Head-Dependent Asymmetries in Phonology

B. Elan Dresher
Harry van der Hulst

Introduction

In his paper on degree-0 learnability, Lightfoot (1989) explores the possibility that the syntax of a language is learnable only from main clauses, without recourse to data from embedded clauses. He notes that the proposal is attractive on several grounds. From the point of view of acquisition, this hypothesis, building on work of Wexler and Culicover (1980), claims that grammars should be learnable on the basis of simple and ubiquitous data that every child has access to. He then goes on to observe that an acquisition strategy of this kind could also account for a generalization noted by Ross (1973) and Emonds (1976), to the effect that many transformations can be found which are limited to root clauses, whereas there are arguably no transformations which are limited to embedded clauses. Lightfoot points out that this asymmetry follows if learning is based primarily on main clauses, because then no operation would be expected in a subordinate clause which did not also occur in a main clause.

Lightfoot is not able to confine learning to degree-0, however, and concludes that a certain amount of embedded clause information is required also, notably data involving complementizer properties. He concludes that what is needed is "degree-0 and a bit". In his commentary on this article, Rizzi (1989) points out the rather arbitrary nature of "degree-0 and a bit", and proposes that the extra bit appears to be limited to information about syntactic heads. He proposes that children pay attention to heads, and that the grammar is to a large extent learnable from the properties of heads.

In this paper we will propose that much the same is true in phonology. Our proposal will include the following claims:

First, there is a meaningful notion of phonological head that cuts across segmental and suprasegmental levels, indeed perhaps across phonology and syntax; cf. Halle & Vergnaud (1987, p. 6), who assume that constituency and heads are fundamental linguistic concepts, as do Anderson & Ewen (1987, p. 283f.).

Second, like root sentences in syntax, phonological heads show the maximum complexity allowed by a grammar. Thus, heads and dependents may be equally complex; but if there is an asymmetry, it will always be the head that is more complex than the dependent. We will discuss a number of these head-dependent asymmetries (HDAs) at various levels of the phonology. At levels above the segment, our observations will be couched in terms of theories of metrical and prosodic structure that are widely accepted. We will argue that at the segmental level, too, there are HDAs of a similar nature, and that these can be perspicuously captured in terms of a theory that enables us to talk about the relative complexity of segments, so that, say, /o/ is more complex than /u/, and /ü/ is more complex than /i/. We then also consider HDAs in the phonology of sign languages, showing that certain asymmetries in two-handed signs form clear illustrations of heads allowing greater complexity than dependents.

Third, as in the Lightfoot–Rizzi hypothesis for syntax, we locate the origin of HDAs in the acquisition process. We assume that learners begin with relatively impoverished representations, and move to more richly articulated representations under the pressure of data. Moreover, the strategy of "pay attention to heads" implies that heads will be expanded before dependents. In many cases, the dependents catch up; but when they do not, the result is an HDA.

This article is organized as follows. In section 1 we will make some proposals and clarifications with regard to key terms such as complexity and dependency, and identify various kinds of HDAs. In the four sections that then follow, we will consider the nature of HDAs at various levels of prosodic structure. We assume the prosodic hierarchy in (1):

(1) *Prosodic Hierarchy*

i	intonational phrase	(section 2)
p	phonological phrase	(section 3)
w	phonological word	(section 4)
f	foot	(section 5)
s	syllable	(section 6)
...		

We will not consider HDAs at the syllable level and lower for reasons given in section 6. Section 7 is on HDAs in the phonology of signs and, finally, in section 8 we summarize our main points.

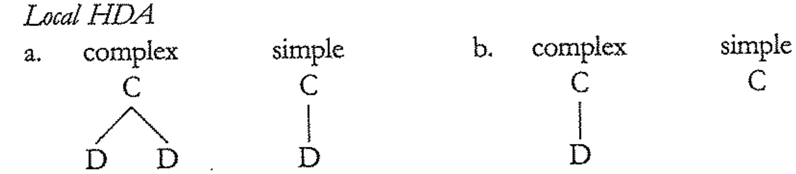
1. Basic notions

Let us note at the outset that complexity is a relative notion, so when we say that a constituent is complex, we always mean relative to one that is less complex. With that understanding, we will focus on two types of complexity asymmetry, which we will call local and nonlocal complexity in sections 1.1 and 1.2, respectively.

1.1. Local complexity

We will say that a node C has local complexity if it branches, whereas other nodes of the same type do not branch, as in (2a); or a node can be locally complex relative to other nodes if it has an immediate dependent when others do not (2b):

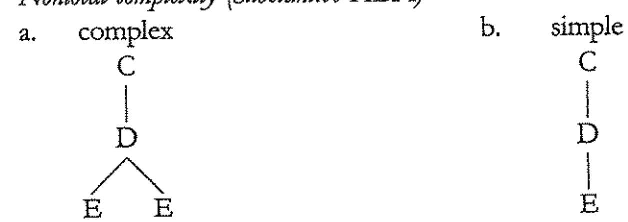
(2) *Local HDA*



1.2. Nonlocal complexity

A second type of complexity relevant to our discussion is nonlocal complexity, which refers to the internal structure of the immediate daughters of a node. In (3), for example, node C is nonbranching, and so has the same amount of local complexity in both cases; however, there is a difference in the complexity of node D:

(3) *Nonlocal complexity (Substantive HDA)*



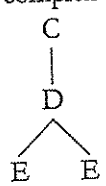
In the case of nonlocal complexity an important distinction arises, as to whether the remote structure — i.e. the internal structure of D in (3) — is accessible or not, a distinction to which we now turn.

1.3. Accessibility

In the simplest case, we might expect nonlocal HDAs to be parallel to local HDAs, as involving a distinction in the relative complexity of constituents. However, there is another, and perhaps more common, sense of nonlocal complexity: a node C is nonlocally complex when it has access to the internal structure of its daughters. In (4), C is complex if it has access to nodes of type E, and simple if it cannot "see" below the level of D:

(4) *Nonlocal complexity (Visibility HDA)*

a. complex



b. simple

opaque domain

In terms suggested by Jean-Roger Vergnaud, it is as if in the head position the D-level is incorporated into the C level. It is important to distinguish the two types of nonlocal HDA. In the former case shown in (3), which we will call a substantive HDA, a remote dependent of the head (3a) may actually be more complex than a remote dependent of a dependent (3b). In such cases, heads may require a certain complexity "lower down" in the hierarchy, where its dependents do not. In the example in (4), which we will call a visibility HDA, the asymmetry has only to do with accessibility: the internal structure of D in (4b) may in fact be equal in complexity to that of (4a), but since it is not accessible to the higher levels of structure, any complexity it may have does not count at the higher level.[1]

[1] Cf. the discussion of constraints on depth in connection with Chomsky's Strict Locality Principle, called the Head Constraint by Hoekstra, van der Hulst, and Moortgat (1980, pp. 27–38).

1.4. α-α vs. α-β dependency

Head-dependent relations can be of two types: a head and a dependent can be constituents of the same type, or they can be constituents of different types. Examples of the first type, which we call α-α dependency, are a series of feet in a word, of which one is the head and the others are dependents; or a series of syllables in a foot, or p-phrases in an i-phrase, and so on. The second type, which we call α-β dependency, involves heterogeneous constituents: for example, the relation between a nucleus and a coda, or a rhyme and its onset, if the first in each pair is considered to be the head of the second. An example at the segmental level would be manner and place nodes, if these enter into a dependency relation. Our discussion of HDAs is limited to α-α dependencies, for the simple reason that the potential complexity of heads and dependents in such relations are comparable. When the constituents are of different types, the complexity measures relevant to each may be different.[2]

1.5. Syntagmatic vs. paradigmatic HDAs

To say that the head position (H) allows (or requires) a greater complexity than a dependent position (D) conflates two different types of asymmetry:

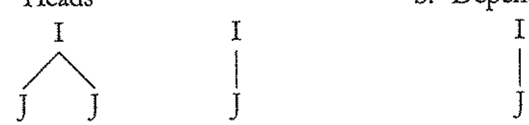
(5) a. *Paradigmatic (lexical) asymmetry*
The set of things, S_H, that may occur in H and the set of things, S_D, that may occur in D is nonidentical: $S_H \neq S_D$

b. *Syntagmatic asymmetry*
In a specific combination, C, what actually occurs in D may not be more complex than what occurs in H: $C_H \geq C_D$

A paradigmatic local asymmetry is illustrated in (6); heads may branch or not, dependents may not branch:

(6) *Paradigmatic HDA*

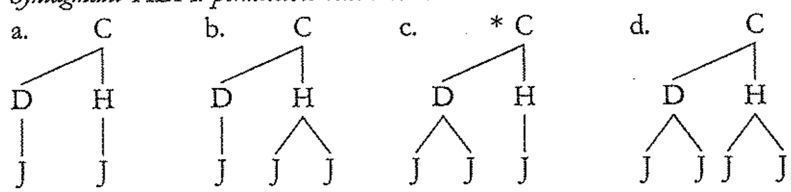
a. Heads b. Dependents



[2] This is not to say that there may not be relevant complexity relations between head and dependent in α-β dependencies: e.g. there may be implicational rules holding of the branching

A syntagmatic local asymmetry is illustrated in (7).

(7) *Syntagmatic HDA: permissible constituents*



In this example, heads and dependents may both branch, so there is no paradigmatic asymmetry; however, in any given structure, the dependent (D) may not be more complex than the head (H). Thus, (7c) is ruled out.

1.6. Relevant properties

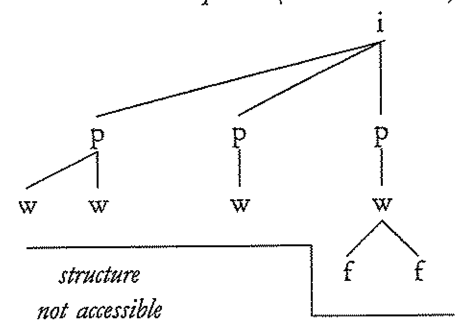
We would like to stress that when we refer to heads and dependents, we have in mind units that are defined with respect to prosodic or metrical structures that exist in a given language. That is, a head is not only a constituent that is somehow more prominent or salient than a dependent, but must have a well-defined relation to that dependent in terms of some higher-level structure. It is also necessary to bear in mind that not every property of a phonological unit is relevant to computing its complexity for purposes of HDAs. For example, in a quantity-insensitive stress system, the internal structure of a syllable has no bearing on its complexity as either a head or dependent of a metrical foot: every syllable in such a stress system has equal weight, regardless of its internal composition. By contrast, in a quantity-sensitive stress system, some aspects of the internal structure of syllables are relevant in determining the weight of a syllable; these properties, which may vary somewhat from language to language, are thus also relevant in assessing the complexity of the constituents of foot structures, while other properties are not. Here, then, we take a position that is fundamentally different from that presented in Steriade (1994), who characterizes positions (which we would like to think of as heads in many of her examples) in terms of their phonetic salience.

2. Intonational phrase level HDAs: head versus dependent phrases

We will begin with a relatively simple example at the level of the intonational phrase. In Tiberian Hebrew, the basic phonological phrase consists of two words or one word. These are the p-phrases in (8). The rightmost

phrase in an intonational phrase i is the most prominent one, a fact attested to by various phonological strengthening phenomena (vowel lengthening, heightened stress) which characteristically occur here. Thus, we can say that the rightmost phonological phrase is the head of its i-phrase, and the other phrases are dependents. Now we observe the following HDA: in the head phrase only, a long word counts as if it is two words. It can be shown (Dresher 1981a, 1981b, 1982) that the relevant notion of long word is a word which consists of at least two feet; thus, the long word in (8) exhausts its p-phrase, because it counts as if it were two words, the usual maximum. In (8), the head of i is the p directly under it, a convention we will use throughout:

(8) *HDA under the i-phrase (Tiberian Hebrew)*



The line represents the bottom level of structure that must be analyzed in the formation of each phrase. Dependent phrases look as far as the word level; the head phrase looks further, to the foot level. Thus, a word with two feet counts as branching in terms of the phonological phrase level. The head phrase, then, cannot be composed of two prosodic words if one of these is bipodal.

This is an example of a visibility nonlocal HDA: head phrases are sensitive to further levels of structure. In dependent positions, all words are treated the same, i.e. as one unit, irrespective of their internal make-up. In head positions, words are not equal. Our claim is that we will not find the reverse cases, where a richer analysis is required in dependent positions than in head positions.

3. Phrase level HDAs: head versus dependent words

Let us move down one level in the prosodic hierarchy, to the level of the phonological phrase.

3.1. Nonlocal visibility HDA

An HDA similar to that of Tiberian Hebrew is found in Italian. According to Ghini (1993), words within the domain of a maximal projection are organized into phrases so as to achieve symmetrical two-word phrases if possible, as in (9a), which has two two-word phrases; in the case of an odd number of words, the extra word is preferably assigned to the rightmost phrase, as in (9b), not (9c). In these examples, forms joined by hyphens comprise a single prosodic word:

(9) *Italian phrasing (based on Ghini 1993)*
 a. (ho-studiàto tútto) (il-libro di-tésto)
  'I have studied the whole textbook.'
 b. (ho-studiáto) (tùtto il-líbro)
  'I have studied the whole book.'
 c. *(ho-studiàto tútto) (il-líbro)

When a word in phrase-final position is long, however, the expected phrasing (10a) is not found; instead we find (10b):

(10) *Italian phrasing with long words in head position of P*
 a. *(ho-studiáto) (tùtta la-rìvoluzióne)
  'I have studied the whole revolution.'
 b. (ho-studiàto tútta) (la-rìvoluzióne)

If the long word *la-rìvoluzióne* is treated as an ordinary word, the pattern in (10) is hard to explain. However, if a long word (presumably a word with at least two feet) is counted as two words, then (10b) would exemplify the same balanced pattern as (9a), i.e. (w w) (w w). The phrasing in (10a) is ruled out as being too unbalanced: (w) (w w w).

Now, it turns out that long words are not always treated as being equivalent to two words for purposes of phrasing: when a long word is not phrase-final, it is counted as one word, as demonstrated in (11):

(11) *Italian phrasing with long words in dependent position of P*
 a. (ho-studiáto) (la-rivoluziòne francése)
  'I've studied the French revolution.'
 b. ?(ho-studiáto) (la-rìvoluzióne) (francése)

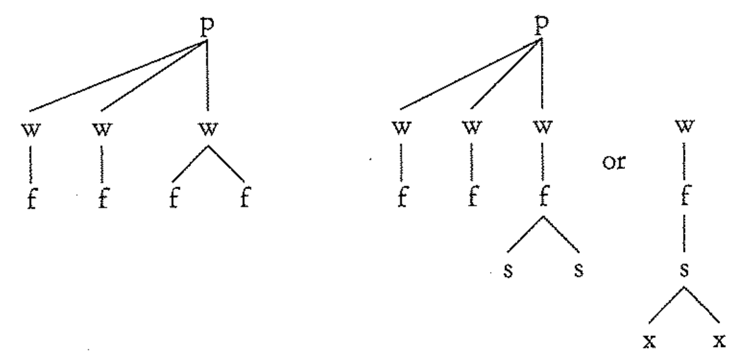
If *la-rivoluzióne* were counted as two words in (11), then (11a) would exemplify the usually avoided pattern (w) (w w w), parallel to (10a), and we might expect (11b) to be preferred. But this is not the case: (11a) is treated

just like (9b). These facts can be explained if, as in Tiberian Hebrew, the internal composition of a long word is relevant to phrasing only in head position. The difference between Italian and Tiberian Hebrew in this respect is that in Italian this HDA holds of every phrase, whereas in Tiberian Hebrew it holds only of the head phrase in an i-phrase.

3.2. Substantive HDAs

The above two examples both involve visibility HDAs: they illustrate an asymmetry between heads and dependents with respect to the accessiblity of lower levels of structure. We might also expect to find substantive HDAs at the p-phrase level. Some HDAs of this type are schematically illustrated in (12). Example (12a) illustrates a language where the word that occupies the head of a phrase, say the rightmost word in a phrase, may have a degree of complexity greater than that permitted to phrase-internal words. For example, the head word, but not the dependent words, might be required, as in (12a), to consist of two feet; or, in the nonlocal version of this HDA in (12b), the head word might be required to have at least a branching foot, or a foot dominating a branching syllable, a degree of structural complexity not required (or allowed) of dependents:

(12) *Substantive HDAs at the word level (hypothetical)*
 a. Local HDA b. Nonlocal HDA

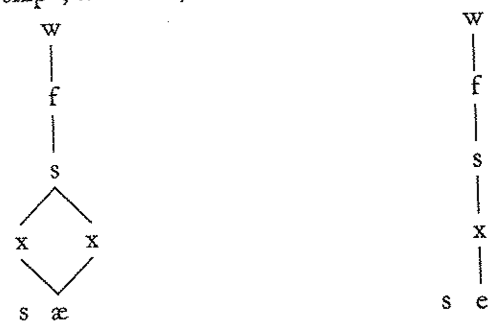


Example (12b) in fact illustrates the typical case of minimal word requirements. Many languages have such requirements, whereby a word must have a certain complexity. Such requirements are typically imposed on content words, i.e. words that can be the heads of maximal projections; other words, such as function words, i.e. words belonging to certain closed classes, are often excluded from these requirements, a point to which we return below. For example, a minimal word in Old English must have at least two moras, and adjectives (13a); however, minor class words may escape it, so that the words in (13b) are permissible:

(13) *Lexicalized HDA at the word level (Old English)*

a. Major class words
scip 'ship', *sæː* 'sea', **sæ*

b. Minor class words
we 'we', *se* 'that', *hwa* 'who?'



We propose that this type of case represents the lexicalization of an HDA: major class words, which are all potential heads, must be complex all the time, not just when they actually are in head position. Minor class words, which are never heads, may be exempt from minimality.

We could imagine a situation in which dependent words would be required to be nonbranching, but we do not expect to find this kind of asymmetry for major class, i.e. content, words, because such a situation would require pervasive allomorphy, whereby all major words would come in two forms: a longer form for head position, and a shorter form for other positions. Moreover, the allomorphy would have to be productive, to apply to new and in fact morphologically complex words if the system is to maintain itself.

Hence, such a situation would be very costly if it were applied to major class items. The same, however, is not true of closed classes, and we do find examples where minor class words come in two forms, strong and weak, whose distribution has a prosodic basis. An example is Modern English, where modals, possessives, determiners, and so on, come in strong and weak varieties. The weak varieties occur in phrase-medial or even cliticized positions, and often fall below the minimal weight requirement for regular English words: e.g. *n't* for *not*, *him* reduced to syllabic *m*, etc. These alternations have been discussed by Selkirk (1972).

To conclude this section, then, we consider the existence of asymmetric minimality requirements to be a lexicalized version of HDAs. Closed class items have forms which are not subject to minimality because these either do not occur as prosodic heads, or, if they do, the lexicon can afford to have two forms,a weak and a strong form.

4. Word level HDAs: head versus dependent feet

Moving one level down to the word level, we will now consider both local and nonlocal HDAs in the metrical structure of words.

4.1. Nonlocal HDAs

4.1.1. QS and QI feet

There is a phenomenon found in a number of languages whereby main stress appears to be sensitive to quantity, but secondary stress is not. Some examples are Seneca (Stowell 1979, Halle & Vergnaud 1987), Maung (Capell & Hinch 1970, Ghomeshi 1990) and to some extent English (Halle & Vergnaud 1987):

(14) *Main stress – secondary stress asymmetry*

a. Seneca:
Main stress falls on the last nonfinal even-numbered syllable that is either closed itself or immediately followed by a closed nonfinal syllable; secondary stress alternates in an iambic pattern preceding the main stress.

b. Maung:
Main stress falls on the first two syllables of words of up to three syllables (equally stressed), and on the penultimate of longer words, except that a preceding closed syllable tends to take primary stress; secondary stresses fall on alternate syllables preceding main stress.

c. English:
Main stress falls on a closed penult, otherwise on the antepenult; secondary stresses fall on alternate syllables preceding main stress.

In these languages, main stress depends on syllable weight and extrametricality; secondary stress then alternates back from the main stress in a quantity-insensitive fashion. Halle & Vergnaud (1987) find this situation to be so common that they give it a special name, the Alternator. The contrary situation, where main stress falls on a fixed syllable regardless of weight, while secondary stress is sensitive to quantity, appears to be rare, perhaps nonexistent.

Of course, we do not exclude cases of quantity sensitive systems where it happens that main stress always falls on the same syllable. For example, stress in Germanic is sensitive to quantity (Dresher & Lahiri 1991), but because feet are trochaic and built from the left, main stress always falls on the initial syllable. As Dresher & Lahiri point out, however, it **is** necessary to count moras, even in the head foot.[3] Here there is **no** asymmetry between head and dependent foot regarding quantity sensitivity.

A variant of this asymmetry in quantity sensitivity is found in languages like Spanish (Roca 1986; Halle, Harris & Vergnaud 1991), Italian (Vogel & Scalise 1982), and Chamorro (Chung 1983; Halle & Vergnaud 1987). In these languages, main stress falls on one of the last three syllables of the word in an unpredictable fashion, and secondary stress alternates evenly on preceding syllables. To account for main stress in such languages we may suppose that certain syllables may be exceptionally marked for accent. Such cases are like quantity sensitivity in that construction of metrical structure depends on some further property of syllables beyond just their linear sequence. In unbounded languages with systematic lexical accent, such as Russian and Sanskrit, any syllable may have a lexical accent; but in bounded languages, lexical accent has an effect only if placed on a syllable that falls in the main stress window.

These facts can be readily represented in terms of current versions of metrical theory, but they remain to be accounted for. Thus, it would be just as easy to model the opposite situation, i.e. to make the Alternator quantity sensitive, or sensitive to lexical accent, and main stress insensitive to quantity or accent.

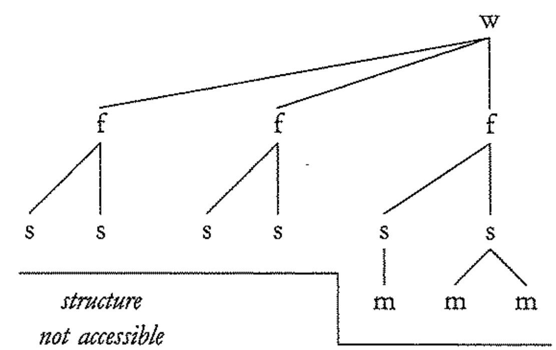
By now the explanation for this tendency should be evident: it is a nonlocal HDA at the level of the word, as shown in (15). The foot bearing main stress in a word is a head, whereas feet controlling secondary stress are subordinate to it. Only the head foot is built on lower-level projections from syllable structure in which the distinction between light and heavy syllables is maintained. The nonhead feet have no access to this distinction, and are rather built on undifferentiated lower-level structures.

The contrary situation, where secondary stress is sensitive to quantity while main stress is not, would require nonheads to attend to a distinction that is not available to the head.

In section 5.1 we will discuss the various ways in which head feet may be quantity sensitive. Note here, that a standard form of QS requires the weak syllables to be nonbranching. Nonlocality, then, implies that the head foot has access to the make-up of its daughters, i.e. its head **and** dependent syllables, not just to the make up of its head syllable.

[3] A similar situation obtains in Finnish, where main stress is fixed on the initial syllable. Here, too, the apparently laxer requirements on the head foot as compared with dependent feet need not analyzed as involving an asymmetry in sensitivity to quantity.

(15) *Nonlocal HDA at the foot level (main stress QS, alternator QI)*



Another variant arises when head and dependent feet show different ways of being quantity sensitive. In Chugach, for example, both long vowels and closed syllables count as heavy for the head foot, whereas only long vowels count as heavy for nonhead feet. In this case, both head and dependent feet have access to syllable structure. The asymmetry lies in the fact that the set of syllables that count as heavy for dependent feet is properly included in the set of syllables that count as heavy for head feet:

(16) *Chugach*

a. Heavy for dependent feet: VV

b. Heavy for head feet: VV VC

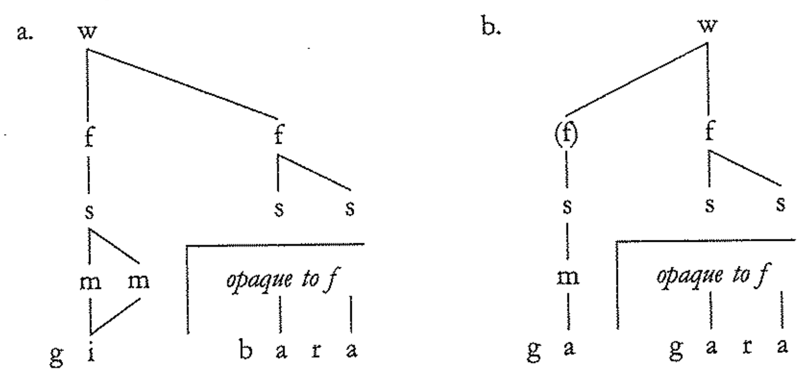
The question that arises here is how this asymmetry translates to a complexity distinction between VV and VC. We observe that many languages exist in which VV counts as heavy and VC does not, though the converse case is quite rare. Therefore, if quantity sensitivity must in general treat VV as heavy before VC, then in Chugach all feet have taken the first step, but only head feet have taken the further step.

4.1.2. The lexicalization of word level HDAs

So far we have discussed cases where a quantity distinction potentially exists throughout the metrical domain but is only exploited in the head. There is another type of situation in which certain syllable quantity types exist only in head feet. A typical example occurs in many Australian languages and is exemplified here by Wargamay (Dixon 1981; Hayes 1991): in simplex words, long vowels occur only in initial syllables, which in such cases bear main stress. If the initial syllable is light, main stress falls on the initial or second syllable depending on which is separated by an odd number of syllables from the right edge. This means that Wargamay has a count system, i.e. stress alternates trochaically from the end of the word and the leftmost foot carries main stress (cf. van der Hulst 1992).

In a word with an odd number of syllables the first syllable remains unfooted if we assume, as is usually done, that a single light syllable cannot form a foot. Given this, we derive main stress by saying that the leftmost foot is the head:

(17) *Lexicalized QS/QI HDA (Wargamay)*



But we believe that it is more revealing to assume that Wargamay has, and had, a HDA in that dependent feet disregard quantity and that this eventually has led to the loss of quantity everywhere except in the head foot.

According to Dixon (1980, p. 212), there is evidence that Proto-Australian had a contrast between long and short vowels in initial syllables, but there is no evidence for long vowels in other syllables. We might nevertheless speculate that at some earlier stage Proto-Australian may have allowed long vowels in noninitial positions also, but had metrical feet which exhibited a nonlocal HDA: dependent feet could look only as far as s, whereas head feet could look deeper. Such a situation could lead diachronically to a loss of the quantity contrast everywhere but in the head foot.

It is instructive to observe what happens in Australian languages where the stress shifts away from the initial syllable. Such a shift has the potential to create a situation where the initial syllable, now a nonhead syllable, retains a contrast between long and short vowels which does not hold of the new head syllable, thus creating a violation of our principle that a dependent syllable may not be more complex than a head. It is noteworthy, then, that such situations do not appear to occur; if they do occur, they are not permitted to persist.

A striking example of this occurs in the Cape York "initial-dropping" languages, whose history was reconstructed by Hale (Hale 1964; Dixon

1980). In these languages, stress shifted from the first to the second syllable, and changes occurred to the initial syllable: the word-initial consonant may be dropped, and the vowel deleted if short, and shortened or dropped if long. (In some cases traces of the initial CV are transferred to the second syllable by metathesis, but we will not discuss that process here.) The historical sequence of these changes is not known. If the reduction of initial syllables preceded the stress shift, then there would be no long vowels anywhere in the language, and no violation of an HDA. If stress shift preceded, then there would have existed a stage immediately following stress shift where long vowels existed only in initial unstressed position, and never stressed (in second position). This follows from the assumption that the earlier stage had long vowels only in the initial syllable.

Such a stage, if it ever existed, would be a counterexample to our claim, since the head foot of a word, now starting with the second syllable, would be systematically lacking a level of complexity, represented by long vowels, which occurs in a dependent position, the initial syllable (a degenerate foot). It is significant, therefore, that this kind of asymmetry is not observed in the Cape York dialects. On the strong interpretation of our theory of HDA, in which such asymmetries are never allowed, a hypothetical stage of the type just sketched would be impossible: in that case, the development of peninitial stress could not occur prior to one of two ocurrences: either the reduction of long vowels in the initial syllable, or the development of new long vowels in the second syllable. Lacking new long vowels, the historical sequence would have had to be reduction of initial syllables followed by stress shift.

On the weaker interpretation of HDAs, it could be that violations may arise through particular historical circumstances, but that the highly marked state so produced would be historically unstable and subject to change. Barring evidence to the contrary, we will continue with the strong intepretation. Putting this in terms of a typology, we find (a)–(c) below, but not (d):

(18) *Length contrasts*
a. languages with long vowels in stressed and unstressed syllables
b. languages with no length contrast at all
c. languages with long vowels only in stressed syllables
*d. languages with long vowels only in unstressed syllables

These languages are different from ones where long vowels occur throughout but do not count as heavy.

The idea that quantity is reduced in dependent feet is in fact synchonically attested in some Australian languages, where long vowels, though confined to morpheme-initial position, may nevertheless potentially occur in word-medial position due to morphological concatenation of morphemes. In some languages, such as Dhuwal and Ritharngu of the Yuulngu group (Heath 1980a; 1980b), such vowels are systematically shortened.[4]

We thus have a range of cases in which quantity distinctions are suppressed in nonhead positions. In the first type, syllable quantity distinctions exist throughout, but are not counted by metrical structure in nonhead positions, as in the Alternator cases. In the second type, syllable quantity distinctions exist in lexical (underlying) structure, but are suppressed by the phonology in the course of the derivation, as in Chimwiini. In the third type, syllable quantity distinctions are restricted by the grammar (morpheme structure conditions) to head positions, as in Wargamay.

What is simply stipulated in the first type is achieved by "conspiracy" in the other two cases. Though the formal mechanisms are different, they lead to similar results.

4.2. Local HDAs

4.2.1. LCPR

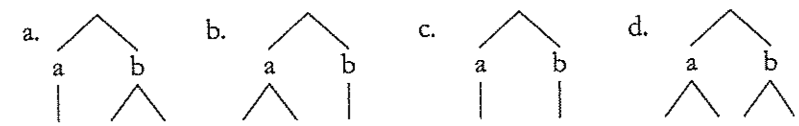
A form of local complexity reveals itself in stress systems (eg. Dutch) that have been analyzed in terms of the so-called Lexical Category Prominence Rule (LCPR) (Liberman and Prince 1977). The essential idea of this labelling rule is that head feet must be branching, iff peripheral. The iff-clause is crucial because in case a penperipheral foot happens to be nonbranching as well this foot will be the head. The LCPR has a "right" and a "left" possibility:

(19) *LCPR (Liberman and Prince 1977)*
 a. LCPR(r): right node is the head iff it branches (default is left)
 b. LCPR(l): left node is the head iff it branches (default is right)

By "default" we mean the situation that holds if the condition imposed by the LCPR fails. Consider the following four unlabelled structures:

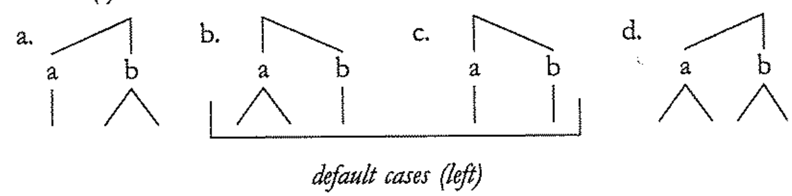
[4] This type of neutralization occurs also as a manifestation of a nonlocal phrase-level HDA and of a local foot-level HDA. The former is found in Chimwiini (Kisseberth & Abasheikh 1974; Selkirk 1986; Hayes 1989), which has underlying long vowels throughout, which are permitted to surface only in one position in a phrase, corresponding to the head metrical position (an abstract main stress). Here, shortening rules are called in to reduce all long vowels in nonhead positions. The latter happens in Yidinj where long vowels reduce in dependent syllables only.

(20) *Unlabeled structures*

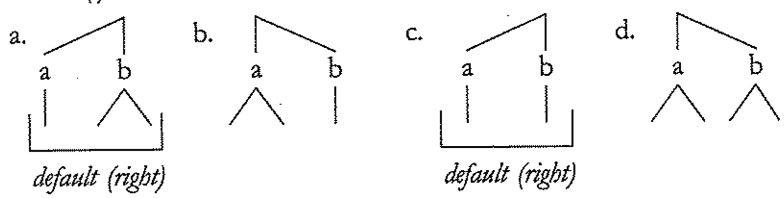


The LCPR(r) and LCPR(l) will label these two structure as follows:

(21) *LCPR (r)*



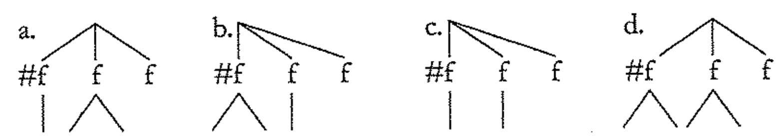
(22) *LCPR (l)*



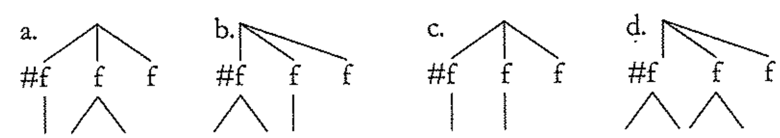
Observe that in one of the cases referred to here as the default situation (cases (21c) and (22c)), an element can be the head without being branching.

When we compare the effect of applying both orientations of the LCPR in (19) at the same edge on a tree that contains more than two feet, we see that one orientation locates the head on a peripheral foot iff branching, whereas the other orientation locates the head on the penperipheral foot iff it is branching. We will illustrate this for the left edge of the word:

(23) *LCPR (r) (applied at the left edge of the word)*



(24) *LCPR (l) (applied at the left edge of the word)*



In (23), the head is nonperipheral iff the nonperipheral node is branching. In (24), the peripheral node is the head iff branching. It seems reasonable to assume that the original conception of the LCPR only reckoned with (24), i.e. with situations in which the condition is on the peripheral foot. In that case, the LCPR(l) should only be allowed to apply at the left side of the word, and the LCPR(r) only to the right side. Let us refer to such a limited (and presumably intended) version of the LCPR as LCPR′.

It has been argued that the LCPR′ must be eliminated, because its effect can be replaced by another mechanism, viz. extrametricality (Prince 1983). Since the extrametricality mechanism has been limited to peripheral syllables, and we have just argued that the LCPR′ is, too, this seems a likely possibility.

It turns out, however, that we can only dismiss the LCPR if we distinguish between early extrametricality and late extrametricality (Zonneveld & Trommelen 1994). In the case of early EM, a peripheral syllable is ignored for foot assignment. In the case of late EM, feet are first assigned, and then the final syllable is made extrametrical. This implies that late EM will only have an effect if the syllable in question is the head of a foot. **Only late** EM can replace the LCPR′. If we want to replace the LCPR′ by early EM, we must add the condition that extrametricality is sensitive to branching. We can see this in (24): if the pattern there must be accounted for in terms of early EM, we must say that the initial unit is EM iff nonbranching.

In our view, replacing the LCPR′ by late EM obscures the basic reason for this effect, which in this context is to be regarded as an HDA: head feet must branch (iff peripheral).

5. Foot level HDAs: head versus dependent syllables

A local HDA exists if the immediate complexity of syllables interferes with the assignment of feet. This phenomenon is generally referred to as quantity-sensitive foot assignment. It is well-known, however, that foot assignment may be sensitive to aspects of syllable structure that are not local, in the sense that segmental information appears to be relevant. Hayes (to appear) separates quantity (syllabic complexity, i.e. long *vs.* short vowels, closed *vs.* open syllables) from prominence, which involves segmental properties.

In this section we discuss various ways in which HDAs are manifested at the foot level. We discuss these difference in terms of local quantity distinctions (i.e. branching vs. nonbranching). In principle, however, we may expect to find the same asymmetries in a nonlocal variety.

5.1. The local variety

A language may have a quantity-insensitive (QI) stress system, which means that syllable weight is not evaluated for purposes of the metrical system. In such a system, the internal structure of the syllable is not a relevant property for evaluating complexity. Therefore, any syllable can occupy any position in a foot without incurring a complexity asymmetry. When weight becomes relevant, i.e. when a stress system is quantity sensitive (QS), we have to take into account what the relevant units are which bear on it. So the first step from QI to QS is to recognize a distinction between heavy (H) and light (L) syllables.

In foot theory, quantity sensitivity comes in a number of varieties. In the following table, we assume syllabic left-headed binary (trochaic) feet:

(25) *Varieties of quantity-sensitive trochees*

	QS type	H L	L L	H H	L H	Type of HDA
a.	No-mis	Yes	Yes	Yes	No	Syntagmatic
b	QS	Yes	Yes	No	No	Weak paradigmatic
c.	ROB	Yes	No	Yes	No	Weak paradigmatic
d.	OB	Yes	No	No	No	Strong paradigmatic

This table lists logical possibilities which do not violate the HDA principle. We can generate other possibilities which do violate HDA, e.g. a foot type which allows only L H, but these have not been contemplated, to our knowledge.

We can make sense of the variety in (25) by assuming that there is a path from minimal to maximal quantity sensitivity. Minimal QS results in the no-mismatch foot (25a): the only situation that is avoided in this case is one in which the intrinsic weight of the syllables clashes with the extrinsic prominence relation imposed by foot organization. No-mismatch feet were discussed and applied (mistakenly, as it turns out) to the Dutch stress system in van der Hulst (1984). Recently, they figure in the analysis of Finnish secondary stress (cf. Grijzenhout 1992).

The other pole, maximal QS, results in OB feet (25d), introduced in Halle & Vergnaud (1978) and Hayes (1980). Here, the very presence of a foot requires a heavy syllable, whereas the dependent position only supports a light syllable.

In between minimal and maximal QS we find two stations on different routes from minimal to maximal QS. In the foot type (25b), the H H foot has been removed. This case has always been considered to be the standard form of QS: in head position, both heavy and light syllables may occur, but in the dependent position only light syllables are tolerated. Hammond (1986) proposes the Revised OB foot type in (25c), which allows H H, but bans the L L option.

The differences between these foot types exemplify the distinction between what we have called paradigmatic (lexical) and syntagmatic HDAs. A syntagmatic asymmetry, wherein a given foot has a head which is less complex than its dependent, is ruled out by all QS foot types. There is no paradigmatic asymmetry in (25a), since the set of syllables which can appear in the head (S_H) is the same as the set of syllables which can appear in the dependent (S_D): in both cases, the set comprises {H,L}.

The asymmetry that may arise between S_H and S_D may take various forms. In the case of OB feet (25d), S_H and S_D are disjoint: S_H={H} and S_D={L}. Let us say that maximal QS entails a strong paradigmatic (lexical) asymmetry (i.e. no intersection between the head and dependent lexicon). The other two cases instantiate relations in which the S_D= {L} is properly included in S_H={L,H} (the standard form of QS) or *vice versa* — S_H={H} is properly included in S_D={L,H} (ROB). Both cases anticipate maximal QS by specializing either the strong lexicon (S_H) or the weak lexicon (S_D). The appropriate generalization over both cases is that the complexity of weak lexical items is not greater than the strong lexical items.

Because lexical specialization is part of the HDA phenomenon, we cannot simply say that it is always the case that the head position reveals all the lexical possibilities. We see this in the ROB feet, but another typical situation involving weak specialized lexical items involves, in the case of foot structure, "reduced" lexical items, i.e. syllables with a schwa (or empty) head (cf. 2b).

We are not aware of any specific metrical theory that incorporates all the foot types in (25). We are not concerned at this point with arguing for or against a specific version of foot theory, but we do believe that the array of possibilities in (25) makes sense in terms of the various types of syntagmatic and paradigmatic HDAs discussed above, and can in fact be put to use more generally at different levels in the phonological hierarchy. Thus, the common minimal word requirement we discussed in section 3.2 above follows the ROB pattern: heads must branch, but dependents need not.

5.2. The nonlocal variety

We believe that separating local and nonlocal complexity (a distinction which is akin to the distinction between quantity and prominence made by Hayes, in press) opens new perspectives on the analyses of various stress systems in which the factors determining weight appear to be somewhat

opaque, or a "mixture" of various factors.[5] We will now discuss a number of specific cases in which the distinction between the strong and weak inventory does not involve local complexity, i.e. branching vs. nonbranching, but rather complexity at the segmental level.

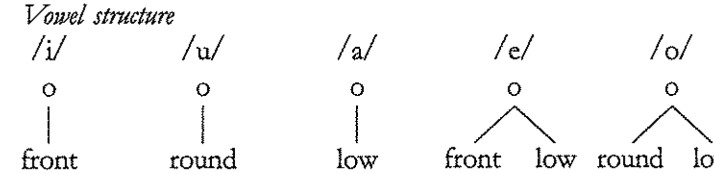
Consider first the often-cited case of Russian, where a strong syllable may contain either of the five vowels in (26a), whereas weak syllables can only contain those in (26b):

(26) *Russian vowels*

a. in strong syllables	b. in weak syllables
i u	i u
e o	
a	a

In order to be able to classify this as a case of nonlocal complexity, we need a theory of segmental representation which ranks the three peripheral vowels as less complex than the two mid vowels. Most theories which view vowels as being composed of combinations of basic particles or elements (versions of dependency phonology, particle phonology, and government phonology) have this property, as shown in the minimal representations in (27):

(27) *Vowel structure*



In such theories, the basic units are unary features which can occur separately or in combination. As shown, mid vowels are branching under this view, and more complex than the other vowels. In the above example, then, the generalization is that vowels with branching structures are permitted only in stressed syllables.

Asymmetries between sets of stressed vowels and sets of unstressed vowels having roughly this character are quite common. A number of such cases were collected by Trubetzkoy (1969). Trubetzkoy's interest was in developing a theory of neutralization, which has obvious points of contact with our enterprise. Thus, in Trubetzkoy's terms, privative and gradual

[5] It is useful to refer to syllable weight in a more abstract sense, as distinguishing between heavy and light syllables however they are characterized in a specific language. Thus, rhymal or nuclear complexity (including quantity) is one expression of weight (local complexity); nonlocal weight distinctions could include segmental properties.

oppositions involve a contrast between an unmarked segment and a segment or segments which are marked for the property in question. Since the neutralization product of such oppositions (the archiphoneme) "can only contain that which is common to both opposition members" (1969, p. 82), it follows that they will neutralize to the unmarked member. We expect that segmental complexity will reflect markedness: if asymmetries between stressed and unstressed vowel sets reflect complexity restrictions on the latter, we expect that the more complex vowels will be the ones that are missing.

Another interesting case is that of Bulgarian, which has stressed and unstressed vowel sets as in (28):

(28) *Bulgarian vowels (Trubetzkoy 1969)*

a. in stressed syllables

i				u
		ə		
	e		o	
		a		

b. in unstressed syllables

i		u
	ə	

We may assume that the structure of Bulgarian vowels is as in Russian. We represent schwa as an indeterminate vowel with no expansion, i.e. as simply a node dominating no structure. We can derive the vowels of unstressed syllables by ruling out any vowels with the element [low].[6]

In the above cases, we have been comparing vowel sets, and neutralization here refers to the difference between contrasts found in one set and the other. More specific evidence bearing on vowel structure and vowel complexity can be found by looking at actual alternations in which the same underlying vowel can be observed in both stressed and unstressed positions. Kamprath (1991) compares neutralization patterns in Catalan and Romansh. According to her, both languages have a seven-vowel stressed system and a three-vowel unstressed system, as shown in (29) below.

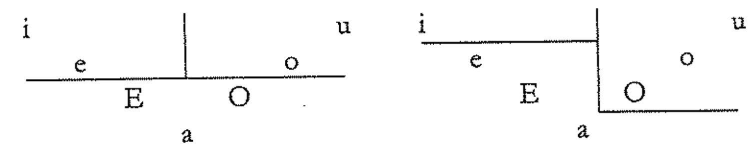
Though these systems look the same, they differ in their neutralization patterns. In Catalan, all round vowels neutralize to [u], and all other vowels except /i/ become schwa. In Romansh, the higher mid vowels /e/ and /o/ neutralize to their high counterparts.

Kamprath suggests that these different neutralization patterns can be

[6] Thus, branching vowels are banned from weak position, but so is the low vowel, which is actually simplex. The reason for banning /a/ is obvious, this being the most prominent vowel, but at this point we reach the limit of "translating" the facts into a pure branching-non branching distinction. Perhaps other dimensions of complexity are implicated in this and similar cases, but we will not pursue this possibility here.

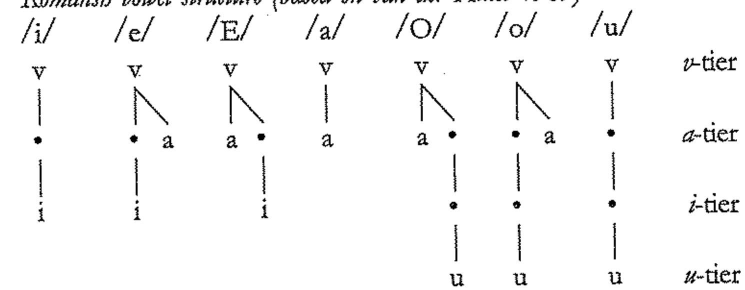
(29) *Romansh and Cataln neutralization patterns (Kamprath 1991)*

a. Raeto-Romansh *b. Catalan of Barcelona*



accounted for if we suppose that mid vowels are differently represented in the two languages. For representations, she adopts the model proposed by van der Hulst (1989), which elaborates considerably on the simple structures we have been using to here (see further van der Hulst 1994). In this model, the basic elements |i|, |u|, and |a| roughly stand for front, round, and low, respectively (though the interpretation is somewhat more complex than this), and head-dependent relations hold of the elements. Kamprath proposes that in Romansh /i/ and /e/ are headed by the |i| element, /u/ and /o/ by the |u| element, and the other vowels by |a|; thus, all segments neutralize to their heads in unstressed syllables:

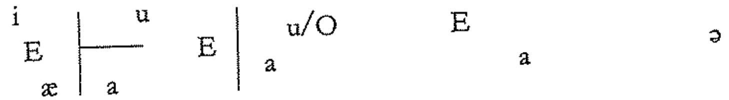
(30) *Romansh vowel structure (based on van der Hulst 1989)*



By contrast, she proposes that in Catalan, all the round vowels are headed by the |u| element, and all the other vowels except /i/ are headed by |a|. While this is one possible approach, the required structures are rather complex and asymmetrical. Another possibility is that the vowel structures of Catalan are basically the same as for Romansh, but the neutralization process is different. Whereas in Romansh reduction is always to the structural head, in Catalan it may be element-driven: thus, all vowels with a |u| element, whether as head or dependent, reduce to it, and all vowels with an |a| element reduce to schwa.

Another type of evidence bearing on this issue comes from diachronic mergers of vowels. For example, Early Old English (Campbell 1959) had the unstressed vowels shown in (31a):

(31) a. Stage I b. Stage II c. Stage III d. Stage IV



In a subsequent stage, the three front vowels merged to E and /u/ developed a prominent allophone O, creating the system in (31b). Still later, the two back vowels merged, creating an opposition between a and E, which is perhaps schwa (31c). The end of the process was the final reduction of all unstressed vowels to schwa (31d). We can interpret this sequence as involving increasing restrictions on what may be a head in unstressed position. In stage (a), vowels may be headed by all three elements, though there are restrictions on complexity, since front rounded vowels and o, which appear in stressed syllables, are excluded. In the next stage, interpreting the derived vowel as schwa, no vowels with branching structures or with an |i| head are permitted. In the third stage, the |u| element is excluded, and the fourth stage represents the state of minimum complexity.

Reduction to schwa raises another issue which is relevant to our discussion. In Old English, unstressed vowels may have started out as a subset of the stressed vowels, but by the time schwa arises, this can no longer be the case, since schwa is excluded from stressed syllables. In many other languages, too, we find that the vowels in dependent positions are not just a subset of those in head positions. In unstressed position we often find reduced vowels of various kinds which may be excluded from stressed syllables. In such cases it is evident that head positions impose conditions of minimum complexity which reduced vowels do not meet.

This situation is also found in Modern Dutch, where according to the standard analysis (cf. Zonneveld & Trommelen 1994) closed syllables are heavy and never dependent, and open syllables are light, and can be both head and dependent. Schwallables, however, must be dependent:

(32) *Modern Dutch feet*

Dependent syllables:	schwa, open
Head syllables:	open, closed

One might consider the possibility that this is really an OB system:

(33) *Dutch feet as OB*

Dependent syllables:	reduced
Head syllables:	full

Under this analysis (which is explored in van der Hulst & Moortgat 1981; van der Hulst, in prep.) open and closed syllables form a class of full-vowel syllables. The difference in behavior between both nonreduced syllable types (i.e. closed syllables are heavier than open syllables) must then be expressed one level up, i.e. at the level where feet are combined into words.

Another possibility, however, is to say that three degrees of weight (closed, open, schwa) may result when both local and nonlocal complexity play a role at the same time. The full vowel - schwa distinction is one of prominence (nonlocal complexity), whereas the closed - open distinction is local.[7]

To conclude this discussion, it should be noted that complexity may not be the sole determiner of the shape of vowel systems. Thus, it has been noted that {a i u} is the favoured three-vowel system, as opposed to, say, {a E O}. While suggestive, this fact by itself does not necessarily demonstrate that /i/ and /u/ are structurally simpler vowels than /E/ and /O/; rather, the vowel system may be favoured because it achieves maximum dispersion over the vowel space (Crothers 1978; Disner 1984; Maddieson 1984). Apart from observations of commonly occurring vowel systems, study of how segments participate in head-dependent asymmetries and patterns of neutralization provoked by these provide a fruitful source of evidence bearing on segmental complexity.

6. HDAs at the syllabic level and lower

Descending the hierarchy, we arrive at levels where fundamental differences of opinion seem to exist regarding the very nature of the units that are combined to form constituents. At the syllabic level, for example, we are confronted with two rather different views: the moraic theory and the onset-rhyme theory. Similarly, different views of segment structure have different implications for evaluating complexity, and hence for HDAs. To pursue the study of HDAs at these levels, we therefore have to first decide what these units are before we can investigate the way in which HDAs manifest themselves. We hope to present a systematic discussion of these issues elsewhere.[8]

[7] Kager (1989) suggests that "melodic complexity" plays a role in stress assignment in Dutch. He, however, refers to various types of full vowels, whereas we focus on the distinction between null-complexity (schwa) and the presence of structure (full vowels), i.e. on the distinction in (2b).

[8] Van de Weijer (1994) contains a discussion of HDAs on the segmental level in the context of a dependency-based model.

7. HDA in the phonology of two-handed signs

Our goal in this section is to explore one way in which HDAs are manifested quite clearly in the organization of signs.[9]

Many signs make use of both hands rather than just one. To refer to the hands, Padden and Perlmutter (1987) use the terms "strong hand" and "weak hand" rather than "preference hand" and "nonpreference hand". The preference hand will normally be the strong hand, but this is not a necessity.

Battison (1978) distinguishes three types of two-handed signs:

(34) *Two-handed signs (Battison 1978)*

a. Type 1:
Two-handed signs in which both hands are active and perform identical motor acts; the hands may or may not contact each other, they may or may not contact the body, and they may be in either a synchronous or alternating pattern of movement (ASL: WHICH, CAR, RESTRAIN-FEELINGS)

b. Type 2:
Two-handed signs in which one hand is active and one hand is passive, but both hands are specified for the same handshape (ASL: NAME, SHORT/BRIEF, SIT/CHAIR).

c. Type 3:
Two-handed signs in which one hand is active and one hand is passive, and the two hands have different handshapes [...] (ASL: DISCUSS, CONTACT (A PERSON)).

In the subsequent literature, type 1 has been opposed to types 2 and 3, the idea being that in the latter types the nonpreference hand can be seen as the "place of articulation" for the strong hand. Van der Hulst (1993) refers to signs in which the weak hand is a place as "unbalanced", whereas the other type is referred to as "balanced".

Since Stokoe (1960), researchers have adopted an analysis of signs in terms of a number of "class nodes", such as Place, Handshape, Location and Movement. For the purpose of this discussion, we can say that in balanced signs both hands have equal specification for all class nodes. Since all signs have some kind of movement (of the hand or fingers, or both), we can say that in balanced signs both hands have the same movement. In

[9] More extensive discussions of two-handed signs can be found in van der Hulst (forthc.), Sandler (to appear a) and van der Hulst & Sandler (1994).

unbalanced signs, the strong hand shows movement while the weak hand is kept still.

In addition, in unbalanced signs the handshapes of both hands **may** differ, but if the handshapes do not differ, we have type 2 in (34). If the handshapes do differ, the weak hand has a choice from a very limited set (at least among the most frequent cases):

(35) Weak handshapes in unbalanced signs

ASL:	A/S	B	5	C/O	G
SLN:	S	B	5	C	
(	FIST	FLAT	FLAT-SPREAD FINGERS	"OPEN" FIST	POINTING FINGER)

The handshapes that may be selected are unmarked. According to Battison (1974, p. 6–7), these handshapes:

· are maximally distinct both in articulatory and perceptual terms;
· have a high frequency of occurrence in a wide variety of contexts;
· are found in all other sign languages studied to date;
· are among the first handshapes acquired by children;
· are the outcome of substitution errors;
· are capable of contacting other body parts in a greater variety of ways.

Sandler (to appear a) contains a broad discussion of the markedness issue and offers a formal charactization of unmarked shapes.

In the current literature, there are differing views as to how to represent two-handed signs. The more specific question is whether the weak hand is represented separately in all cases (with various degrees of underspecification), only in some cases, or not at all. Variants of all three positions have been defended. The most conservative position is that which somehow or other represents the weak hand separately in all cases. Most recently, this position has been taken in Brentari (1991) and van der Hulst (forthc. b). Sandler (to appear b) proposes to represent only the weak hand in balanced signs.

Van der Hulst argues that the asymmetry between strong and weak handshapes fits the general HDA syndrome rather well. If we assume that the two hands enter into a head-dependent relation in which the strong hand is the head, the limitation on weak handshapes is entirely in line with the general asymmetry between heads and dependents. The class of weak handshapes that may occur in unbalanced signs forms a subset of the class of strong handshapes. This phenomenon is in fact very reminiscent of the widespread asymmetry between strong and weak syllables in foot structure. In such cases, we often see that the set of vowels which may appear in weak syllable, is a proper subset of the set that occurs in strong position. Moreover, the subset occurring in the weak position counts as the unmarked set. In balanced signs, we find an even more dramatic reduction for the dependent hand: all contrast has been removed.[10] Clearly, if the weak hand-as-place is represented under the place node, we have no formal basis for explaining this asymmetry.

8. Conclusion

To conclude, we have tried to show that head-dependent asymmetries occur at all levels of the phonology. In particular, these asymmetries systematically correspond to differences in complexity, in the sense that heads can be more complex than dependents in two ways, which we have referred to as local and nonlocal complexity.

We have not discussed the implications these facts might have for the developmental course of acquisition; however, if this investigation is on the right track, we expect that the empirical study of stages of acquisition will shed a great deal of light on head-dependency relations.

Among his strategies of acquisition, Slobin (1973) proposed maxims such as "pay attention to stressed syllables", "pay attention to the beginnings (or ends) of words", and so on. The question arises, what is it about these things that makes them part of a class to which learners should pay special attention? Our proposal is that they are all heads at some level of the grammar, and that many of these maxims can be subsumed under a more general one: "pay attention to heads!"

Acknowledgements

Work on this article began when the coauthors collaborated in the Project on Language Acquisition sponsored by NIAS (Netherlands Institute for Advanced Study in the Humanities and Social Sciences) in 1990–1991. Early versions were presented at: the GLOW Workshop on Acquisition of Phonology, Leiden University, March 1991; the Workshop on Formal Issues in Language Acquisition, Max-Planck-Institut für Psycholinguistik, Nijmegen, June 1991; the MOT Phonology Workshop, University of Ottawa, January 1992; and the First HIL Conference on Phonology, Leiden University, January 1993. This article is a revised version of Dresher & van der Hulst (1993). In addition to the organizations mentioned above, Dresher acknowledges the support of SSHRCC (Social Sciences and Humanities Research Council of Canada) Research Grant 410–92–0885.

[10] In a somewhat similar spirit, Brentari (1990) and Brentari and Goldsmith (1992) represent the weak hand as a kind of "coda", deriving the limited number of contrasts as a "coda weakening effect".

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