyntactic features that transmit the information between syntax and morphology are also handled by these operations, thereby steering clear of the problem whether morphosyntactic features are to be treated as morphological (Kiparsky 1986), syntactic (Gazdar *et al* 1985), or semantic (Lapointe 1980).

1.2 Summary of new results

2.1 develops an algebraic treatment of phonological features which, through the investigation of the relation between phonological features and natural classes, provides a unified treatment of the original (Pāṇinian), the standard (SPE), and the modern (autosegmental) approaches.

Here I will omit the algebraic details and provide a somewhat simplified model that employs only concepts from elementary set theory.

Let $P = \{p_1, p_2, ..., p_k\}$ be a set of phonemes and $F = \{f_1, f_2, ..., f_n\}$ be a set of binary features. The mapping C:$P \rightarrow 2^F$ will be a *feature analysis* if it satisfies the following criteria:

(3) Emicity. If $i \neq j$, then C$(p_i) \neq$C(p_j).

(4) Compactness. If $N \subset P$ is a natural class, we can find a set of forbidden features T' and a set of required features B such that $p \in N$ iff $B \subset$C$(p) \subset F - T'$

In the dissertation I argue that features and phonemes can be treated uniformly in the algebraic model, and show that the standard theory of features makes two predictions concerning the set of natural classes:

(5) The number of natural classes is a (small) polynomial function of the number of phonemes $(k^{1.585})$

(6) The set of natural classes is closed under intersection

I show that the Pāṇinian theory makes essentially the same predictions (with the function k^2 instead of $k^{1.585}$), and I develop a concept of 'natural class' for the autosegmental case that leaves (5) and (6) in force. The theory is illustrated on a feature analysis of Hungarian vowels based on the tridirectional features $< I, U, A >$ and the model is interpreted with the aid of barycentric coordinates so that it relates phonological features to phonetic facts.

2.2 deals with the feature analysis of consonants by reformulating the traditional analysis in terms of the feature geometry suggested by Clements (1985). The investigation of consonant epenthesis undertaken here provides a new argument in favor of a proposal made by É. Kiss and Papp (1984) that in Hungarian *dz* should be treated as a sequence of two phonemes.

2.4 deals with syllable structure. Earlier results (chiefly Siptár 1979,1980) are discussed from the point of sonority, and the ID/LP model of constituency (Gazdar and Pullum 1982) is used to exclude final clusters such as *pj, kj* that appear only in inflected forms.

2.5 deals with postlexical rules. In addition to an outline of Hungarian consonant sandhi, the rules of Hungarian sentence intonation, jointly developed with László Kálmán, are also sketched.

1.3 Vowel harmony

The investigation of Hungarian vowel harmony traditionally concentrates on the binary alternations *a/e, á/é, o/ö, ó/ő, u/ü, ú/ű*, and mentions the ternary alternation *o/e/ö* only in passing. An important empirical result of the present dissertation is that it includes the quaternary alternation *a/e/o/ö* which, following Vágó 1975, is treated in the literature as if it were independent of the problem of vowel harmony. As we shall see, a unified treatment of binary, ternary, and

quaternary alternation is justified not only because in the surface representation the alternant *a* (as in *házat, házak, házam*) plays the same role as the alternants *o,e,ö*, but also because this way suffix-combinations can be described by the same machinery used for single suffixes.

A fundamental difference between the earlier analyses and the one proposed here is that here *a* and *á*, as well as *e* and *é*, are treated as differing only in length. In order to show that there are no differences between *a* and *á* or *e* and *é* in (underlying) height or roundedness, I analyze two quantity-changing processes, Low Vowel Lengthening (*apa/apát, epe/epét*) and Stem Shortening (*tél/telet, nyár/nyarat, tűz/tüzet, víz/vizet, nyúl/nyulat*).

For the description of a seven vowel system at least three features must be used. A feature analysis using only three features can be reconstructed from the phonological pattern of Hungarian: the feature A separates the vowels of the quaternary archiphoneme from the rest, the feature I separates the two alternants of binary alternations, and the feature U will group the vowels according to ternary alternation. If we also take the proximal/distal alternations *itt/ott, ez/az, így/úgy* into account, we arrive at a feature chart that is equivalent to a Jakobsonian analysis: I = <–grave>, A = <–diffuse>, U = <+flat>.

The next step in the analysis is to show that the traditional palatal/velar as well as the more modern front/neutral/back stem classifications are not sufficiently detailed and that in fact we need five stem classes. The stems *had, bab, hit, hölgy,* and *tök* all have to be in different classes, since no two of these will get the same alternants for every (binary, ternary, and quaternary) suffix (cf *hadat, babot, hitet, tököt*, and *hithez, hölgyhöz*). Stems of the *had* and *hölgy* type (which are treated in Vágó (1980) with the aid of a 'Minor Lowering' rule triggered by a diacritic ML) require separate classes not only because they are numerous, but also because this treatment permits all stems (including derived ones) to be unambiguously classified. Although from a diachronic point of view, these classes are closed, in a synchronic description they must be treated as productive, since stems bearing plural (or possessive) suffixes all belong here (cf **babokot, *babomot, *tökököt* etc.).

The simplest possible harmony rules are:

How far can an analysis employing these rules be pushed? It would go against the Principle of Brevity to leave the stems selecting the *a*-alternant unmarked and mark the stems selecting the *o* alternant with a diacritic — we must suppose that for back stems the unmarked member of the opposition *a/e/o/ö* is *o*. Therefore the diacritic ML turns [+A,+U] into [+A] (in the *had* class) and turns [+A,+U,+I] into [+A,+I] (in the *hölgy* class). It follows from our basic aim of eliminating diacritics that the *ad hoc* ML has to be replaced by the phonologically motivated <–U>.

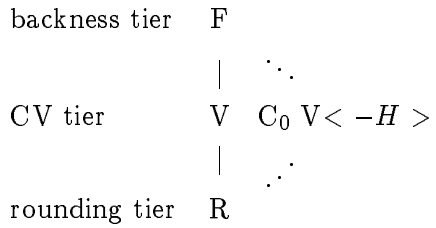
Given the existence of such ML stems as *lyuk*, the only way to reconcile the +U feature

of the stem vowel and the –U required by the exceptional harmonic behavior of the stem is to specify the same feature on different tiers. In other words, the parsimonious treatment of features results in the introduction of an extra tool such as the *core specification* (in the sense of Halle and Vergnaud 1983) that is used in the analysis given in 2.3. Thus, it seemed advisable to provide an alternative analysis based on four vowel quality features. This analysis, given in 2.7, is based on the standard features:

	a	e	i	o	u	ü	ö	a/e	o/ö	u/ü	o/e/ö	a/e/o/ö
back	+	-	-	+	+	-	-	0	0	0	0	0
high	-	-	+	-	+	+	-	-	-	+	-	-
low	+	+	-	-	-	-	-	+	-	-	-	0
round	0	0	-	+	+	+	+	0	+	+	0	0

The role of the diacritic ML is played by a (floating) <+low>. It can be seen that the spreading of <+low> will narrow down the quaternary archiphoneme *a/e/o/ö* to the binary archiphoneme *a/e*. The rules of (privative) I-spread are replaced by a pair of (equipollent) spreading rules:

and there is a separate rule for ternary harmony:



While the analysis based on three features had to use feature changing rules, this analysis employs only monotonic (feature adding) rules. As a result, the spreading of <+low> onto the ternary archiphoneme is blocked because *o/e/ö* is underlyingly specified as <–low>. Since the standard analysis does not distinguish between the ternary and the quaternary archiphoneme, the Minor Lowering rule of Vágó 1980 would generate the incorrect form **hölgyhez* in such cases.

1.4 Summary of conclusions

Chapter 3 discusses the notions *word* and *lexical category*. The explanatory value of the notion *word* is argued to stem from the fact that several logically independent methods of segmentation yield essentially the same word-sized units. Lexical categories are defined morphologically which has the advantage of yielding a feature analysis (X-bar theory) of lexical categories as a byproduct of morphological analysis. The (morphosyntactic) features defining lexical categories are argued to have their own 'geometry'. The basic restriction on the tree structures thus formed is that only "+" (marked) nodes can have daughters. The theory is illustrated on the category system of Hungarian, with special emphasis on the problem of defective paradigms.

4.1 and 4.2 provides a detailed description of the Hungarian verbal and nominal paradigms. The diacritic ML was eliminated in Chapter 2 — here two other diacritics, governing Stem Shortening (as in *nyár/nyarat*) and Vowel Drop (as in *cukor/cukrot*) are eliminated in favor of more motivated features. In order to describe the 52 verbal forms discussed, we need 26 morphemes (ordered by the Elsewhere Principle). This is more than twice as many as the 12 morphemes that would be necessary in a fully agglutinative system, but only half of the 52 that would be needed in a purely inflecting system. Roughly the same degree of agglutination is found in the nominal (possessive) paradigm.

In sum, the investigation of diacritics in Hungarian arguably supports the thesis that it is often the arrangement, and not the substance of the atomic units that gives rise to different behaviors, much like in the case of graphite and diamond. The investigation of feature-changing rules, however, does not seem to yield the same kind of 'conservation laws' that are common in the physical sciences. Although Hungarian vowel harmony is amenable to a feature-adding treatment, there are places both in the verbal paradigm (such as the 3rd singular present definite *ja/i*) and in the nominal paradigm (such as the plural possessive *i*) that require the use of feature-changing rules under any analysis of vowel harmony.