Morphological Word Structure in English and Swedish: the Evidence from Prosody [1]

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Abstract

Trubetzkoy's recognition of a delimitative function of phonology, serving to signal boundaries between morphological units, is expressed in terms of alignment constraints in Optimality Theory, where the relevant constraints require specific morphological boundaries to coincide with phonological structure (Trubetzkoy 1936, 1939, McCarthy & Prince 1993). The approach pursued in the present article is to investigate the distribution of phonological boundary signals to gain insight into the criteria underlying morphological analysis. The evidence from English and Swedish suggests that necessary and sufficient conditions for word-internal morphological analysis concern the recognizability of head constituents, which include the rightmost members of compounds and head affixes. The claim is that the stability of word-internal boundary effects in historical perspective cannot in general be sufficiently explained in terms of memorization and imitation of phonological word form. Rather, these effects indicate a morphological parsing mechanism based on the recognition of word-internal head constituents.

Head affixes can be shown to contrast systematically with modifying affixes with respect to syntactic function, semantic content, and prosodic properties. That is, head affixes, which cannot be omitted, often lack inherent meaning and have relatively unmarked boundaries, which can be obscured entirely under specific phonological conditions. By contrast, modifying affixes, which can be omitted, consistently have inherent meaning and have stronger boundaries, which resist prosodic fusion in all phonological contexts. While these correlations are hardly specific to English and Swedish it remains to be investigated to which extent they hold cross-linguistically.

The observation that some of the constituents identified on the basis of prosodic evidence lack inherent meaning raises the issue of compositionality. I will argue that certain systematic aspects of word meaning cannot be captured with reference to the syntagmatic level, but require reference to the paradigmatic level instead. The assumption is then that there are two dimensions of morphological analysis: syntagmatic analysis, which centers on the criteria for decomposing words in terms of labelled constituents, and paradigmatic analysis, which centers on the criteria for establishing relations among (whole) words in the mental lexicon. While meaning is intrinsically connected with paradigmatic analysis (e.g. base relations, oppositeness) it is not essential to syntagmatic analysis.

[1] Parts of this material were presented at the workshop on word structure in Leipzig (April 2004), at the MMM5 in Fréjus (September 2005), at the universities in Tübingen (February 2005), Stony Brook, Princeton (March 2006) and the Institut für Deutsche Sprache in Mannheim (May 2006). I thank the audiences for valuable comments and criticism, in particular I wish to acknowledge Joachim Ballweg, Stig Eliasson, Christiane Fellbaum, Lutz Gunkel, Alice Harris, Robert Hoberman, Daniel Osherson, Hubert Truckenbrodt, Bernd Wiese, and Gisela Zifonun. Thanks to Roger Schwarzschild for discussing the ideas in section 4 with me. All errors are mine.

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1. Introduction

The question of whether and how to divide words into morphological constituents is controversial. Some consider the word the smallest unit of grammatical analysis and reject segmentation altogether, in accordance with the traditional position in western linguistics (cf. Robins 1967:25). On such a view, morphological analysis amounts to recognizing relations among whole words in the mental lexicon, based on similarities in meaning and form (cf. Paul 1880). Once these relations are established, learners may detect recurrent patterns, allowing for the abstraction of schemas or 'correlative patterns' (Marchand 1969:) of the types illustrated in (1).

(1) a. [ri:zʌ́mpʃən]$_N$ 'resumption' - [ri:zú:m]$_V$ 'resume'
[əsʌ́mpʃən]$_N$ 'assumption' - [əsú:m]$_V$ 'assume' [Xʌ́mpʃən]$_N$ - [Xú:m]$_V$
[kənsʌ́mpʃən]$_N$ 'consumption' - [kənsú:m]$_V$ 'consume'

b. [ɔ:dǽsəti]$_N$ 'audacity' - [ɔ:déɪʃəs]$_A$ 'audacious'
[tɪnǽsəti]$_N$ 'tenacity' - [tɪnéɪʃəs]$_A$ 'tenacious' [Xǽsəti]$_N$ - [XéɪʃəS]$_A$
[mɛnd´æsəti]$_N$ 'mendacity' - [mɛndéɪʃəs]$_A$ 'mendacious'

c. [ʃáɪnəs]$_N$ 'shyness' - [ʃáɪ]$_A$ 'shy'
[káɪndnəs]$_N$ 'kindness' - [káɪnd]$_A$ 'kind' [Xnəs]$_N$ - [X]$_A$
[i:vənnəs]$_N$ 'evenness' - [i:vən]$_A$ 'even'

The knowledge of schemas such as [xʌ́mpʃən]$_N$ – [xú:m]$_V$ is prone to enhance the recognizability of relatedness between additional pairs (e.g. *subsumption* - *subsume*)and could be used productively to coin new words (e.g. ? [ɪgzʌ́mpʃən] '*exhumption'* based on knowing the verb [ɪgzú:m] *exhume*[2]).

While it would be possible to enrich the schemas by inserting word-internal (labeled) brackets, there is no clear motivation for doing so. Such labels would contribute neither to clarifying the conditions under which relations between existing words are recognized, nor to adequately restricting the conditions under which new words are created.

The position that only paradigmatic relations between whole words should be recognized is supported by the failure of attempts to provide clear criteria for identifying word-internal constituents (morphemes). Invocation of meaning is problematic as some apparently morphologically complex words cannot be divided into meaningful parts. Consider the verbs *undergó*, *undertáke* and *undermíne*, where final main stress indicates a bimorphemic structure (cf. sections 3 and 4), yet their meanings cannot be computed compositionally. Aronoff's (1976) proposal to define morphemes as crucially involving an arbitrary relation, not necessarily between form and meaning, but also between two forms allows for the identification of a morpheme *go* in *undergo* (cf. *undergo* - *underwent*) and a morpheme *take* in *undertake* (cf. *undertake* - *undertook*). Yet, this criterion does not allow for the identification of the remaining

[2] The coinage *exhumption* used in the context of cemeteries or graves is indeed attested in Google.

parts (e.g. *under*, *mine* in *undermine*), which do not exhibit irregular alternations with other strings (cf. Bochner 1993:30).[3]

Despite the absence of a coherent set of criteria determining the identification of morphemes it appears that reference to word-internal constituents in linguistic descriptions is characterized by certain tacit conventions. For English, these include the following:

(2) a. Recurring sound strings exhibiting recurring alternations and/or a common etymological origin are treated in a uniform manner (e.g. [su:m] (from Latin *su:mere* 'to take up') in the verbs *assume*, *consume* which alternate with [zu:m] in *resume*, *presume* and [sʌmp] in -*assumption, consumption*).

b. Stem constituents which correspond to independent words are distinguished from those which do not correspond to independent words (e.g. *fate* in *fateful* is associated with a boundary/category distinct from the one associated with *grate* in *grateful*)

c. Constituents which assimilate are distinguished from those which do not assimilate (e.g. *im* in *impolite* is associated with a boundary/category distinct from the one associated with *un* in *unpleasant*)

Apart from the suspect adherence to etymology in synchronic description there are grounds for questioning the relevance of any of the properties addressed in (2) for the analysis of word-internal morphological structure. Specifically, the evidence from boundary signals presented below suggests that morphological segmentation is determined by head recognition, which means that only the properties of heads can be relevant to segmentation. The central concern of this paper is then to argue for a non-uniform treatment of the case in (2a), where a head affix is recognized in some but not all words, as opposed to a uniform treatment of the cases in (2b,c), where head constituents, are recognized in all words.

The article is organized as follows. Section 2 describes the sort of phenomenon intended by the term "boundary effect". In section 3 I explore the distribution of these effects as a window on the morphological structure of English, concluding that there are two types of structure. Additional correlations pertaining to these two types, including semantic properties, are discussed in section 4. In section 5 I discuss some supporting evidence from Swedish. In section 6 I confront the findings of this study with previous results of psycholinguistic work (Hay 2001, 2002).

[3] An important empirical argument supporting the non-existence of word-internal constituent structure concerns the (alleged) invisibility of such structure to morphosyntactic processes. Invisibility has led researchers to postulate a number of constraints (cf. the “Bracket Erasure Convention” (Pesetsky 1979), “Lexical Integrity Hypothesis” (Lapointe 1981), “Atom Condition” (Williams 1981), “Morphological Island Constraint” (Botha 1981)). As noted by Anderson (1992) these conventions could be dispensed with if internal structure were not recognized to begin with.

2. Boundary effects

The notion of boundary effect used here is restricted to those deviations from canonical sound patterns which involve coinciding morphological and prosodic boundaries. Compare the form of the adjective in (3a), which represents regular sound patterns of English, with the form in (3b), which exhibits an internal boundary effect:

(3) a. [sə.bɔ́r.də.nət] 'subordinate'
b. [sʌ̀**b.**ɔ́r.bə.təl] 'suborbital'

The syllabification of the boldfaced consonant in (3b) is 'deviant' in that it is syllabified as a syllable coda rather than an onset, despite preceding a stressed vowel (cf. the regular syllabification of a consonant before a stressed vowel in (3a)). This deviation indicates a division of the word in two separate prosodic domains, which coincide with separate morphological constituents. It is because of this coincidence that the deviation in question qualifies as a boundary effect. Throughout this paper I will represent prosodic boundaries with round brackets and morphological boundaries with square brackets:

(4) a. (subordinate) b. (sub)(orbital)
[subordinate] [sub][orbital]

The occurrence of coinciding prosodic and morphological boundaries as in (4) indicates the satisfaction of alignment constraints of the type given in (5), where the (left or right) boundaries of some morphological category *GCat* must align with the (left or right) boundaries of some prosodic boundaries *PCat*. The letter "E" in (5) is used as a variable ranging over left and right boundaries:

(5) Align (GCat, E; PCat, E)

GCat stands for all grammatical (morphosyntactic) categories including word-internal categories such as root, stem and affix. PCat includes prosodic categories such as syllable, foot and pword (phonological word), as well as prosodic features. Alignment of the type described in (5) is henceforth referred to as GP-alignment.

The first task is then to analyse observable prosodic effects as in (3) by identifying the relevant alignment constraints, in order to arrive at the "underlying" GCat.[4] Before tackling this task a general remark is in order concerning the diagnostic value of using prosodic boundary effects as a window on morphological structure. That is, while the presence of prosodic boundary effects reliably indicates the presence of morphological boundaries, the absence of prosodic boundary effects does not necessarily indicate the absence of morphological boundaries. This is because alignment constraints can be crucially dominated by other constraints. For instance a high-ranking markedness constraint ONSET, which prohibits syllables without an onset, results in the

[4] The ultimate task is to identify the criteria for morphological analysis which yield the respective morphological boundaries. The question is whether the structure in (3b) is determined by the recognition of the prefix *sub-*, by the recognition of the stem *-orbital*, or by the recognition of both parts. That task is pursued in section 3.

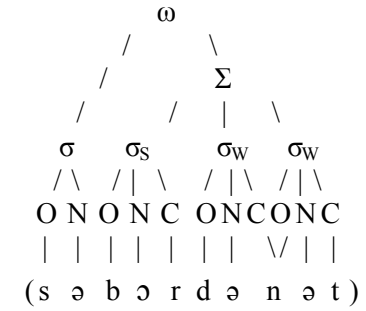
absence of boundary effects in cases where a consonant-final morpheme is followed by a vowel-initial morpheme. This sort of constraint domination can be illustrated by comparing French *subalpin* in (6a), which forms a single domain of syllabification, with English *subalpine* in (6b), which consists of two separate domains.

(6) a. s[y.ba]lpin 'subalpin' b. s[ʌb.æ]lpine 'sub-alpine'

The general absence of word-internal boundary effects in French in cases where a consonant-final morpheme is followed by a vowel-initial morpheme does accordingly not indicate that such combinations lack morphological structure. Rather, this absence indicates that alignment constraints, too, are violable[5] (cf. Prince & Smolensky 1993). While it is possible then that the string spelled *sub* in English *subordinate* is also a morpheme it cannot be the same type of morpheme as *sub* in *suborbital*. This is because whatever constraints dominate the relevant alignment constraint in English causing a fused prosodic structure in *subordinate* should have the same effect in *suborbital*. What can be said then is that the prosodic boundary effects observed in (3) clearly indicate some internal morphological boundary in (3b), where an analogous structure is ruled out in (3a).

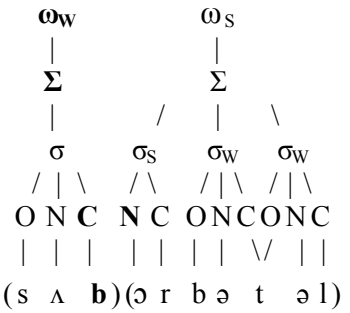
Turning now to the question of how to represent the prosodic contrast in (3) there is evidence for the representation in (7), where *sub* in *suborbital* constitutes a separate phonological word ω = pword, Σ = foot σ = syllable):

(7) a.



'subordinate'

b.



'suborbital'

According to the theory of Prosodic Phonology, pwords, feet and syllables are part of a hierarchy of prosodic constituents such that pwords rank immediately above feet, which in turn rank immediately above syllables (cf. Selkirk 1981, 1995, Nespor & Vogel 1986). Pwords differ from lower prosodic constituents in that they necessarily align with morphological constituents, which makes their proper identification especially relevant for the task at hand. Assuming the structures in (7), not only the "deviant" syllabification but also the "deviant" pretonic stress in *suborbital* can be explained in terms of general constraints on the Prosodic Hierarchy. Specifically, the coda syllabification of the prevocalic consonant satisfies the constraint Containment in (8a) and pretonic stress satisfies Headedness in (8b).

[5] This is not to deny a potential functional difference between the two cases illustrated in (6). Plausibly, in English *sub-alpine*, compared to French *subalpin*, access to morphological structure is facilitated by the prosodic signaling of the morphological boundaries, making it easier for the hearer to recognize the constituents in question. The impact of prosodic fusion on the recognition of word-internal constituents is addressed repeatedly below.

(8) a. Containment
A unit of a given level is exhaustively contained in the superordinate unit of which it is a part. (e.g. syllables are properly contained within feet)

b. Headedness
A given non-terminal unit is composed of one or more units of the immediately lower category. (e.g. a pword dominates at least one foot)

One type of evidence to support alignment of the prefix boundaries with pword boundaries (rather than just foot boundaries) concerns general constraints on syllable rhymes and the special status of pword-final consonants. In English, non-final rhymes contain no more than a single coda consonant preceded by a short vowel as in (9a), unless that coda consonant is a sonorant or *s* followed by a coronal or homorganic voiced obstruent in onset position (e.g. *shoulder*, *chamber*, *rooster*). Closed syllables with either a complex nucleus as in (9b) or a complex coda as in (9c) do not occur:

(9)	a.		b.		c.	
		h[ɛl].met 'helmet'		*h[i:l].met		*h[ɛlk].met
		[æt].las 'atlas'		*[eɪt].las		*[æst].las
		gr[ʌm].py 'grumpy'		*gr[oʊm].py		*gr[ʌlm].py

While being absent pword-internally such rhymes occur freely in pword-final position.

(10)		
	(h[i:**l**])$_{\omega}$ 'heal'	m[ɪl**k**])$_{\omega}$ 'milk'
	(w[eɪ**t**])$_{\omega}$ 'wait'	l[ɪs**t**])$_{\omega}$ 'list'
	(f[oʊ**m**])$_{\omega}$ 'foam'	[ɛl**m**])$_{\omega}$ 'elm'

A possible analysis of these patterns is that pword-final consonants are only phonetically, but not structurally, part of the syllable coda (cf. also section 5).[6] Significantly, the occurrence of such "extrasyllabic" consonants signals right pword boundaries, which necessarily align with morphological boundaries. Below I illustrate the occurrence of "Final-C effects" as signals of internal compound boundaries in (11a), of the boundary between a stem and a suffix in (11b), and of the boundary between a prefix and a stem in (11c).

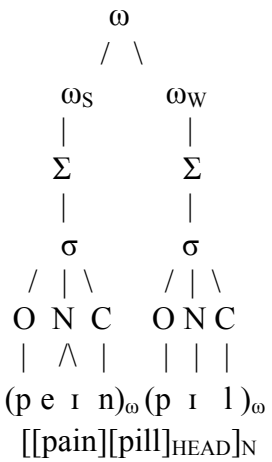
[6] Cf. Piggott (1999) and Harris and Gussman (2003), who also inform about the general acceptance of the 'final-onset view' in traditional non-western linguistics.

(11)

a.	b.	c.
(p[eɪ**n**])$_{\omega}$(pill)$_{\omega}$ 'pain pill' (m[ɪl**k**])$_{\omega}$(bar)$_{\omega}$ 'milk bar'	(p[eɪ**n**])$_{\omega}$(ful)$_{\sigma}$ 'painful' (m[ɪl**k**])$_{\omega}$(man)$_{\sigma}$ 'milkman'	(p[oʊ**st**])$_{\omega}$(doctoral)$_{\omega}$ 'postdoctoral' ([æn**t**])$_{\omega}$(arctic)$_{\omega}$ 'antarctic'

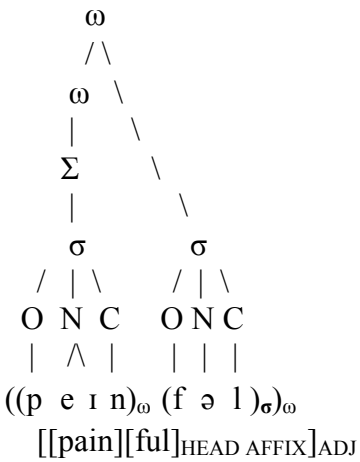
The data in (11) illustrate the significance of prosodic boundaries for signaling not only the presence of morphological boundaries, but for indicating the sort of morphological category involved. Whereas both *pill* in *pain pill* and *ful* in *painful* function as heads in that they determine the category of the respective complex word the latter has historically developed into an affix, which can no longer stand for the whole word. Such constituents are henceforth referred to as 'head affixes', whereas the term 'head' is reserved for constituents having the same category as the complex word. Significantly, prosodic structure reflects this syntactic contrast in English in that a head, but not a head affix, forms a separate pword as is shown in (12). [7] The labeling of the respective left constituents in (12) will be discussed in section 3.1.

(12) a.



[[pain][pill]$_{\text{HEAD}}$]$_{\text{N}}$
'pain pill'

b.

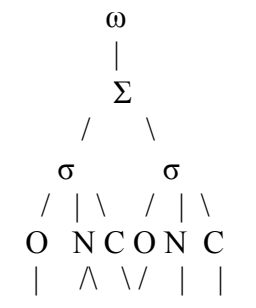


[[pain][ful]$_{\text{HEAD AFFIX}}$]$_{\text{ADJ}}$
'painful'

Although the Final-C effect indicates the presence of a word-internal pword boundary in (12b) it is often assumed that the affix is integrated, forming a trochaic foot together with the stem (cf. Burzio 1993). However, there is a systematic correlation between Final-C effects and Containment effects, which supports the non-integration of suffixes. Containment of syllable-structure is indicated by the phonetic contrasts between simplexes and suffixed words indicated in (13). A consonant between a stressed and an unstressed nucleus is regularly weak, which indicates foot-internal ambisyllabicity as in (13a). The relative strength of the intervocalic consonant marked by the superscript "f" (fortition) in (13b) indicates that it is strictly syllable-initial, which indicates satisfaction of Containment (cf. Umeda & Coker 1974). This analysis is corroborated by the "deviant" vocalic length in (13b), which signals foot-final (rather than foot-internal) position.

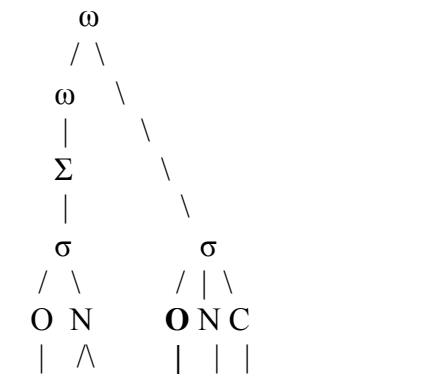
[7] Regular GP-alignment constraints yield the structure in (12a), where the pwords in a compound are dominated by an additional pword. However, given the lack of independent prosodic motivation for this topmost pword node (e.g. reference to this node is neither sufficient nor necessary for stating relative prominence) I will assume a convention by which multiple adjacent pword boundaries are reduced to single boundaries (e.g. $((X)_{\omega}(Y)_{\omega})_{\omega}$ => $(X)_{\omega}(Y)_{\omega}$).

(13) a.



[minus] 'minus'

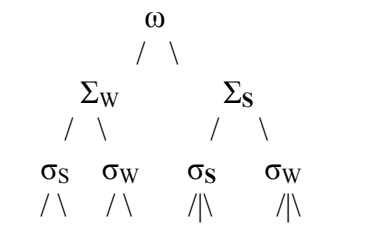
b.



[[shy][ness]$_{\text{HEAD AFFIX}}$] 'shyness'

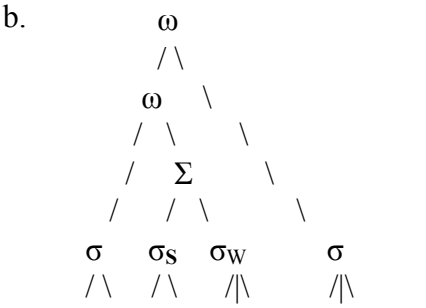
More salient Containment effects concerning foot structure can be observed in polysyllabic words. The simplex in (14a) illustrates regular foot structure in English, with stress on a closed penultimate syllable. The deviant stress pattern in (14b) indicates the presence of an internal pword boundary, which confines the domain of foot construction. Again, the prosody signals not only the presence of a morphological boundary but also indicates the types of constituents involved (i.e. stem plus head suffix):

(14) a.



[rhododendron]
'rhododendron'

b.



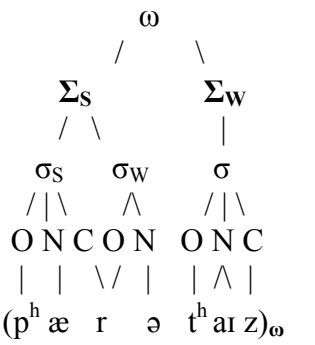
[[environ][ment]$_{\text{HEAD AFFIX}}$]
'environment'

Assuming the adequacy of the representations in (12) - (14), the non-integration of head suffixes could be described in terms of a separate GP-alignment constraint, aligning the boundaries of head suffixes with syllable boundaries. However, positing such a constraint misses the generalization that the prosodic organization of English head affixes consistently reflects independently motivated constraints on parsing segmental material into prosodic constituents. That is, strings of segments are parsed into syllables, depending on the sonority structure of the string. For instance, the head affixes illustrated in (12) - (14), all of which consist of CVC(C) strings, are parsed into single syllables. Not being dominated by a separate pword, these syllables are unfooted, as reflected in the reduced vowels. Single syllables are footed only under specific (segmental) conditions, including the occurrence of the fricative [h] in onset position (cf. the suffix -*hood*). Here the foot is stabilized by a constraint aligning [h] with foot-initial position (cf. Davis and Cho 2003) in conjunction with a constraint prohibiting the deletion of segments. Given that in English both the syllabification and the pedification

of head affixes are determined by segmental (consonantal) structure there is a further generalization that the only prosodic constituent involved in English GP-alignment is the pword.

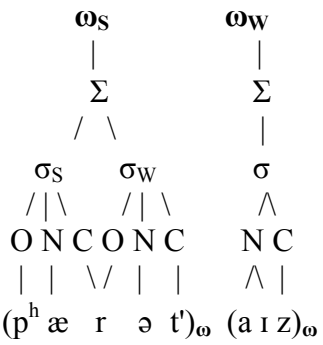
The distinct treatment of heads and head affixes proposed here (i.e. alignment of head boundaries, but not head affix boundaries, with prosodic boundaries) is supported by the striking contrast in the syllabification of stem-final *t* in (15a) versus (15b). Whereas aspiration (strengthening) in (15a) indicates regular onset syllabification before a stressed nucleus the glottalization (weakening) in (15b) in the same segmental environment indicates the presence of a following boundary:

(15) a.



[[parrot][ize]HEAD AFFIX]
'parrotize'

b.



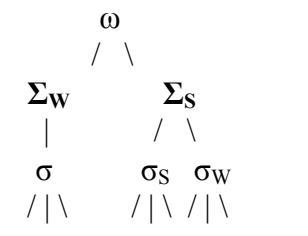
[[parrot][eyes]HEAD]
'parrot eyes'

The generalization emerging from a comparison of the pairs in (12) and (15) is that both members of a compound, including the relatively weak head, form separate pwords regardless of their segmental structure. By contrast, head suffixes are separate from the pword of the stem only if they begin with a consonant-vowel sequence. Vowel-initial suffixes like *-ize* or consonantal suffixes like *-th* are integrated into the pword of the stem, presumably to satisfy phonological markedness constraints (cf. the discussion of French *subalpin*).[8]

The distinct prosodic organization of identical segmental material in (15) accounts not only for the aspiration versus glottalization of stem-final *t* but also indicates distinct sources for the prominence on the initial syllable. In (15a) initial main stress is attributed to the strength of the initial foot within the pword whereas in (15b) initial main stress is attributed to the strength of the initial pword within compounds. Evidence for this distinction comes from cases where the final foot is trochaic. Here the rule that the initial pword in a compound is strongest still holds, regardless of the pword-internal foot structure (cf. 16b). By contrast, *within* pwords a final foot consisting of more than one syllable attracts main stress as in (16a).

[8] The integration of consonantal suffixes into the pword of the stem can be inferred from the fact that suffixed words like *truth* rhyme perfectly with simplexes like *tooth*. The relevant phonological constraints dominating alignment (thereby causing the absence of boundary effects) concern the requirement that all segments must be parsed into syllables along with a constraint on minimal sonority of syllable nuclei.

(16) a.



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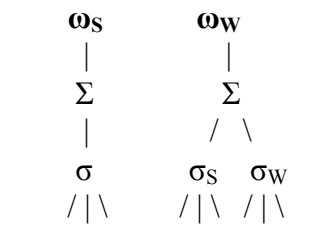
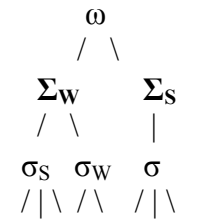


As a result of the phonologically conditioned fusion, the noun *gestation*, which contains a head suffix, is prosodically indistinguishable from a simplex like *dalmation*. Similarly, the noun *cameleer*, which also contains a head suffix, is prosodically indistinguishable from the simplex *cavalier*: in both nouns the final foot attracts main stress because it contains a high tense vowel. Weak stress on the final foot in *camel ear* is then again a boundary signal, indicating that relative prominence follows the compound rule.

(17) a.



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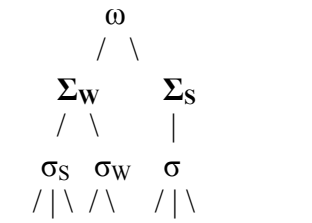
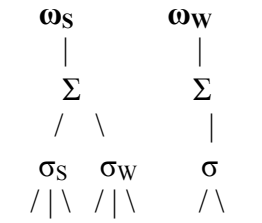


c.



The data in (15) to (17) indicate that the integration of head affixes due to higher-ranking phonological constraints is complete. That is, apart from possible paradigm uniformity effects, which are independently motivated (cf. the end of this section), words with integrated head affixes are precisely like simplexes.

Prosodic structure offers cues not only to the morphological contrast between affixes and non-affixes but also indicates distinctions among affixes. Consider the contrast in the pronunciation of the word-initial syllables as transcribed by Wells (2000). Simplexes with pretonic vowels spelled <e> are consistently represented with two variants, one with schwa and one with a short raised vowel as in (18a). Significantly, there are two distinct patterns of deviation from that structure, both of which qualify as boundary effects. One type, illustrated in (18b), contains a prefix transcribed with a stressed long vowel and is consistently represented with a single form. This type matches the examples *suborbital*, *postdoctoral*, and *antarctic*, where the prefix forms a separate pword. The other type, illustrated in (18c), is consistently represented with three variants, two of which match the simplex patterns. The third variant, boldfaced in (18c), deviates from the simplex patterns in that it is transcribed with a tense, long vowel in prestress position, a structure henceforth referred to as "Final Nucleus Enhancement". The relevant form differs from the case illustrated in

(18b) not only in its association with variants, but also in that the vowel, though long and tense, is not marked for stress. The absence of stress indicates that the prefix does not form a separate pword in (18c), thereby contrasting with the type in (18b).

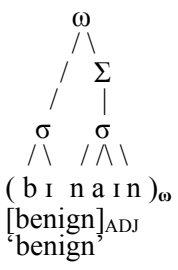
(18)	Phonetic transcriptions (Wells 1990):	Prosodic representations:	
a.	[bənáɪn]$_A$, [bɪnáɪn]$_A$ [rəg´ætə]$_N$, [rɪg´ætə]$_N$ [bəlú:gə]$_N$ [bɪlú:gə]$_N$	(benígn)$_ω$ (regátta)$_ω$ (belúga)$_ω$	‘benign’ ‘regatta’ ‘beluga’
b.	**[rì:bɝ́:θ]**$_N$ **[prì:kǽn^{t}sərəs]**$_A$ **[dì:m´ɪstɪfàɪ]**$_V$	(rè)$_ω$(birth)$_ω$ (prè)$_ω$(cáncerous)$_ω$ (dè)$_ω$(mýstify)$_ω$	‘rebirth’ ‘precancerous’ 'demystify'
c.	[bəgét]$_V$, [bɪg´ɛt]$_V$, **[bi:gɛ́t]**$_V$ [dədú:s]$_V$, [dɪdú:s]$_V$, **[di:dú:s]**$_V$ [rənú:]$_V$, [rɪnú:]$_V$, **[ri:nú:]**$_V$ [prəzú:m]$_V$, [prɪzú:m]$_V$, **[pri:zú:m]**$_V$	((be)$_σ$(gét)$_ω$)$_ω$ ((de)$_σ$(dúce)$_ω$)$_ω$ ((re)$_σ$(new)$_ω$)$_ω$ ((pre)$_σ$(súme)$_ω$)$_ω$	‘beget’ ‘deduce' ‘renew’ ‘presume’

The boundary effect in question is most salient in words which include an intervocalic *s*C-cluster. Such clusters are regularly heterosyllabic as in (19a), where the initial syllable is closed, but they are syllable-initial when preceded by a prefix forming a separate pword as in (19b). In (19c), "Final Nucleus Enhancement" correlates with the tautosyllabic syllabification of the cluster to indicate hat the prefix is not integrated, although it does not form a separate pword.

(19)				
a.	s[əs.p]éct]$_V$	(suspect)$_ω$	'suspect'
b.	r[ì:sp]éll]$_V$	(re)$_ω$(spell)$_ω$	'respell'
c.	r[i: sp]éct]$_V$	((re)$_σ$(spect)$_ω$)$_ω$	'respect'

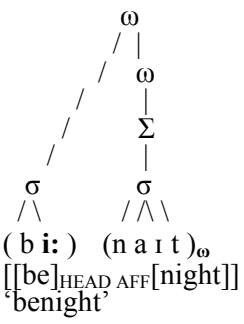
"Final Nucleus Enhancement", like all other effects discussed here, is sensitive to pword structure in that it occurs immediately before a pword boundary (cf. (20)):[9]

(20) a.



[benign]$_{ADJ}$
‘benign’

b.



[[be]$_{HEAD}$ $_{AFF}$[night]]
‘benight’

[9] Reference to a following pword boundary is also essential to vowel tenseness observed in the compound *béll*[i]*bànd* 'bellyband' or the affixation *béll*[i]*ful* 'bellyful', as opposed to lack of tenseness in *béll*[i]*còse* 'bellicose'.

Turning now to the question of what the contrast in the prosodic structure of the prefixes reveals about the underlying morphological structures, we find a correlation between prosodic and morphosyntactic properties. Specifically, the prefixes in (18b), (19b), which are stressed and form separate pwords, never affect the combinatory properties of the complex word and can accordingly be omitted without affecting grammaticality (e.g. *(re)birth of a nation, (pre)cancerous lesions*). They are henceforth referred to as modifying prefixes. By contrast, the prefixes in (18c) and (19c), which are unstressed and marked by Final Nucleus Enhancement, cannot be omitted, a property shared with head suffixes. Additional motivation for the analysis of these prefixes as head affixes concerns their association with specific syntactic categories. In English, such prefixes are primarily associated with verbs, for which the boundary effects in question are consistently marked in Wells (2000)[10], but also with abstract nouns and prepositions.

Recall that the prosodic contrast between heads and head suffixes observed in pairs like *pain pill* versus *painful* is accompanied by the fact that head boundaries are always signaled whereas the boundaries of head suffixes are signaled only when the suffix begins with a consonant. Otherwise the suffix is integrated into the pword of the stem. The question then arises of whether the prosodic contrast between modifying prefixes and head prefixes observed in (18) and (19) correlates with a similar difference in phonological sensitivity. In fact, there are phonological conditions under which fusion is systematic for head prefixes, whereas modifying prefixes consistently form separate pwords. First, head prefixes integrate when preceding an unstressed syllable, forming a trochaic foot together with that syllable as is shown in (21a). Phonologically, such fused structures become indistinguishable from simplexes. Consonants are ambisyllabic when preceded by a stressed vowel and followed by an unstressed vowel (i.e. in foot-internal position). Vowels are lax when followed by two or more syllables, the first of which is unstressed ("Trisyllabic Laxing" as in *p*[ˊɛ]*lican* (**p*[íː]*lican*) 'pelican', [ˊæ]*necdòte* (*[éɪ]*necdòte*) 'anecdote). "Final Nucleus Enhancement" observed in (18c) and (20b) is accordingly restricted to pretonic position.

(21)	a.	[[re]$_{\text{HEADPREF}}$[concíle]]$_{\text{VERB}}$	=>	(r[ɛ́]concìle)$_{\omega}$	'reconcile'
		[[de]$_{\text{HEADPREF}}$[legáte]]$_{\text{VERB}}$	=>	(d[ɛ́]legàte)$_{\omega}$	'delegate'
		[[pre]$_{\text{HEADPREF}}$[dicáte]]$_{\text{VERB}}$	=>	(pr[ɛ́]dicàte)$_{\omega}$	'predicate'
	b.	[[be]$_{\text{HEADPREF}}$[líttle]]$_{\text{VERB}}$	=>	((b[iː])$_{\sigma}$(líttle)$_{\omega}$)$_{\omega}$	'belittle'
		[[de]$_{\text{HEADPREF}}$[líver]]$_{\text{VERB}}$	=>	((d[iː])$_{\sigma}$(líver)$_{\omega}$)$_{\omega}$	'deliver '
		[[re]$_{\text{HEADPREF}}$[cóver]]$_{\text{VERB}}$	=>	((r[iː])$_{\sigma}$(cóver)$_{\omega}$)$_{\omega}$	'recover'
		[[pre]$_{\text{HEADPREF}}$[váricàte]]$_{\text{VERB}}$	=>	((pr[iː])$_{\sigma}$(váricàte)$_{\omega}$)$_{\omega}$	'prevaricate'

The representations in (21) are intended to show that given identical morphological structures consisting of a uniform head prefix and a root, the independent contrast in the stress pattern of the root could account for fusion in (21a) vis-à-vis the occurrence of

[10]That is, when occurring in verbs, abstract nouns or prepositions, the prefixes *be-*, *re-*, *de-*, and *pre-*, are consistently transcribed with a tense vowel in Wells (2000) (e.g. *prepare*, *decubitus*, *behind*). This does not hold for corresponding initial strings in words belonging to other categories (e.g. *benign, beluga, regatta*).

boundary effects in (21b).[11] The plausibility of this analysis lies in the observation that there is an independently motivated phonological markedness constraint (Foot Binarity), whose ranking above the relevant GP-alignment constraint would cause fusion in (21a), but not in (21b).[12] While this analysis may reflect the (historical) cause of the restricted occurrence of boundary effects in (21) and may explain the restriction of native head prefixation to stress-initial base words it is questionable that the morphological structures in (21a) and (21b) are indeed identical in the minds of speakers. Rather, it is likely that (historical) prosodic fusion in (21a) affects the morphological analyzability of the verbs, in particular, the recognizability of the prefix. The point here is to demonstrate a contrast between head prefixes, which exhibit boundary effects only under specific phonological conditions (cf. (21b) versus (21a)), and modifying prefixes, which consistently form separate pwords, regardless of the phonological structure of the stem as is shown in (22):

(22) $[[re]_{MODPREF}[combíne]_X]_{VERB}$ => $(r[ì:])_\omega(combíne)_\omega$ 'recombine '
$[[de]_{MODPREF}[compóse]_X]_{VERB}$ => $(d[ì:])_\omega(compóse)_\omega$ 'decompose '
$[[pre]_{MODPREF}[concéive]_X]_{VERB}$ => $(pr[i:])_\omega(concéive)_\omega$ 'preconceive '

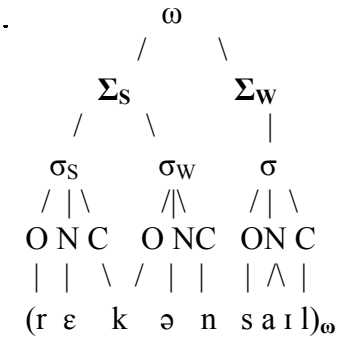
The phonological evidence for the distinct prosodic organizations in (21) and (22) is supported by relative prominence patterns. Recall that a final monosyllabic foot within a polysyllabic pword is usually weak. This rule also applies to verbs, except that a final monosyllabic foot is strong if the verb ends in a consonant cluster (e.g. *àpprehénd*, *rèsurréct*). Final main stress in verbs ending in a single consonant (or none) as in (22) indicates then that relative prominence is determined not with reference to pword-internal foot structure, but follows the rule in (23) (cf. also previous examples like *sùbálpine, àntárctic, pòstdóctoral*):

(23) If: $\omega \quad \omega$ Then: $\omega_{\mathbf{W}} \quad \omega_{\mathbf{S}}$
$([X]_{MODPREF})_\omega([Y]_{HEAD})_\omega$ $([X]_{MODPREF})_\omega([Y]_{HEAD})_\omega$
where head = verb, adjective

The rule in (23) is typical of relative prominence rules in English in that it refers both to prosodic structure and to morphological categories. Significant for the purposes of this paper is the reference to word-internal pwords, which indicates the presence of complex morphological structure. Specifically, the stress pattern (final main stress in a polysyllabic verb) indicates the presence of a modifying prefix in (24b), in contrast to the verb in (24a), which exhibits the regular relative prominence relations within pwords.

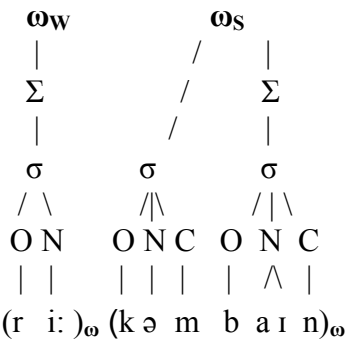
[11]The stress pattern is independent in that it can be predicted on the basis of the total number of syllables in the root and the weight of the final syllable.
[12]In (21b), a trochaic foot involving the prefix could be formed only if the root-initial foot were deleted. This, however, would violate higher-ranking PARSE-constraints and is therefore ruled out. As a result, GP-alignment prevails in (21b).

(24) a.



[[re]$_{\text{HEADPREFIX}}$[concíle]]
'reconcile'

b.

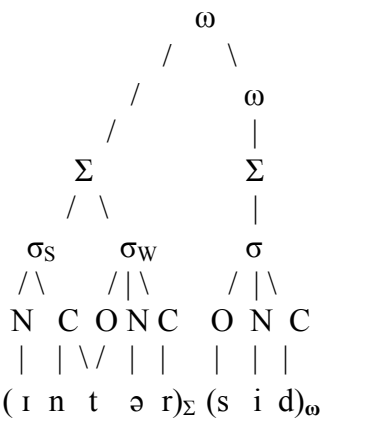


[[re]$_{\text{MODPREFIX}}$[combíne]]
'recombine'

It is, however, not the case that final main stress in a polysyllabic verb (ending in maximally one consonant) necessarily indicates the presence of a modifying prefix. Final main stress is also quite regular in verbs with a disyllabic head prefix followed by a monosyllabic root as illustrated in (25a) (cf. also *overcóme, undermíne*).[13] The representations in (25) are based on the assumptions that modifying prefixes regularly form separate pwords due to GP-alignment (i.e. Align (MODPREF,E;ω,E) whereas the prosodic form of head prefixes is determined by segmental structure alone. That is, whereas the presence of the initial foot in (25b) is an independent Headedness effect it results from the occurrence of two sonority peaks in the relevant segment string in (25a).

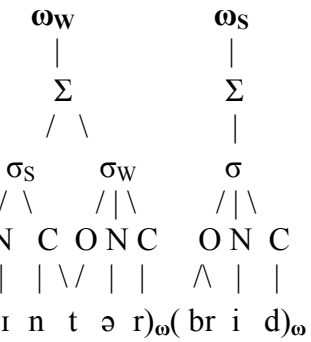
Word-final main stress in (25a) would then be accounted for under the further assumptions that roots (i.e. the sister constituents of head affixes within words) form separate pwords and that for any combination of distinct prosodic constituents, the higher-ranking constituent is more prominent. By contrast, in (25b) final main stress is determined by rule (23), which yields weak prominence on the modifying prefix.[14]

(25) a.



[[inter]$_{\text{HEADPREFIX}}$[cede]$_{\text{ROOT}}$]
'intercede'

b.



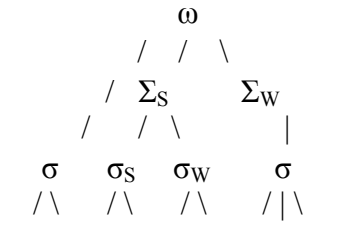
[[inter]$_{\text{MODPREFIX}}$[breed]]
'interbreed'

[13]Exceptions to this generalization concern verbs which relate to nouns with regular initial main stress and can accordingly be analysed as paradigm uniformity effects (e.g. *súpervìse - súpervìsor*).

[14]The verb *persevére*, which includes neither a modifying prefix nor a recognizable head prefix, illustrates a third source for final main stress. Recall that the last foot in a polysyllabic words is strong if it dominates a syllable with a high tense nucleus (e.g. *cavalíer*).

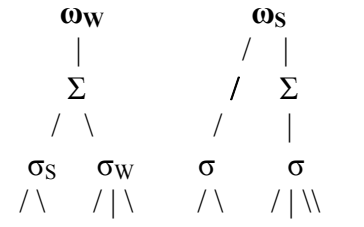
The distinction between these structures is again supported by cases of phonologically conditioned integration. Recall that head prefixes, but not modifying prefixes, integrate when preceding an unstressed syllable. As a result, we find a clear contrast in the stress patterns of the verbs in (26). In (26a), relative prominence is determined by the regular rule applying within pwords, which says that a monosyllabic final foot is weak. In (26b), relative prominence is determined by rule (23), which yields weak prominence on a modifying prefix.

(26) a.



[[inter]$_{\text{HEADPREFIX}}$[pelláte]]
'interpellate'

b.



[[inter]$_{\text{MODPREFIX}}$[connect]]
'interconnect'

Additional examples are given in (27). In (27a), the bisyllabic head prefix is not integrated because it precedes a stressed syllable. In (27b), integration before a stressless syllable is regular. In (27c) we see that modifying prefixes consistently form separate pwords, regardless of phonological factors:

(27) a. [[inter]$_{\text{HEADPREFIX}}$[díct]$_{\text{ROOT}}$]$_{\text{WORD}}$ => ((ìnter)$_{\Sigma}$(díct)$_{\omega}$)$_{\omega}$ 'interdict'[15]
[[inter]$_{\text{HEADPREFIX}}$[véne]$_{\text{ROOT}}$]$_{\text{WORD}}$ => ((ìnter)$_{\Sigma}$(véne)$_{\omega}$)$_{\omega}$ 'intervene'
[[inter]$_{\text{HEADPREFIX}}$[fére]$_{\text{ROOT}}$]$_{\text{WORD}}$ => ((ìnter)$_{\Sigma}$(fére)$_{\omega}$)$_{\omega}$ 'interfere'

b. [[inter]$_{\text{HEADPREFIX}}$[rogáte]$_{\text{ROOT}}$]$_{\text{WORD}}$ => (intérrogàte)$_{\omega}$ 'interrogate'
[[inter]$_{\text{HEADPREFIX}}$[poláte]$_{\text{ROOT}}$]$_{\text{WORD}}$ => (intérpolàte)$_{\omega}$ 'interpolate'
[[inter]$_{\text{HEADPREFIX}}$[caláte]$_{\text{ROOT}}$]$_{\text{WORD}}$ => (intércalàte)$_{\omega}$ 'intercalate'

c. [[inter]$_{\text{MODPREFIX}}$[depénd]$_{\text{HEAD}}$]$_{\text{WORD}}$ => (ìnter)$_{\omega}$(depénd)$_{\omega}$ 'interdepend'
[[inter]$_{\text{MODPREFIX}}$[diffúse]$_{\text{HEAD}}$]$_{\text{WORD}}$ => (ìnter)$_{\omega}$(diffúse)$_{\omega}$ 'interdiffuse'
[[inter]$_{\text{MODPREFIX}}$[reláte]$_{\text{HEAD}}$]$_{\text{WORD}}$ => (ìnter)$_{\omega}$(reláte)$_{\omega}$ 'interrelate'

An additional context for the integration of head prefixes concerns S-V junctures, where S is any segment and V is a vowel. In (28a) it is shown that (for some speakers) C-V contexts cause fusion for head prefixation, but not for modifying prefixation (cf. MacCarthy 1945). In (28b) I illustrate the analogous contrast for V-V contexts:

(28) a. [[en]$_{\text{HEADPREFIX}}$[áble]$_{\text{ROOT}}$]$_{\text{VERB}}$ => (e[.]nable)$_{\omega}$ 'enable'
[[un]$_{\text{MODPREFIX}}$[áble]$_{\text{HEAD}}$]$_{\text{WORD}}$ => (ùn)$_{\omega}$(áble)$_{\omega}$ 'unable'

b. [[re]$_{\text{HEADPREFIX}}$[áct]$_{\text{ROOT}}$]$_{\text{VERB}}$ => (r[i]áct)$_{\omega}$ 'react'
[[re]$_{\text{MODPREFIX}}$[áctivàte]$_{\text{HEAD}}$]$_{\text{WORD}}$ => (r[ì:])$_{\omega}$(áctivàte)$_{\omega}$ 'reactivate'

[15] This verb is relevant here when pronounced [ɪntərdaɪt], with a single final consonant.

As a result of fusion, *enable* is prosodically on a par with simplexes like *finagle*. Similarly, the hiatus in *react*, transcribed only with a tense, short [i] in Wells (2000), is indistinguishable from the hiatus in simplexes like *m*[i]*ánder* 'meander'.
The effects of fusion for head prefixation can generally be demonstrated only with loanwords. For native head prefixation, contexts which would induce fusion usually yield gaps. There are accordingly no cases of native head prefixation based on a word beginning with a vowel or with a stressless syllable. The results of this section are summarized below:

- There is a systematic correlation between Containment effects, Final-C effects, Final Nucleus Enhancement, Headedness effects and Relative Prominence effects in English. All effects refer to pword boundaries, which necessarily coincide with morphological boundaries.

- Each member of a compound and modifying prefixes form separate pwords in English, regardless of phonological contexts. As a result each of these constituents exhibit consistent boundary effects.

- Unlike modifying affixes, head affixes do not form separate pwords and integrate into the pword of the stem under specific phonological conditions. The segments of non-integrated head affixes are parsed into syllables and possibly feet, in accordance with general rules of prosodic parsing. Integration results in prosodic identity with the structure of simplexes.

The summary calls for a few clarifying remarks. The claim that certain types of morphological structures exhibit consistent boundary effects does not rule out the possibility that individual words may fuse prosodically into a single pword. Such fusion is illustrated in (29a) vis-à-vis the unfused structures in (29b):

(29)	a.		b.	
		[kʌ́bərd] 'cupboard'		[klíp.bɔ̀:rd] 'clipboard'
		[də.síntəgreɪt] 'disintegrate'		[dɪs.íntrəst] 'disinterest'
		[ná:nsəns] 'nonsense'		[nɑ̀:n.stɑ́:p] 'nonstop

The phenomenon illustrated in (29a) will be referred to as "High Frequency Fusion" because high token frequency appears to be a necessary (but by no means sufficient) prerequisite for the (historical) loss of boundary signals. It is important to properly identify cases of High Frequency Fusion, to distinguish such cases from cases of regular fusion resulting from the domination of GP-alignment constraints by phonological markedness constraints.

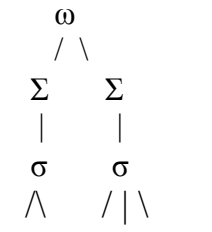
The claim that certain constituents exhibit consistent boundary effects does not mean that the effects are equally salient. The Containment effect in the compound *night rate*[16] vis-à-vis the simplex *nitrate* is perhaps always easily perceived, regardless of register, whereas the phonetic contrast between the compound *oxe-eyed* and the simplex *oxide* all but vanishes in fast speech (cf. Jones 1956:102). This difference in perception is due to the salient allophony characteristic of *t* (e.g. *nigh*[t']*rate* 'night rate' with

[16]The effect is that *t* preceding the *r* is contained within the initial constituent *night* and hence syllabified in coda position, rather than syllabified in onset position to form a cluster *tr*.

glottalized *t* indicative of syllable-final position versus *ni*[t^h]*rate* 'nitrate' with aspirated *t* indicative of syllable- and foot-initial position) compared to the lack of special allophones associated with the cluster [ks]. Such differences in salience are irrelevant to the argumentation, which rests on the demonstration that there are some (phonological) contexts and some register, presumably careful though not hyperarticulated speech, where boundary effects exist.

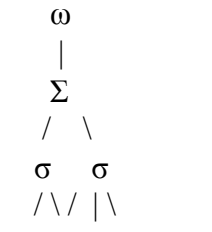
In general, careful investigation of the phonological context is essential for the proper identification of boundary effects. For instance, foot stability may qualify as a Headedness effect, indicative of the presence of pword boundaries but may also be contextually determined. Compare the lack of stress of the final syllable in the nouns in (30a), as opposed to the stress on the corresponding syllable in (30b), which could be diagnosed as a Headedness effect indicative of the structures $(\text{hém})_{\omega}(\text{lòck})_{\omega}$ versus $(\text{hámmock})_{\omega}$. However, the relevant contrast in stress could also be attributed to the contrast in syllable structure, demonstrated with the well-known variants in the pronunciation of Arab in (30). In (30a), the heaviness of the initial syllable allows for the following consonant to be syllabified in strictly syllable-initial position, which in turn is necessary for forming a separate foot (cf. the constraint Containment in (8a)). When ending in a non-coronal obstruent such feet appear to be fairly stable (cf. Fidelholtz 1967). In (30b), the intervocalic consonant necessarily closes the initial stressed syllable to ensure bimoraicity. Being ambisyllabic, that consonant can occur only foot-internally, but not foot-initially, which indicates the representation in (30b):

(30) a. hémlòck



'Arab'

b. hámmock



'Arab'

The evidence from stress consequently does not motivate internal pword boundaries for words like *hémlòck*, *shámròck* or *wédlòck*, where the initial syllable is closed. Similarly, word-final stress in (31a) does not motivate the presence of internal pword boundaries but is sufficiently motivated by the presence of [h] in onset position. The necessary alignment of [h] with foot-initial position mentioned above apparently stabilizes the word-final foot in (31a). The connection between stress and the presence of [h] is again supported by the specific variants for *mayhem* in (31):

(31) a. cóhòrt
[méɪhèm] 'mayhem'

b. yógurt
[méɪəm] 'mayhem'

These examples demonstrate the need for careful study of the (syntagmatic) phonological context before concluding that a specific sound pattern qualifies as a boundary effect indicative of complex morphological structure. Equally important for the evaluation of potential deviations from canonical phonology is the study of the

relevant paradigmatic context. Consider again the occurrence of tense [i:] in pretonic position in the verbs in (32a) (as opposed to the absence of such a vowel in the corresponding position in the non-verbs *benign* or *belúga*) which has been analysed as a boundary effect indicative of complex morphological structure ("Final Nucleus Enhancement"). Phonetically similar violations are seen in the words in (32b), which are paradigmatically related to the respective words to their right:

(32)	a.	b[i:]cóme 'become'	b.	l[i:]gálity 'legality' -> l[í:]gal 'legal'
		b[i:]líeve 'believe'		d[i:]mónic 'demonic' -> d[í:]mon 'demon'
		b[i:]gín 'begin'		[i:]g´yptian 'Egyptian' -> [í:]gypt 'Egypt'

The deviations from simplex phonology in (32b) cannot be analysed as boundary effects because they do not involve coinciding morphological and prosodic boundaries. Instead these deviations appear to be "licensed" by the corresponding vowels in the respective base words. "Licensing" means that the phonological feature identified as deviation in one word (e.g. the occurrence of a long, tense vowel in unstressed position in *l*[i:]*gálity*) appears in a different phonological context in a related word, such that that context sanctions the feature in question (e.g. the occurrence of a long, tense vowel in *stressed* position in *l*[i:]*gal*). The "transfer" of the feature from the regular context (i.e. stress) to the irregular context (i.e. lack of stress) is then motivated by a constraint on paradigm uniformity, which requires identity of corresponding phonological structure in paradigmatically related words.

Given this analysis the occurrences of the pretonic tense vowels in (32a) versus (32b) are entirely distinct phenomena. In (32a), this deviation from regular phonology serves as a boundary signal indicating the presence of a head prefix which functions as an indicator of syntactic category. In (32b), the deviation in question signals the existence of a paradigmatically related word in the lexicon, which licenses the deviation. The latter function has nothing to do with morphological complexity as it can also be detected in words like (33a), which do not have internal morphological structure. The noun in (33a) has not (?yet) developed initial stress, unlike the nouns with comparable syllable structure in (33b). The stability of final stress in the noun in (33a) is presumably a PU-effect (paradigm uniformity effect), to secure sameness of stress with respect to the base verb, where final stress is regular.[17]

(33)	a.	succéss -> succéed	b.	áccèss, príncèss, récèss, ábscèss

Whereas morphological complexity is irrelevant to the occurrence of PU-effects it is essential for the occurrence of boundary effects. By contrast, the existence of paradigmatically related words is essential for the occurrence of PU-effects but not to the occurrence of boundary effects (cf. the examples in (32a)).[18] For the purpose of this paper it is only important to be aware of PU-effects as a possible source of "deviant" sound patterns which, unlike boundary effects, do no reflect on word-internal morphology.

[17]Several of the nouns in (33b) are also etymologically related to iambic verbs (e.g. *accéde, recéde*), but unlike in the case of *success - succeed*, there are no close semantic relations.

[18] Additional differences between boundary effects and PU-effects are discussed in Raffelsiefen 2005.

3. Boundary effects as a window on morphological structure

Assuming now that phonological boundaries signal the presence of "underlying" morphological structure it suggests itself to analyse the distribution of such signals to gain information about morphology, including the recognition and labeling of morphological structure. For instance, given the boundary effects (Containment and Headedness) in *suborbital*, the question arises of what motivates the underlying morphological structure: the fact that *orbital* matches an independent word, the fact that *sub-* recurs in other words like *subalpine* or *subtropical*, or the fact that *sub-* has meaning? Similarly, is the boundary effect in *repel* (Head-Final Enhancement) due to the recurrence of *–pel* in other verbs (e.g. *compel*, *impel*, *expel*), the recurrence of *re-* (*reject*, *relent*) or the existence of the near-homophonous productive modifying prefix *re-*? Should *pain* in *painful* be categorized as a noun, a word, a stem or a root? How about the categorization of *orbital* in *suborbital*, *little* in *belittle* or *-pel* in *repel*? The answers to these questions based on the evidence from boundary signals are presented below.

3.1. The results

The evidence from word-internal boundary effects in English supports two basic morphological structures. One type consists of a modifier or a modifying prefix followed by a head whereas the other type consists of a head-affix and a root arranged in either order. Moreover, boundary effects indicate that the recognition of the head, or head affix respectively, determines the overall structure. The relevant evidence for the two types of structures is presented in section 3.1.1 and section 3.1.2.

3.1.1. Modifier-head structures

The evidence from boundary effects indicates an asymmetry regarding the status of the components in compounds. The basic generalization is that boundary effects in compounds may persist for as long as the rightmost member corresponds to an independent word. If that word becomes obsolete, however, fusion results as in (34a). By contrast, if the word corresponding to the lefthand member becomes obsolete prosodic boundaries may persist as is shown in (34b). The restriction "may" is added to account for the fact that "High Frequency Fusion" is always possible, regardless of the status of the rightmost member (cf. possible fusion in all compounds ending in *-berry*, e.g. [rɑ:zbəri] 'raspberry', [blu:bəri] 'blueberry').

(34) a. √ice-†ickel (c.f. O.E. gićel 'glacier') (ícicle)$_{\omega}$
√nose-†thirl (c.f. O.E. þȳrel 'hole') (nóstril)$_{\omega}$

b. †luke-√warm (c.f. O.E. hlēow 'warm') (lúke)$_{\omega}$(wàrm)$_{\omega}$
†step-√child (cf. O.E. ste:op 'bereaved') (stép)$_{\omega}$(chìld)$_{\omega}$

Assuming that the examples in (34) are representative they indicate that the recognition of a head constituent, which in English is rightmost within the word, is crucial to morphological analysis. Specifically, given an input word with a certain category as in (35a) and the recognition of a constituent in rightmost position corresponding to an independent word with that same category as in (35b), the constituent is labeled as head of the input word as in (35c). Paradigmatic knowledge is accordingly essential to the recognition of head constituents in complex words.

(35) a. $[\text{lúkewàrm}]_{\text{ADJ}}$

b. $[\text{lúke}[\text{wàrm}]]_{\text{ADJ}} = [\text{wárm}]_{\text{ADJ}}$

c. $[\text{lúke}[\text{wàrm}]_{\text{HEAD}}]_{\text{ADJ}}$

Since any two items with the same category as in (35b) necessarily commute, the rest of the word could be omitted without affecting grammaticality. As a result that rest is classified as a modifier, regardless of its properties as in (36a). The boundaries of both heads and modifiers are aligned with pword boundaries as in (36b), giving rise to boundary effects.

(36) a. $[[\text{lúke}]_{\text{MOD}}[\text{wàrm}]_{\text{HEAD}}]_{\text{ADJ}}$

b. $[([\text{lúke}]_{\text{MOD}})_{\omega}([\text{wàrm}]_{\text{HEAD}})_{\omega}]_{\text{ADJ}}$

Given the prosodic structure in (36b) the occurrence of the word in actual speech will presumably satisfy potential prosodic requirements for head recognition, thereby ensuring the stability of the boundary effects in historical perspective.
If no head is recognized as in the somewhat hypothetical form in (37a), the entire word is mapped into a single pword with the (eventual) result that the phonological structure matches that of simplexes as in (37b). [19]

(37) a. $[\text{nósethìrl}]_{\text{NOUN}}$

b. $([\text{nóstril}]_{\text{NOUN}})_{\omega}$

It seems that once prosodic fusion has affected the phonological form of the (former) compound (e.g. loss of the weak foot, assimilation), head recognition is ruled out, even if the word corresponding to the original head were to reappear in the language. If this is correct, the recognition process modeled in (35)-(36) is also sensitive to (surface) prosodic structure, represented by the stress marks in the input in (35a). The recognition procedure outlined above aims accordingly not for maximal parsimony in lexical entries. Rather, the aim is to capture the conditions necessary for transfering language

[19]Plausibly not only the complete loss of the relevant word from the language, but a low token frequency relative to the compound, may suffice to cause fusion. This is because lower relative frequency implies that the word is likely not to be known by the time the compound is acquired, and consequently cannot be recognized. This may be the cause of prosodic fusion in *há*[ŋ]*kerchief* 'handkerchief', which is far more common than the historically related noun *kérchief* (cf. section 6).

structures from speakers to learners, thereby accounting for potential stability of morphological and prosodic structure in historical perspective.

The analysis illustrated in (35)-(36) extends to the cases in (38), which are usually considered part of derivational morphology. Specifically, the presence of two separate pwords can generally be attributed to head recognition as described above. That is, given an input word such as the adjective *subalpine* in (38a) and the recognition of a constituent in rightmost position corresponding to an independent adjective as in (38b), that constituent is labeled as head of the input word as in (38c).

(38) a. [sùbálpìne]$_{ADJ}$

b. [sùb[álpìne]]$_{ADJ}$ = [álpìne]$_{ADJ}$

c. [sùb[álpìne]$_{HEAD}$]$_{ADJ}$

The rest of the word is again classified as a modifier, specifically a modifying prefix, marked by the subscript "MODP". The classification of a given "rest"-constituent as a modifying prefix as opposed to a simple modifier appears to be determined by the semantic relationship obtaining between the input word and its head, which supports the relevance of paradigmatic knowledge to syntagmatic analysis involving heads (as opposed to head affixes, cf. section 3.1.2. below).[20] The boundaries of both heads and modifying prefixes are aligned with pword boundaries as in (39b), giving rise to boundary effects.

(39) a. [[sùb]$_{MODP}$[álpìne]$_{HEAD}$]$_{ADJ}$

b. [([sùb]$_{MODP}$)$_{ω}$(álpìne]$_{HEAD}$)$_{ω}$]$_{ADJ}$

The distinction between modifiers and modifying prefixes is motivated by relative prominence patterns: *sub-* in (39), although forming a separate pword like *luke-* in (36), has weak prominence. This distinction is systematic only for adjectives and verbs. All modifiers, including modifying prefixes, tend to have main stress in nouns.

The irrelevance of the inherent properties of modifiers is demonstrated by the occurrence of stable boundary effects in words with unique modifying prefixes. The modifying prefixes in (40a) do not recur, yet their stable stress in pretonic position qualifies as a Headedness effect, indicative of their status as separate pwords. The analysis of stress in (40a) as a Headedness effect is based on the prosodic contrast with the words in (40b), which do not allow for the recognition of a head.

(40)	a.	([æb])$_{ω}$(nórmal)$_{ω}$ 'abnormal'		b.	[əb]nóxious 'obnoxiuos'
		([ɪg])$_{ω}$(nóble)$_{ω}$ 'ignoble'			[ɪg]nóre 'ignore'
		([ænt])$_{ω}$(árctic)$_{ω}$ 'antarctic'			[ən]ténna 'antenna'

[20] Typical semantic relations that motivate the classification of a modifier as a prefix ("MODP") are non-gradient, including privative relations (*asymmetry - symmetry, nontoxic - toxic*), contrary relations (*unfriendly - friendly*, *impolite - polite*), and spacial or temporal relations (e.g. *precook - cook*, *postdate - date*).

Given their non-recurrence, the modifying prefixes in (40a) cannot be learned and recognized independently. Instead, their prosodic form as separate pwords derives from their role as "rests", which remain as parts of words after the respective heads have been recognized and bracketed as shown in (41):

(41)	Input:	1. Head recognition	2. "Rest" => modifier
	[àbnórmal]$_{ADJ}$	[àb[nórmal]$_{HEAD}$]$_{ADJ}$	[[àb]$_{MODP}$[nórmal]$_{HEAD}$]$_{ADJ}$
	[ìgnóble]$_{ADJ}$	[ìg[nóble]$_{HEAD}$]$_{ADJ}$	[[ìg]$_{MODP}$[nóble]$_{HEAD}$]$_{ADJ}$
	[àntárctic]$_{ADJ}$	[ànt[árctic]$_{HEAD}$]$_{ADJ}$	[[ànt]$_{MODP}$[árctic]$_{HEAD}$]$_{ADJ}$

On this analysis, morphophonological properties of modifying prefixes are expected to be likewise irrelevant for the prosodic organization of words. In fact, the prosodic evidence shows that the modifying prefix *iN*-, which exhibits regular phonologically conditioned allomorphy, forms a separate pword on a par with non-varying modifying prefixes such as *non-, pan-,* and *un-*. That is, all modifying prefixes are stressed to satisfy Headedness, yielding the (potential) contrast in pretonic initial stress seen in (42b) vs. (42c) (cf. the stress marks in Wells 2000, Webster's 2000).

(42)	a.	b.	c.
	(nò**n)**$_{ω}$(mémber**)**$_{ω}$	(ì**m)**$_{ω}$(móral**)**$_{ω}$	(immédiate**)**$_{ω}$
	(ù**n)**$_{ω}$(líke**)**$_{ω}$	(ì**l)**$_{ω}$(légal**)**$_{ω}$	(illúsion**)**$_{ω}$
	(pà**n)**$_{ω}$(Búddhism**)**$_{ω}$	(ì**r)**$_{ω}$(régular**)**$_{ω}$	(iráscible**)**$_{ω}$

Others have proposed to represent the words in (42b) as single pwords, arguing that "assimilation" in (42b), as opposed to (42a), indicates prosodic fusion (cf. Szpyra 1989). However, in contrast to the low-level allophonic effects discussed in section 2 the sort of variation seen in (42b) is hardly a consequence of prosodic organization. Instead, the variation in the form of the negative prefix indicates phonologically conditioned allomorph selection with no obvious reference to suprasegmental structure.

Although not a consequence of prosodic structure, the occurrence of adjacent identical sonorants in (42b) conceivably enhances the likelihood of prosodic fusion in casual or fast speech. This would account for the fact that Wells lists at least three variants for words with modifying *in-, im-, il-, ir-,* as illustrated in (43), but not for words with modifying *non-, un-,* or *pan-*. Wells uses the diacritic ['] to indicate that the following syllable has main stress, [ˌ] indicates secondary stress.

(43)		
	[ˌɪm'mɑrːəl], [ˌɪ'mɑːrəl], [ɪ'mɑːrəl]	'immoral'
	[ˌɪl'liːgəl], [ˌɪ'liːgəl], [ɪ'liːgəl]	'illegal'
	[ˌɪr'regjʊlər], [ˌɪ'regjʊlər], [ɪ'regjʊlər]	'irregular'

A greater tendency for phonetic fusion in (42b), as opposed to (42a), could in addition be due to the lesser intensity of the prefix vowel [**ɪ**], compared to the vowels [å], [ʌ], and [æ]. Significantly, both these differences in vowel quality and the relevant phonotactic differences (i.e. adjacency of more similar consonants across morpheme boundaries for *iN*-prefixations compared to *un-, non-*, and *pan*-prefixations) concern segmental structure and its potential effect on the salience of boundary marking (cf. the

discussion of *night rate* versus *oxe-eyed* in section 2).[21] These differences accordingly do not argue against representing the modifying prefixes in the words in both (42a) and (42b) as separate pwords.

Representing all modifying prefixes as separate pwords is motivated not only by the (potential) contrast in pretonic stress as in (42a,b) vis-à-vis (42c) [22] but by the more stable and salient contrasts in relative prominence. The generalization in nouns and adjectives is that a branching foot is strong relative to a following non-branching foot resulting in initial main stress as in (44a). Since modifying prefixes are always weak in adjectives there are clear contrasts in relative prominence as shown in (44a) versus (44b): [23]

(44)	a.		b.	
		(rétrogràde)$_\omega$		(ùn)$_\omega$(afráid)$_\omega$
		(tácitùrn)$_\omega$		(ùn)$_\omega$(concérn)$_\omega$
		(circumspect)$_\omega$		(ìn)$_\omega$(diréct)$_\omega$
		(érudìte)$_\omega$		(ìm)$_\omega$(políte)$_\omega$

Both the Headedness effects observed in (42) (i.e. the presence of pretonic stress in (42a,b) as opposed to (42c)) and the contrasts in relative prominence illustrated in (44) support the parsing mechanism outlined above. That is, the deviations from the canonical stress patterns observed in (42a,b) and (44b) follow if morphological parsing is determined by head recognition as in (45), such that the inherent properties of the modifier are irrelevant. Basing alignment on the morphological structures inferred in (45) will yield the prosodic structures illustrated in (42) and (44).

(45)	Input:	1. Head recognition	2. "Rest" => modifier
	[ìmpolíte]$_{ADJ}$	[ìm[políte]$_{HEAD}$]$_{ADJ}$	[[ìm]$_{MODP}$[políte]$_{HEAD}$]$_{ADJ}$
	[ìllégal]$_{ADJ}$	[ìl[légal]$_{HEAD}$]$_{ADJ}$	[[ìl]$_{MODP}$[légal]$_{HEAD}$]$_{ADJ}$
	[ùnlíke]$_{ADJ}$	[ùn[líke]$_{HEAD}$]$_{ADJ}$	[[ùn]$_{MODP}$[líke]$_{HEAD}$]$_{ADJ}$
	[nònmémber]$_N$	[nòn[mémber]$_{HEAD}$]$_N$	[[nòn]$_{MODP}$[mémber]$_{HEAD}$]$_N$

A further prediction of the parsing mechanism outlined in (41) and (45) is that variation in prosodic structure arises whenever the head is somewhat obscure, known to some but not to others. The variation observed in (46) can be analyzed as a direct consequence of head recognition.

[21] The relevance of these differences in segmental structure for the perception of boundaries and the occurrence of prosodic fusion (with concomitant reduction) could be tested by comparing combinations such as *Tim Miller* versus *Don Miller*.

[22] Recall that words like *immediate* or *illusion*, which do not include a modifying prefix, never have initial stress.

[23] The evidence from relative prominence in support of analysing all modifying prefixes as separate pwords, regardless of allomorphy, is particular strong in Swedish or German, where modifying prefixes have main stress. That is, there is a striking contrast between Latinate words with regular main stress on the final syllable (e.g. *legál, radikál, fundamentál*) and a word with a modifying prefix such as *íllegàl* with initial main stress. For a detailed review of the evidence supporting the analysis of *iN-* as a separate pword, see Raffelsiefen 1999 and 2004.

(46)	Input:	Head recognition	Fully parsed structure
	[inclément]$_{ADJ}$	-	[inclément]$_{ADJ}$ ~ [ínclement]$_{ADJ}$
		[in[clément]$_{HEAD}$]$_{ADJ}$	[[ìn]$_{MOD}$[clément]$_{HEAD}$]$_{ADJ}$
	[acéphalous]$_{ADJ}$	-	[[ə]céphalous]$_{ADJ}$
		[a[céphalous]$_{HEAD}$]$_{ADJ}$	[èɪ]$_{MOD}$[céphalous]$_{HEAD}$]$_{ADJ}$

The irrelevance of the modifier is supported by the observation that even productive modifiers are not parsed as separate pwords when occurring in a word lacking a recognizable head as in (47).

(47)	Input:	Head recognition	Alignment
	[nónchalant]$_{ADJ}$	-	([nónchalant]$_{ADJ}$)$_{ω}$
	[míschievous]$_{ADJ}$	-	([míschievous]$_{ADJ}$)$_{ω}$
	[pandémic]$_{ADJ}$	-	([pandémic]$_{ADJ}$)$_{ω}$
	[discrépant]$_{ADJ}$	-	([discrépant]$_{ADJ}$)$_{ω}$
	[subtráction]$_{N}$	-	([subtráction]$_{N}$)$_{ω}$

Alternatively, the cause of failed morphological analysis (as reflected by the absence of boundary signals) could relate to the fact that the words in (47) are loanwords. However, word prosody offers clear evidence for the morphological analysis of loanwords as long as there is a recognizable head. Some examples are given in (48):

(48)	Input:	1. Head recognition	2. "Rest" => modifier
	[dishónest]$_{ADJ}$	[dis[hónest]$_{HEAD}$]$_{ADJ}$	[[dis]$_{MOD}$[hónest]$_{HEAD}$]$_{ADJ}$
	[malconténт]$_{ADJ}$	[mal[conténт]$_{HEAD}$]$_{ADJ}$	[[mal]$_{MOD}$[conténт]$_{HEAD}$]$_{ADJ}$
	[archbíshop]$_{N}$	[arch[bíshop]$_{HEAD}$]$_{N}$	[[arch]$_{MOD}$[bíshop]$_{HEAD}$]$_{ADJ}$
	[panóptical]$_{ADJ}$	[pan[óptical]$_{HEAD}$]$_{ADJ}$	[[pan]$_{MOD}$[óptical]$_{HEAD}$]$_{ADJ}$
	[misadvénture]$_{N}$	[mis[advénture]$_{HEAD}$]$_{N}$	[[mis]$_{MOD}$[advénture]$_{HEAD}$]$_{ADJ}$
	[asýmmetry]$_{N}$	[a[sýmmetry]$_{HEAD}$]$_{N}$	[[a]$_{MOD}$[sýmmetry]$_{HEAD}$]$_{ADJ}$

Aligning the morphological structures in the righthand column with pword boundaries yields the familiar correlation of boundary effects including relative prominence effects (i.e. weak-strong), Containment effects (e.g. di[s.ɑ]nest 'dishonest'), and Headedness effects (pretonic stress with concomitant stability of vowels as in [è] sýmmetry (*[ə]sýmmetry) 'asymmetry').

To summarize, while the presence of frequent modifiers like *non-*, *dis-*, *re-*, or *pre-* plausibly influences the morphological parsing of a word the prosodic evidence suggests that the recognition of such a modifier is neither a necessary condition for morphological analysis (cf. the data in (40)), nor a sufficient condition (cf. the data in (47)). What is both necessary and sufficient for the analysis of a modifier-head structure is the recognition of a head constituent.[24]

[24]Potential counter-examples include the adjectives *uncouth* and *unkempt*, which suggest that the presence of specific modifiers (possibly only *un-* in English) can be sufficient for morphological parsing.

3.1.2. Head-affix root structures

The evidence from boundary effects in words (historically) derived by head affixation supports the notion of asymmetry in morphological parsing. Here the basic generalization is that boundary effects may persist for as long as there is a recognizable head affix. In the examples in (49) the Final-C and Containment effects indicate the existence of word-internal pword-boundaries despite the absence (or extremely low frequency) of the respective base words.

(49)		
	†ruth-√less (cf. M.E. *ruthe* 'pity')	$(\text{rúth})_{\omega}(\text{less})_{\sigma}$
	†gorm-√less (cf. M.E. *gome* 'attention')	$(\text{gorm})_{\omega}(\text{less})_{\sigma}$
	†feck-√less (cf. Scott. *feck* 'efficacy')	$(\text{féck})_{\omega}(\text{less})_{\sigma}$
	†grate-√ful (cf. M.E. *grate* 'agreeable')	$(\text{gráte})_{\omega}(\text{ful})_{\sigma}$
	†wist-√ful (cf. M.E. *wistly* 'intently')	$(\text{wíst})_{\omega}(\text{ful})_{\sigma}$
	†dole-√ful (cf. M.E. *dol* 'pain, grief')	$(\text{dóle})_{\omega}(\text{ful})_{\sigma}$
	†bale-√ful (cf. M.E. *bale* 'evil influence; anguish')	$(\text{bále})_{\omega}(\text{ful})_{\sigma}$
	†rue[25]-√ful (cf. M.E. *rue* 'sorrow; regret')	$(\text{rúe})_{\omega}(\text{ful})_{\sigma}$
	†environ-√ment (cf. M.E. *environen* 'to encircle')	$(\text{envíron})_{\omega}(\text{ment})_{\sigma}$
	†oint-√ment (cf. M.E. *oint* 'to anoint')	$(\text{óint})_{\omega}(\text{ment})_{\sigma}$

In fact, there are no cases where the low frequency or loss of a base word has affected the prosodic structure of derived words (i.e. the presence of internal pword boundaries) as long as there has been a recognizable head affix. This generalization indicates the parsing mechanism illustrated in (50), which is determined by the recognition of a head affix.

(50)	Input:	Head affix recognition	"Rest" => root
	$[\text{gráteful}]_{\text{ADJ}}$	$[\text{gráte}[\text{ful}]_{\text{H-AFF}}]_{\text{ADJ}}$	$[[\text{gráte}]_{\text{ROOT}}[\text{ful}]_{\text{H-AFF}}]_{\text{ADJ}}$
	$[\text{fáteful}]_{\text{ADJ}}$	$[\text{fáte}[\text{ful}]_{\text{H-AFF}}]_{\text{ADJ}}$	$[[\text{fáte}]_{\text{ROOT}}[\text{ful}]_{\text{H-AFF}}]_{\text{ADJ}}$
	$[\text{rúthless}]_{\text{ADJ}}$	$[\text{rúth}[\text{less}]_{\text{H-AFF}}]_{\text{ADJ}}$	$[[\text{rúth}]_{\text{ROOT}}[\text{less}]_{\text{H-AFF}}]_{\text{ADJ}}$
	$[\text{tóothless}]_{\text{ADJ}}$	$[\text{tóoth}[\text{less}]_{\text{H-AFF}}]_{\text{ADJ}}$	$[[\text{tóoth}]_{\text{ROOT}}[\text{less}]_{\text{H-AFF}}]_{\text{ADJ}}$

The indiscriminate labelling of all "rests" in (50) as *roots*, regardless of whether or not these rests correspond to independent words, is based on the evidence from prosody. Specifically, the right boundaries of all roots preceding non-integrated head affixes exhibit the properties characteristic of right pword boundaries, including Final-C effects and Containment effects. This observation is accounted for by aligning all roots with pword boundaries. In addition, the outer word boundaries are aligned with pword boundaries which leaves the segments of the head affixes to be parsed "bottom-up", resulting in (unfooted) syllables.

[25]In addition to the noun *rue*, which is the historical base of this adjective and became obsolete, there is also a verb *rue*, meaning 'regret'. However that verb is far less common than the adjective *rueful* and also differs semantically. According to the American Heritage Dictionary of the English Language (4th edition, 2000) the main meaning of the adjective is 'inspiring pity or compassion'.

(51)	Alignment	Output
	$([([\text{gráte}]_{\text{ROOT}})_{\omega}[\text{ful}]_{\text{H-AFF}}]_{\text{ADJ}})_{\omega}$	$((\text{greɪt})_{\omega}(\text{fəl})_{\sigma})_{\omega}$
	$([([\text{fáte}]_{\text{ROOT}})_{\omega}[\text{ful}]_{\text{H-AFF}}]_{\text{ADJ}})_{\omega}$	$((\text{feɪt})_{\omega}(\text{fəl})_{\sigma})_{\omega}$
	$([([\text{rúth}]_{\text{ROOT}})_{\omega}[\text{less}]_{\text{H-AFF}}]_{\text{ADJ}})_{\omega}$	$((\text{ru:}\theta)_{\omega}(\text{ləs})_{\sigma})_{\omega}$
	$([([\text{tóoth}]_{\text{ROOT}})_{\omega}[\text{less}]_{\text{H-AFF}}]_{\text{ADJ}})_{\omega}$	$((\text{tu: }\theta)_{\omega}(\text{ləs})_{\sigma})_{\omega}$

The key question raised by the analysis illustrated in (50) is what determines the recognition of the suffixes. Because of the phonologically conditioned integration of all vowel-initial and consonantal suffixes into the pword of the root the prosodic evidence offers potential insight only for words with consonant-initial syllabic suffixes. Here the generalization emerges that productivity is the decisive factor for recognition. Rare cases of apparent High Frequency Fusion aside (e.g. *business, beautiful*), there is a clear tendency for productive suffixes, in particular *-ness, -less,* and *-ful*, but also *-ment*, *-ship*, and *-hood*, for which productivity is confined to base words with specific morphological or semantic properties[26], to be associated with stable word-internal boundary effects.

What complicates the evaluation of the role of productivity for affix recognition are potential PU-effects. Consider the adjectives in (52a), which include an unproductive suffix and yet deviate from canonical phonological form :

(52)			
	a.	[loʊðsəm] 'loathsome' [loʊnsəm] 'lonesome'	
	b.	cf. [loʊð] 'loathe' cf. [loʊn] 'lone'	
	c.	$(\text{bʌksəm})_{\omega}$ 'buxom'	< M.E. buhsum (cf. O.E. bugan 'to bend')
		$(\text{lɪsəm})_{\omega}$ 'lissom'	< M.E. l[i]thsom (cf. l[i:]the 'gentle')
		$(\text{gru:səm})_{\omega}$ 'gruesome'	< dial. gruesome/grewsome (†grue 'to shiver')
		$(\text{nɔɪsəm})_{\omega}$ 'noisome'	< M.E. noyesum (†noy 'to trouble, vex')
		$(\text{hænsəm})_{\omega}$ 'handsome'	< M.E. handsom *-> hand

Evidence for the analysis of the non-canonical sound patterns in (52a) as PU-effects rather than boundary effects pertains to the observation that such deviations from simplex structure are consistently licensed by a base word (cf. (52b)). When there is no recognizable base, either because the historical base became obsolete (e.g. (†*grue* 'to shiver' in *gruesome*), dissociated by sound change (e.g. *buxom* (< O.E. *bu:hsum*) - *bow* (< O.E. *bu:gan*), or because of a concrete meaning[27] (e.g. *hand* in *handsome*) we find

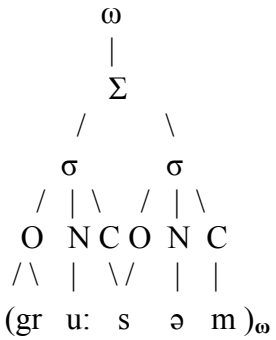
[26] The suffix *-ment* combines productively with *be-* or *en*-prefixations (e.g. *besmirchment*, *endearment*, cf. Marchand 1969:332), the suffix *-hood* combines productively with relational nouns and age-related nouns referring to humans (e.g. *sisterhood, adulthood*, cf. Marchand 1969:293), the suffix *-ship* combines productively with terms referring to ranks (e.g. *kingship, dictatorship*, cf. Marchand 1969:346).

[27] The meaning of concrete base nouns is prone to be reflected less and less in the meaning of derived adjectives over (historical) time. Compare the meanings of *handy, fishy, hairy,* which are based on concrete nouns, with the meaning of adjectives based on abstract nouns such as *hungry, wealthy, greedy*.

that (historical) -*some* derivations exhibit no deviation from simplex phonology as is shown in (52c).

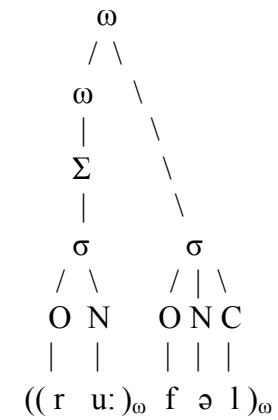
The effects of affix recognition on the prosodic organization of words are seen in the subtle difference between *gruesome*, where the stressed vowel is foot-internal in a closed syllable, and *rueful*, where the stressed vowel is foot-final and therefore lengthened (cf. the transcriptions in Wells 2000). For some speakers schwa can delete foot-internally, as in *gruesome*, but not outside the foot (hence the contrast between *rueful*, transcribed with schwa, and *rifle*, transcribed with a syllabic sonorant in Kenyon & Knott (1953)). The contrasts in foot and syllable structure seen in (53) correspond accordingly precisely to the contrasts between the simplex *minus* and suffixed *shyness* represented in (13).

(53) a.



'gruesome'

b.



'rueful'

The morphological parsing mechanisms indicated by the prosodic structures in (53) are given in (54):

(54)	Input:	Head affix recognition	"Rest" => root	Output:
	[grúesome]$_{ADJ}$	-	-	see (53a)
	[rúeful]$_{ADJ}$	[rúe[ful]$_{H\text{-}AFF}$]$_{ADJ}$	[[rúe]$_{ROOT}$[ful]$_{H\text{-}AFF}$]$_{ADJ}$	see (53b)

The claim that affix recognition is essential only to boundary effects, but not to PU-effects, is supported by the clear cases of PU-based phonological changes in (55):

(55)		
	comp[æ]rison > comp[ɛ]rison 'comparison'	(cf. -> comp[ɛ]r 'compare')
	cons[ɑ]latory > cons[oʊ]latory 'consolatory'	(cf. -> cons[oʊ]le 'console')
	p[æ]tronage > p[eɪ]tronage 'patronage'	(cf. -> p[eɪ]tron 'patron')
	sph[ɛ]rical > sph[ɪ]rical 'spherical'	(cf. -> sph[ɪ]re 'sphere')

All suffixes in (55) are vowel-initial, hence necessarily fused with the root into a single pword, and none is productive in English. Prosodic fusion and non-productivity of affixes are consequently consistent with the occurrence of PU-effects. The only condition for the occurrence of the PU-effects is the recognition of relatedness between words, which can be based entirely on phonological and semantic similarities between the relevant words. Given that the occurrence of PU-effects is consistent with lack of

internal morphological structure and given that PU-effects tend to be sporadic, eliminating alternations in some, but not all, related words, the English data confirm the relevance of affix productivity to word-internal morphological structure. Specifically, these data show that words which include productive suffixes have stable boundary effects indicative of internal pword boundaries, whether or not the root corresponds to an independent word. These data further show that words with unproductive suffixes consistently have simplex structure when there is no recognizable base (because PU-effects are ruled out then) and often have simplex structure even when there is a recognizable base (because PU-effects are sporadic and do not necessarily cause deviations from simplex structure). Examples are the words *laughter* and *knowledge*, which include non-recurring suffixes and are phonologically indistinct from simplexes like *after* and *college*:

(56)	Input:	Head affix recognition	Alignment	Output:
	[láughter]$_{ADJ}$	-	([láughter]$_{ADJ}$)$_{\omega}$	(læftər)$_{\omega}$ - (æftər)$_{\omega}$ 'after'
	[knówledge]$_{N}$	-	([knówledge]$_{N}$)$_{\omega}$	(nɑ:lɪdʒ)$_{\omega}$ - (kɑ:lɪdʒ)$_{\omega}$ 'college'

To summarize, the investigation of the prosodic evidence as a window on morphological structure indicates the crucial importance of suffix recognition, yielding the results in (57) for English. Recall that the prosodic evidence can be explored for non-cohering (i.e. consonant-initial, syllabic) suffixes only:

(57)	Recognized suffixes		Unrecognized suffixes
	<----------		---------->
	-ness, -less, -ment, -man, -ful -hood, -ship, -ling	?-dom	-some, -ter, -ledge

Suffix-recognition for *-ness, -less, -ment, -man* and *-ful* can be related to productivity, which in turn may be enhanced by phonological structure, possibly the combination of a salient (sonorant or non-coronal) onset and a coronal coda. The suffixes *-hood, -ling,* and *-ship*, which are also associated with stable boundaries, are less productive but their recognition may be secured by the combination of recurrence and phonological salience. Most notable here is the presence of full vowels, which in turn results from the consonantal structure of these suffixes. The full vowel in *-hood* owes its presence to the stability of the foot, which is secured by the restriction of [h] to foot-initial position in English (cf. 31). The combination of a strictly syllable-initial (i.e. non-ambisyllabic) onset and the occurrence of a non-coronal obstruent in coda position secures the stability of the foot and the concomitant stability of the full vowel in *-ship* (cf. 30). Finally, the postvocalic velar nasal ensures the stability of the feature [+high] in the vowel in *-ling*.

The significance attached to the recognizability of the suffixes for word-internal morphological structure is supported by the evidence from head prefixation. The results are presented in (58):

(58)	Recognized head prefixes		Unrecognized head prefixes
	<----------		---------->
a.	re-, de-, pre-, be-	? un-, ?in-/en, ?im-/em	se-, e-, per-, for-, ab-, ob-, neg-, con-, com-, col-, cor- sub-, suf-, sur-, dis-, ex-
b.	inter-, super-, over- under-		circum-, retro-, extra-

The classification of the monosyllabic prefixes in (58a) is based on the observation that only verbs including the prefixes *re-, de-, pre-*, or *be-* exhibit clear and consistent boundary effects. That is, apart from phonologically conditioned cohesion described in section 2 these prefixes never form a single domain of syllabification with the root and, for many speakers, are consistently distinguished by 'Head Final Enhancement'. The exclusive relevance of the identity of the head prefixes is demonstrated by the data in (59). All verbs in (59a) involve non-recurring roots, yet they exhibit consistent boundary effects, clearly because of the presence of the respective prefixes. By contrast, the verbs in (59b) include the recurring and hence in principle learnable (etymological) root *-lect* (From Latin *legere* 'to gather, choose'), yet these verbs are phonologically indistinguishable from simplexes. Tensing or lengthening of the prefix vowel in (59b) is ungrammatical, despite its occurrence in syllable-final position and its orthographic representation with <e>.

(59)	Input:	Head affix recognition	"Rest" => root	
a.	[relént]$_V$	[[re]$_{H\text{-}AFF}$lént]$_V$	[[re]$_{H\text{-}AFF}$[lént]$_{ROOT}$]$_V$	'relent'
	[desíre]$_V$	[[de]$_{H\text{-}AFF}$síre]$_V$	[[de]$_{H\text{-}AFF}$[síre]$_{ROOT}$]$_V$	'desire'
	[prepáre]$_V$	[[pre]$_{H\text{-}AFF}$páre]$_V$	[[pre]$_{H\text{-}AFF}$[páre]$_{ROOT}$]$_V$	'prepare'
	[begín]$_V$	[[be]$_{H\text{-}AFF}$gín]$_V$	[[be]$_{H\text{-}AFF}$[gín]$_{ROOT}$]$_V$	'begin'
b.	[se**léct**]$_V$	-	-	'select'
	[e**léct**]$_V$	-	-	'elect'
	[neg**léct**]$_V$	-	-	'neglect'

The parsing mechanism in (59) yields the structure in (60), which serves as a basis for alignment. The correct output forms presuppose alignment of both word and root boundaries with pword boundaries. By contrast, there is no motivation for invoking alignment when parsing the segments of head prefixes, which form monosyllabic and hence unfooted syllables. "Final Nucleus Enhancement" applies before pword boundaries as in (60a), but not before foot boundaries as in (60b):

(60)	Morphologically parsed structures:	Alignment:	Output:
a.	[[re]$_{H\text{-}AFF}$[lént]$_{ROOT}$]$_V$	([[re]$_{H\text{-}AFF}$([lént]$_{ROOT}$)$_\omega$]$_V$)$_\omega$	((r[i:])$_\sigma$(lént)$_\omega$)$_\omega$
	[[de]$_{H\text{-}AFF}$[síre]$_{ROOT}$]$_V$	([[de]$_{H\text{-}AFF}$([síre]$_{ROOT}$)$_\omega$]$_V$)$_\omega$	((d[i:])$_\sigma$(sire)$_\omega$)$_\omega$
	[[pre]$_{H\text{-}AFF}$[páre]$_{ROOT}$]$_V$	([[pre]$_{H\text{-}AFF}$([páre]$_{ROOT}$)$_\omega$]$_V$)$_\omega$	((pr[i:])$_\sigma$(páre)$_\omega$)$_\omega$
	[[be]$_{H\text{-}AFF}$[gín]$_{ROOT}$]$_V$	([[be]$_{H\text{-}AFF}$([gín]$_{ROOT}$)$_\omega$]$_V$)$_\omega$	((b[i:])$_\sigma$(gín)$_\omega$)$_\omega$
b.	[seléct]$_V$	([seléct]$_V$)$_\omega$	(s[ɪ]léct)$_\omega$
	[eléct]$_V$	([eléct]$_V$)$_\omega$	([ɪ]léct)$_\omega$
	[negléct]$_V$	([negléct]$_V$)$_\omega$	(n[ɪ]gléct)$_\omega$

The irrelevance of (etymological) root recurrence for prosodic structure (and, presumably for morphological parsing), can be further demonstrated with the near-minimal pairs in (61). These data support the claim that the occurrence of boundary effects, in particular the tensing and lengthening of the prefix vowel, is exclusively determined by the recognizability of a head prefix:[28]

(61)	Input:	Head affix recognition:	"Rest": root	Alignment:
	$[redúce]_V$	$[[re]_{H\text{-}AFF}dúce]_V$	$[[re]_{H\text{-}AFF}[dúce]_{ROOT}]_V$	$[[re]_{H\text{-}AFF}([dúce]_{ROOT})_\omega]_V$
	$[sedúce]_V$	-	-	$([sedúce]_V)_\omega$
	$[recéde]_V$	$[[re]_{H\text{-}AFF}céde]_V$	$[[re]_{H\text{-}AFF}[céde]_{ROOT}]_V$	$[[re]_{H\text{-}AFF}([céde]_{ROOT})_\omega]_V$
	$[secéde]_V$	-	-	$([secéde]_V)_\omega$

The indiscriminate labeling of "rests" as roots, regardless of whether or not those rests correspond to independent words, is supported by prosodic structure. In the verbs presented in (62), all etymological roots correspond to independent words, thereby differing from the verbs in (59). Yet, prosodically all of these verbs are on a par: there are systematic boundary effects for *re-, de-, pre-*, and *be*-prefixation. There are no boundary effects elsewhere:

(62)	Input:	Head affix recognition	"Rest" => root	Output:
	$[renéw]_V$	$[[re]_{H\text{-}AFF}néw]_V$	$[[re]_{H\text{-}AFF}[néw]_{ROOT}]_V$	$(r[i:])_\sigma(néw)_\omega$
	$[decéase]_V$	$[[de]_{H\text{-}AFF}céase]_V$	$[[de]_{H\text{-}AFF}[céase]_{ROOT}]_V$	$(d[i:]_\sigma(céase)_\omega$
	$[prescríbe]_V$	$[[pre]_{H\text{-}AFF}scríbe]_V$	$[[pre]_{H\text{-}AFF}[scríbe]_{ROOT}]_V$	$(pr[i:])_\sigma(scríbe)_\omega$
	$[bewítch]_V$	$[[be]_{H\text{-}AFF}wítch]_V$	$[[be]_{H\text{-}AFF}[wítch]_{ROOT}]_V$	$(b[i:])_\sigma(wítch)_\omega$
	$[secúre]_V$	-	-	$(s[ɪ]cúre)_\omega$
	$[condénse]_V$	-	-	$(c[ə]ndénse)_\omega$
	$[submérge]_V$	-	-	$(s[ə]bmérge)_\omega$
	$[abúse]_V$	-	-	$([ə]búse)$

The generalization, already established for English head suffixation, is simply that the morphosyntactic status of the "rest" is irrelevant to prosody.

Considering now the question of what makes the head prefixes *re-, de-, pre-*, and *be-* recognizable, as opposed to the other historical monosyllabic prefixes in (58a), a possible generalization concerns the existence of the near-homophonous modifiers *re-, de-,* and *pre-*. Specifically the fact that these modifiers combine productively with verbs in native word formation (e.g. *rewrite, demystify, precook*), might be relevant. This proposal raises the question of why precisely these prefixes, which historically emerged from head prefixes in Latinate loan verbs, became productive. Possibly the productivity

[28] The representation of the string *-duce* in *reduce*, but not in *seduce*, as a root could be criticized because of the identical alternations observed in *reduce- reduction* and *seduce - seduction* (cf. Aronoff 1976). However, this correspondence is arguably significant from a paradigmatic perspective only, as illustrated in (1), but does not reflect on word-*internal* structure.

of these modifying prefixes has been adopted from French. Perhaps, there is something to be said about phonological form here as well. The assumption that the combination of a salient onset (i.e. non-coronal and/or voiced consonants) and an open syllable makes head prefixes more recognizable accounts not only for the recognizability of *re-, de-,* and *pre-* in Latinate loan verbs (and possibly their rise to productivity as a modifying prefix in native word formation) but also explains the fact that *be-* is the only surviving head prefix from Germanic (as opposed to *†for-, †to:-, †a:-, †of-, †on- †oθ-, †ymb- †at-, †ed-, †with-* etc.).

The relevance of productivity and phonological form for head prefix recognition is supported by the bisyllabic prefixes in (63a). Here the prosodic evidence, specifically the evidence from relative prominence, indicates that the prefixes *inter- super-*, *under-*, and *over-* are recognized, whereas other verb-initial iambic feet are not recognized, as shown in (63b). Again, root-inherent properties are irrelevant:

(63)	Input:	Head affix recognition	"Rest" => root
a.	[ìntermít]$_V$	[[ìnter]$_{H\text{-}AFF}$mít]$_V$	[[ìnter]$_{H\text{-}AFF}$[mít]$_{ROOT}$]$_V$
	[sùperscríbe]$_V$	[[sùper]$_{H\text{-}AFF}$scríbe]$_V$	[[sùper]$_{H\text{-}AFF}$[scríbe]$_{ROOT}$]$_V$
	[ùndermíne]$_V$	[[ùnder]$_{H\text{-}AFF}$míne]$_V$	[[ùnder]$_{H\text{-}AFF}$[míne]$_{ROOT}$]$_V$
	[òvercóme]$_V$	[[òver]$_{H\text{-}AFF}$cóme]$_V$	[[òver]$_{H\text{-}AFF}$[cóme]$_{ROOT}$]$_V$
b.	[pérsecùte]$_V$	-	-
	[rétrogràde]$_V$	-	-
	[círcumcìse]$_V$	-	-
	[éxtradìte]$_V$	-	-

Aligning all word- and root boundaries with pword boundaries yields the structures in (64a). The prosodic parsing of the segments of the head prefixes yields disyllabic and hence trochaic feet as in (64b):

(64)	a. Alignment:	b. Output:
	([[ìnter]$_{H\text{-}AFF}$([mít]$_{ROOT}$)ω]$_V$)ω	((ìnter)$_\Sigma$(mít)ω)ω
	([[sùper]$_{H\text{-}AFF}$([scríbe]$_{ROOT}$)ω]$_V$)ω	((sùper)$_\Sigma$(scríbe)ω)ω
	([[ùnder]$_{H\text{-}AFF}$([míne]$_{ROOT}$)ω]$_V$)ω	((ùnder)$_\Sigma$(míne)ω)ω
	([[òver]$_{H\text{-}AFF}$([cóme]$_{ROOT}$)ω]$_V$)ω	((òver)$_\Sigma$(cóme)ω)ω
	([pérsecùte]$_V$)ω	(pérsecùte)ω
	([rétrogràde]$_V$)ω	(rétrogràde)ω
	([círcumcìse]$_V$)ω	(círcumcìse)ω
	([éxtradìte]$_V$)ω	(éxtradìte)ω

Recall that combining a foot with a pword yields weak-strong prominence, thus yielding boundary effects indicative of internal morphological structure for all verbs ending in maximally one consonant (cf. the first four examples in (64)).[29] The regular stress for such verbs is seen in the last four examples in (64), where the combination of a trochaic and a monosyllabic foot yields strong-weak prominence.

[29]I assume that initial main stress in the verb *supervise* is due to paradigm uniformity with the noun *supervisor*, where initial main stress is regular.

Recognition of the prefixes can in some instances be related to the existence of homophonous modifiers which productively combine with verbs. This holds in particular for *over*- and *under*- (e.g. typical pairs like *overcharge - undercharge*, *overspend - underspend*, *overfeed - underfeed*), less so for *super*-, which however is productive with nouns and adjectives, and least for *inter*-. The property shared by the prefixes in question is again phonological. All prefixes are disyllabic trochees ending in *-er*.

The relevance of morphosyntactic category for the significance of affix productivity for morphological parsing is supported by the phonology of verbs historically derived by ex-prefixation. As a modifier, *ex*- is highly productive with nouns (e.g. *ex-husband, ex-cop*), but not with verbs. The claim that this prefix fails to be recognized in Latinate loan verbs is supported by the cases in (65), all of which involve a (historical) root spelled with initial <h>. Such verbs are typically marked by prosodic fusion, as is indicated by the correlating 'silence' of the <h> and the voicing of the prefix-final cluster.

(65)	e[gz]áust	'exhaust'
	e[gz]ílaràte	'exhilarate'
	e[gz]órt	'exhort'
	e[gz]íbit	'exhibit'

Pronunciation of the root-initial [h] and concomitant voicelessness of the syllable-final cluster [ks] in (66) is not a boundary effect indicative of head prefix recognition but rather a paradigm effect. This is because such structure presupposes the existence of an independent, semantically related word, in which <h> occurs in a context where pronunciation is ensured (e.g. after sonorant). The words in (66a,b) are directional opposites, where the variation in (66b) plausibly relates to the very low token frequency of *inhume* compared to *exhume*.[30] The relevance of meaning relations for the occurrence of the phonological effect in question is demonstrated by the examples in (66c,d). Here the <h>-initial root recurs in independent words, which however fail to be semantically related to the historic *ex*-prefixations. As a result, the latter conform entirely to canonical phonological patterns.

(66)	a.	e[ks.h]ále	'exhale'	<=> in[h]ále 'inhale'
	b.	e[ks.h]úme ~ e[gz]úme	'exhume'	<=> † in[h]úme 'inhume'
	c.	e[gz]íbit	'exhibit'	in[h]íbit 'inhibit'
	d.	e[gz]órt	'exhort'	co[h]ort 'cohort'

The examples in (66) versus (59) to (64) support the need to distinguish between boundary effects and paradigm uniformity effects, both of which involve deviations from the sound structure of simplexes. Whereas boundary effects presuppose a recognizable head affix in a word with a specific category, regardless of the existence of other words, the occurrence of paradigm uniformity effects as in (66) presupposes the

[30] A well-known example for a paradigm uniformity effect based on semantic oppositeness is the change in the pronunciation of the vowel in English *female* (i.e. *femelle* > *female*), clearly in analogy to the vowel in *male*.

recognition of a semantic relation between whole words (cf. also the analogous cases in (52) versus (49) to (51)).

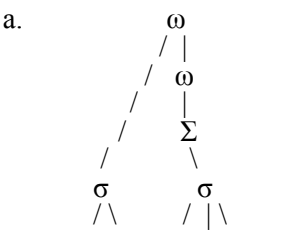
3.2. Summary and discussion

In this section I have presented a morphological parsing mechanism based on the recognition of heads and head affixes, respectively. The (non-cohering) head affixes which are systematically recognized are listed in tables (57) and (58). The observation that these affixes are amenable to a characterization in phonological terms suggests that phonological form might be essential to the recognition of head affixes. In contrast to the analysis of modifier-head structures, the analysis of words derived by head affixation does not appear to involve paradigmatic knowledge.

The parsing rules given here are motivated by the prosodic structure of words. Specifically, these rules yield word-internal morphological structures which serve as a basis for alignment with pword boundaries. Such alignment is manifested by a range of systematically correlating deviations from the sound structure of simplexes including Containment effects, Headedness effects, Final-C effects, Relative Prominence effects and Final Nucleus Enhancement. The claim is that the historical stability of these effects, some of which are quite subtle (e.g. *shyness - minus*), indicates an acquisition process involving the parsing procedure for word-internal morphology outlined here. To demonstrate this claim it is adequate, in fact appropriate in view of the actual conditions for language learning, to represent input forms with surface phonological structure, including stress. It may be significant, however, that the correct output forms would result even if most of the stress marks, including all relative prominence marking, were eliminated from input forms.

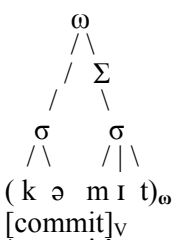
A possible objection to the analysis of the morphology-phonology interface presented here is that it lacks comprehensiveness. Chomsky and Halle (1968) analyse stress in verbs such as *commít* versus *vómit* in terms of morphological complexity, arguing that final stress indicates the structure *com+mit*, consisting of a prefix and a root, compared to the simplex *vomit*. However, unlike the verb *remit*, which is marked by Final Nucleus Enhancement, the phonological form of *commit* does not exhibit any deviation from the sound patterns of simplex verbs. Both patterns in (67b) and (67c) are equally regular and stable for verbs (cf. final stress in *caréss, haráss, ignóre, avér*).

(67) a.



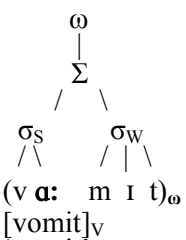
[[re]$_{\text{H-AFF}}$[mit]]$_V$
'remit'

b.



[commit]$_V$
'commit'

c.



[vomit]$_V$
'vomit'

As has been demonstrated above, the complex prosodic structure in *remit* is due to the recognition of the head prefix *re-*. The cause for the distinct stress pattern in *commít* versus *vómit* is historical, specifically the antepenultimate stress pattern in the donor language Latin (cf. Latin *commítere* (Fr. *cométre*) > Middle English *commítten* > New

English *commít* versus Latin *vómere* (past part. *vómitus*) > Middle English *vómiten* > New English *vómit*).

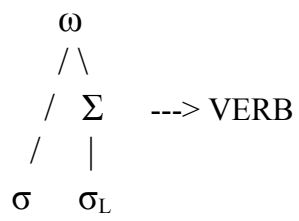
The claim that foot structure in English loan verbs is determined by the position of stress in the etymological source along with historical stability is further illustrated by the verbs in (68), all of which involve the same historical root *-jur* 'right, law'. Final stress in (68a) is due to the stress in the donor languages, presumably based on the (boldfaced) inflected present tense singular form, rather than a form with suffixal stress. Initial stress in (68b) is due to the origin of the words as back-formations from the respective nouns, for which initial stress is regular.[31] Synchronically these are paradigm uniformity effects, supported by the close meaning relations.[32]

(68) a. abjúre < M.E. abjúren < Fr. **abjúr**/abjurér
adjúre < M.E. adjúren < Fr. **adjúr**/adjurér

b. ínjure < ínjury]$_N$
pérjure < pérjury]$_N$

It appears then that the stress patterns in none of the verbs in (67b,c) or (68a,b) indicate word-internal morphological analysis. Instead, these data demonstrate the historical stability of stress, regardless of syllable weight, in English verbs[33], as opposed to the tendency to leftward stress shift in nouns (e.g. *perfúme* > *pérfume*).[34] The generalization that final main stress, especially on a light syllable, (weakly) indicates verbhood is expressed in (69) ("σ_L" means 'light syllable')[35].

(69)



The intuition that learners know something about words like *commít* or *haráss*, namely that these words are most likely verbs, can be captured as in (69) without referring to word-internal morphological structure.

A second case where morphological complexity may seem to be indicated by phonological structure concerns word-internal phonotactics. Trubetzkoy (1958) remarks that certain types of clusters can function as boundary signals, indicative of an internal morphological boundary (cf. 1958:247). For German he lists various consonant clusters, including clusters consisting of a consonant and [h]. Similar cases of unusual clusters are found in English, as is illustrated in (70):

[31] In addition, there are variants *cónjure* versus *conjúre*, which according to the OED go back to a "stress mutation" in Old French.

[32]Paradigm uniformity effects might also reinforce the stability of stress in *commít* (cf. the nouns *commítal, commítment*) and *vómit* (cf. the noun *vómit*).

[33]The only cases of stress instability in disyllabic verbs are those which include a recognizable head suffix like *-ize* or *-ate* (e.g. *chastíze ~ chástize, capsíze ~ cápsize, rotáte ~ rótate, donáte ~ dónate*).

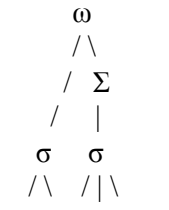
[34] Cases where stress has seemingly shifted in verbs, like the variant *cóntrast*, invariably involve a noun that has undergone prior stress shift (i.e. contrást]$_N$ > cóntrast]$_N$) and are best analysed as conversions exhibiting PU-effects.

[35] I ignore for now the existence of adjectives, which pattern partially with verbs (e.g. the stress in *absúrd*), partially with nouns (e.g. the stress in *séparate*).

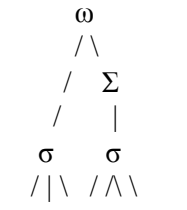
(70) a[**bh**]ór 'abhor'
co[**nf**]íne 'confine' (cf. triu[mf] *triu[nf] 'triumph')
o[**bt**]áin 'obtain'

ùHowever, while the clusters may indicate that these words are originally adopted from Latin or French, they do not indicate morphological complexity. All relevant segments are easily parsed into pword-internal prosodic constituents, including the [h] in (71a), which occurs foot-initially:

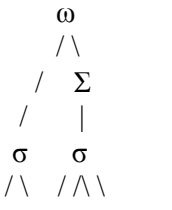
(71) a.



b.

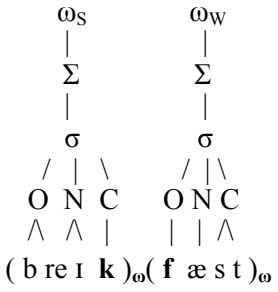


c.

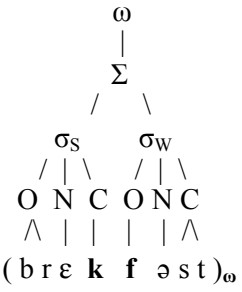


The claim is then that the occurrence of unusual clusters does not qualify as boundary signal if the relevant segments can be parsed into well-formed pword-internal prosodic constituents.[36] The insignificance of mere rareness of consonant combinations compared to the boundary effects reviewed above is revealed by the outcome of historical prosodic fusion. In (72) it is shown that HFF (High Frequency Fusion) results in the correlating loss of the Headedness effect (loss of the weak foot no longer dominated by a pword) and the loss of the Final-C effect (shortening of the superheavy rhyme no longer in pword-final position). By contrast, the cluster [kf] emerges unscathed, even though it is the only such consonant combination within an English word.[37]

(72) a.



b.



While the phonological form in the examples in (71) does not indicate word-internal morphological structure it does again signal word class membership. Specifically, the lack of stress on the initial syllable despite syllable closure indicates that the word is a

[36] For instance, the cluster [bh] in *abhor* is not a boundary signal since [h] is parsed in foot-initial position. By contrast, intervocalic [h] in *pro*[h]*awaiian* cannot be parsed in foot-initial position, thereby signaling pword-initial position indicative of a morphological boundary (i.e. (pro)ω(Hawaiian)ω).

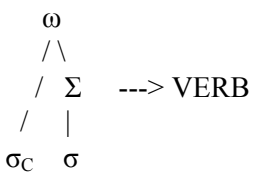
[37] It remains to be investigated whether there are other combinations, in particular certain violations of constraints on syllable contacts, combinations of obstruents differing only in voicedness, combinations of nasals differing only in place of articulation, etc. which, unlike the cluster [kf], are affected by prosodic fusion and consequently do signal boundaries. My point is that rareness or even uniqueness of clusters in historically complex words in itself is insignificant.

verb, rather than a noun. In bisyllabic nouns, closed pretonic syllables are regularly stressed as is demonstrated by the contrasts in (73a,b):[38]

(73) a. c[ə]n.táin]$_V$ 'contain'
c[ə]m.páre]$_V$ 'compare'
c[ə]n.trást]$_V$ 'contrast'
[ə]b.séss]$_V$ 'obsess'
s[ə]s.péct]$_V$ 'suspect'

b. c[æ]n.téen]$_N$ (*c[ə]ntéen]$_N$) 'canteen'
c[æ]m.páign]$_N$ (*c[ə]mpáign]$_N$) 'campaign'
p[ɑ]n.tóon]$_N$ (*p[ə]ntóon]$_N$) 'pontoon'
[æ]b.sínth]$_N$ (*[ə]bsínth]$_N$) 'absínth '
s[ɛ̀]s.tét]$_N$ (*s[ə]stét]$_N$) 'sestet')

The rule in (74) expresses the knowledge that the words in (71) and (73a) are verbs ("σ_C" means 'closed syllable'). Reference to word-internal structure is again unmotivated.

(74)


To summarize, I argue that word-internal boundary effects, which crucially involve reference to pword boundaries, should be distinguished from other peculiarities of sound structure including rare phonotactics and word class specific phonological patterns. Assuming then that English verb stress is adequately described by the structures in (67) and (71) both the acquisition of the sound patterns in cases like (68) and (70) and their concomitant stability in historical time can be explained without referring to word-internal morphological structure. By contrast, the acquisition and stability of the sound patterns referred to as boundary effects above does require reference to morphological structure. This structure reflects the parsing mechanism based on head recognition outlined in section 3.1.

4. A case for universality: optionality and the form-meaning parallelism

Up to this point the discussion has been focused on the morphology-prosody interface. Specifically, a parsing mechanism has been introduced which yields morphological structures based on the recognition of heads or head affixes respectively. For instance, assuming that *able* is recognized as a head in the adjective *unable* and that *en-* is recognized as a head affix in the verb *enable* this parsing mechanism yields the output in (75a)

(75)				
a.	Output of parsing:	[[un]$_{\text{MOD-AFF}}$[able]$_{\text{HEAD}}$]$_{\text{WORD}}$	[[en]$_{\text{H-AFF}}$[able]$_{\text{ROOT}}$]$_{\text{WORD}}$
b.	Correlating affix properties:	paradigmatic variability syntagmatic autonomy	no paradigmatic variability less syntagmatic autonomy
	Prosodic properties:	=> (un)$_\omega$(able)$_\omega$ ("top-down"-parsing, "crisp boundaries")	=> (enable)$_\omega$ ("bottom-up"-parsing, fusion)
	Semantic properties:	necessarily inherent meaning (not')	possibly inferred meaning (cause to become')

[38] The fact that pretonic destressing of closed syllables is ungrammatical only in disyllabic nouns, but not in longer nouns (cf. c[`æ]n.téen]$_N$ (*c[ə]ntéen]$_N$) 'canteen' but [`æ]nténna ~ [ə]nténna 'antenna') shows that foot stability is a minimality effect here.

As was noted above, the definition of heads based on commutation with the input word implies the optionality of the modifying affix. This is what is meant by paradigmatic variability in (75b). Head affixes, which are recognized based on their occurrence within a word with a specific category, are inherently not optional, implying a lack of paradigmatic variability. Below I will discuss a possibly universal correlation between paradigmatic variability and syntagmatic autonomy, both with respect to prosody and meaning.

A close connection between paradigmatic variability and syntagmatic autonomy in relation to prosodic structure is demonstrated in section 3. Specifically, it has been shown that modifying prefixes, which can be omitted, are mapped into separate pwords, necessarily resulting in stress (because of Headedness) and "crisp boundaries" (because of Containment). This sort of prosodic parsing of segments dominated by a separate pword is "top-down" in the sense that a pword necessarily dominates a foot, regardless of the segmental structure involved.

By contrast, head affixes, which cannot be omitted, are not parsed into separate pwords. Rather, the segments of head affixes are parsed into syllables and feet in accordance with general constraints on prosodic structure. This sort of parsing has been characterized as "bottom-up", because of the dependence of foot licensing on the segmental material (e.g. the presence of a foot in the suffix *-hood*, but not in the suffix *-ness*).

The fact that head affixes do not form separate pwords affects not only stress, but also the potential of phonologically conditioned fusion. The verb *enable* in (75) illustrates fusion of a head prefix with a vowel-initial root. The phonological conditioning indicates domination of the relevant GP-alignment constraints by other constraints. Significantly, this sort of fusion (or lack of syntagmatic autonomy) affects only (obligatory) head affixes, not (optional) modifying affixes.

In addition to correlating with differences in prosodic structure, the optionality of affixes also correlates with semantic differences. Specifically, modifying affixes always have inherent meaning, which cannot be inferred from either syntagmatic or paradigmatic structure. By contrast, the meaning associated with head affixes can often be inferred on the basis of syntagmatic context and paradigmatic relations. For instance, the meaning "causative" associated with the verb *enable* must not be analysed as an inherent meaning component of the head prefix *en-* because all transitive verbs for which an adjectival base can be recognized have a causative meaning. A statement of the relevant rule from an analytic perspective (i.e. from the perspective of the hearer/learner) is given in (76).[39] For illustration see the examples in (76b) ("X => Y" reads 'For word X, word Y is recognized as the base'; M(X) means 'meaning of X'):

(76) a. If: $[X]_{TV}$ => $[Y]_A$
Then: M(X): cause to become Y'

b.

[**en**large]$_{TV}$ => [large]$_A$	'cause to become large'
[humid**ify**]$_{TV}$ => [humid]$_A$	'cause to become humid'
[legal**ize**]$_{TV}$ => [legal]$_A$	'cause to become 'legal'
[wid**en**]$_{TV}$ => [wide]$_A$	'cause to become wide'
[corrupt]$_{TV}$ => [corrupt]$_A$	'cause to become corrupt'

[39]For an alternative approach from a synthetic perspective (i.e. the perspective of the speaker) see Beard (1995:177ff), who refers to Szymanek (1988). For criticism of Beard's analysis, which would not apply to the analytic approach presented here, see Plag 1999:237ff).

Transitivity of verbs can be inferred from the syntagmatic context (i.e. the utterance in which the verbs appear). The paradigmatic relation to the relevant adjectives, which must be assumed to be stored in the mental lexicon, is recognized on the basis of sound-meaning correspondences (cf. Raffelsiefen 1998). It would be inappropriate to treat the boldfaced head affixes, including the "zero" affix in the verb *corrupt*, as Saussurean signs which yield compositional meanings in combination with the respective roots. Rather the predictability of the meanings on the basis of the independently given syntagmatic relations (transitivity) and paradigmatic relations (base relations) shows that the affixes in question have no meaning. Their sole function is to indicate word class, i.e. the membership of the relevant word to the class of verbs. This morphosyntactic function is also fulfilled in the cases in (77), where a noun could be recognized as a base (77a) or no word at all (77b). Significantly, the alleged semantic function, to signal causativeness, is no longer manifest.[40] This demonstrates that causativeness is a not a property of specific affixes, but rather derives from the paradigmatic relation between a transitive verb and a recognized base adjective.

(77) a. [**en**courage]$_{TV}$ => [courage]$_{N}$
[burglar**ize**]$_{TV}$ => [burglar]$_{N}$
[person**ify**]$_{TV}$ => ?[person]$_{N}$
[threat**en**]$_{TV}$ => [threat]$_{N}$

b. [**en**chant]$_{TV}$ => Ø
[ostrac**ize**]$_{TV}$ => Ø
[rat**ify**]$_{TV}$ => Ø

An additional rule of semantic interpretation crucially involving paradigmatic knowledge is stated in (78a). This rule describes the meaning assignment to abstract nouns ("AN") for which an adjectival base is recognized. The classification "abstract" is here used with reference to syntax, meaning that the nouns can appear without a determiner. The rule is illustrated in (78b):

(78) a. If: [X]$_{AN}$ => [Y]$_{A}$
Then: M(X): condition/property/state of being Y'

b.

[kind**ness**]$_{N}$ => [kind]$_{A}$	'condition/property/state of being kind'
[obes**ity**]$_{N}$ => [obése]$_{A}$	'condition/property/state of being obese'
[silen**ce**]$_{N}$ => [sílent]$_{A}$	'condition/property/state of being silent'
[just**ice**]$_{N}$ => [just]$_{A}$	'condition/property/state of being just'
[warm**th**]$_{N}$ => [warm]$_{A}$	'condition/property/state of being warm'
[height]$_{N}$ => [high]$_{A}$	'condition/property/state of being high'
[moist**ure**]$_{N}$ => [moist]$_{A}$	'condition/property/state of being moist'
[modest**y**]$_{N}$ => [modest]$_{A}$	'condition/property/state of being modest'
[cold]$_{N}$ => [cold]$_{A}$	'condition/property/state of being cold'

[40]Deciding whether or not causation is involved is sometimes difficult since many transitive verbs involving volition lend themselves to a paraphrase with a causative element (e.g. to eat X: 'to cause X to go down one's esophagus'). For some discussion see Comrie (1985:332ff). Certainly causation can persist (temporarily) in a verb after the relation to the etymological base adjective is obscured by sound change, as is shown in (ia,b) (cf. Raffelsiefen 1998). Only the example in (ic) shows clear loss of a causative meaning:

(i) a. blea[tʃ]]$_{TV}$ 'bleach' *=> blea[k]]$_{A}$ 'bleak' 'cause to become *bleak]$_{A}$
b. clo[z]]$_{TV}$ 'close' *=> clo[s]]$_{A}$ 'close' 'cause to become *close]$_{A}$
c. loa[ð]]$_{TV}$ 'loathe' *=> loa[θ]]$_{A}$ 'loath' *'cause to become loath]$_{A}$

Again, given the generality of the rule in (78a), it would be inappropriate to assign the meaning 'condition/property/state of being' to the individual affixes, including the 'zero affix', and computing the meaning of the nouns in a compositional fashion. The claim that the meaning is not an inherent component of the affixes, but rather results from knowledge of syntagmatic and paradigmatic structure, is supported by the fact that the homophonous affixes, boldfaced in (79), are associated with a deverbal meaning (act of Y'ing) when a verb is recognized as a base:

(79)	[forgive**ness**]$_N$ => [forgive]$_V$	'act/process/result of forgiving'
	[serv**ice**]$_N$ => [serve]$_V$	'act/process/result of serving'
	[grow**th**]$_N$ => [grow]$_V$	'act/process/result of growing'
	[pursui**t**]$_N$ => [pursue]$_V$	'act/process/result of pursuing'
	[fail**ure**]$_N$ => [fail]$_A$	'act/process/result of failing'
	[talk]$_N$ => [talk]$_V$	'act/process/result of talking'

An argument against the paradigmatic rule stated in (78a) and for inherent affix meanings concerns the semantic differences below, first observed by Riddle (1985:438):

> (3) Her **ethnicity** was not a factor in the hiring decision. We are an equal opportunity employer.
> (4) Her **ethnicness** was certainly a big factor in the director's decision. He wanted someone who personified his conception of the prototypical Greek to play the part.

Riddle (1985:438) comments as follows:

> In (3), ethnicity refers to nationality or race, an abstract entity, while in (4), ethnicness refers to an embodied trait involving personal characteristics.

The semantic difference in question concerns the full range of possible values of the spectrum associated with the adjective *ethnic* (i.e. *ethnicity* 'the question of which ethnic group someone belongs to', where everyone is assumed to belong to some group), as opposed to a positive value on that spectrum, in this case asserting that the referent ranks highly on the scale of 'Greekness'. This difference is indeed systematic, but does not, contra Riddle and Plag (2003:66ff), prove that *-ness* and *-ity* have distinct meanings. It can be shown that the "full-spectrum" reading is not inherently associated with *-ity*, but with any established abstract noun for which an adjective can be recognized. The "positive-factual" reading, on the other hand, is consistently obtained for non-established *-ness*-coinages based on that same adjective. We accordingly get an analogous contrast by inserting the noun *age*, which is the established abstract noun based on the adjective *old*, as opposed to the non-established coinage *oldness*, in identical sentence frames:

(80) *Her **age** was a factor in the hiring decision* => No implicature: referent could be young or old
*Her **oldness** was a factor in the hiring decision*. => Necessarily positive value on the scale: assertion that referent is old

The notion of establishedness is reflected in token frequency, with *ethnicity* and *age* vastly outnumbering *ethnicness* and *oldness*, respectively.[41] The relevant contrasts emerge most clearly for adjectives which are semantically unmarked (cf. Lyons 1977).[42] Some additional examples attested in Google are given in (81):

(81) *...request clarification on the **frequency** with which safety showers must be tested...* => no implicature regarding the rate or occurrence of testing
*...the **frequentness** with which her family moved...* => necessarily positive value on the scale: assertion that referent moved frequently.

*...I felt that the **length** of the book was sufficient...* => no implicature regarding the question of whether the referent is considered long or short.
*…I liked alot except the **longness** of the book. It got kind of boring...*
=> Necessarily positive value on the scale: the referent is considered long.

The generalization emerging from these examples is stated below:

> Given an *established* abstract noun X, for which a relation to an unmarked adjective Y is recognized, where unmarkedness implies denotation of the set of all values of the relevant dimension/spectrum, X also includes the set of all values. By contrast, the use of a *non-established* abstract noun Z based on Y, formed by applying a productive morphological rule, yields the positive value of the relevant dimension, resulting in a factual reading.

The generalization suggests that the relevant contrasts in meaning are not inherently associated with the relevant suffixes, but are pragmatic effects predictable on the basis of the respective paradigmatic relations formed in a hearer's mental lexicon. That is, a noun regularly 'inherits' the full spectrum of readings from its (unmarked) adjectival base. The positive-factual reading is a special effect resulting from the use of a non-established noun licensed by a highly productive morphological rule, which would normally be blocked by the existence of the established word (so-called "synonymy-blocking"). This special effect is accordingly pragmatic in nature, resulting from a violation of the 'maxim' to use established words ("Talk like the others").
This interpretation of the semantic contrast in question entails two predictions. First, *ness*-derivatives should yield positive-factual readings only when they are 'blocked' by established nouns. The examples in (82) show that full-spectrum readings are indeed available for 'unblocked' *ness*-derivatives:

(82) *... The dots can't vary in **darkness** or size ... The usual result is that the print is either too dark or too light...* => no implicature regarding the question of whether the dots are dark or not.

*Humans and animals sense a wide range of sound amplitude, volume or **loudness**--from the very quiet to the extremely loud ...* => no implicature regarding the question of whether the sensations are loud or not.

[41] For instance, in February 2006, the number of hits in Google for *ethnicity* versus *ethnicness* were as follows: *ethnicity*: 41.600.000; *ethnicness*: 181.
[42]Unmarked adjectives have both a specific meaning and a general meaning, relating to the whole dimension in question. They appear in neutral questions as in *How old is she*?, as opposed to the question *How young is she*?, which presupposes that the referent is young. For discussion of semantic markedness, see Cruse 2000:172ff.

Assuming that the effect is pragmatic it should not be language-specific. The second prediction is accordingly that the same effect should be found in other languages, whenever there are both 'lexical' abstract nouns for which an adjectival base can be recognized and a highly productive rule for coining nouns based on the relevant adjectives. This prediction is born out by the Swedish example in (83a) and the German example in (83b).[43] To avoid transfer of semantic properties from the corresponding English etablished versus non-etablished nouns I translate the relevant nouns by giving the relevant base relations (e.g. '[N-> long]' means a noun for which *long* is recognized as a base).

(83) a. *Bokens **längd*** [established] *är ca 200 sidor vilket gjorde den ganska snabbläst*. ' The [N-> long] of the book is roughly 200 pages, which made it a rather quick read '=> no implicature regarding the question of whether the referent is considered long or not.
*Även den onödiga **långheten*** [non-established noun formed by productive *-het*-suffixation] *är något som till slut gynnar boken*.
'Even the unnecessary [N-> long] is something which in the end serves the book well' => Necessarily positive value on the scale: the referent is considered long.

b. ...dein **alter** [established] interessiert niemanden, beurteilt wird nach leistung ... 'your [N -> old] does not interest anyone, people are judged by their performance' => no implicature regarding the question of whether the referent is considered old or not
*Deine **Altheit*** [non-established noun formed by productive *-heit*-suffixation] *widert mich an.* 'Your [N -> old] disgusts me'. => Necessarily positive value on the scale: the referent is considered old.

Given that suffixes like English *-ness* or *-ity* are entirely meaningless their sole function is to signal that the words in question are nouns. The table in (75) can thus be continued as follows:

(84)

Output of parsing:	$[[un]_{\textbf{MOD-AFF}}[able]_{HEAD}]_{WORD}$	$[[en]_{\textbf{H-AFF}}[able]_{ROOT}]_{WORD}$
Affix function:	Semantic modification	Word class marking

The claim is then that only modifying affixes, which have inherent meaning, contribute to the meaning of the complex word in a compositional fashion. The main function of head affixes, on the other hand, is to signal word class, in particular the opposition verbs versus non-verbs.[44] For English it holds that head prefixes, which in most instances are non-cohering, signal verbhood (e.g. *be(gin)*, *re(fute), en(large)*).[45] By contrast, all non-

[43]Like all examples in this section these examples were found by using Google.
[44] It is true that there are also head affixes which do seem to have semantic content. For instance the contrast in meaning between the English nouns *employer* and *employee* appears to be associated with the suffixes. But even in these cases there is a question to what extent the meaning contrast is inherent in the suffixes. Perhaps it is not a coincidence that the canonical sound shape for nouns (i.e. lack of stress on the final syllable) in *employer* is associated with the less marked active meaning as opposed to the association of the non-canonical sound shape with final main stress in *employee* with the more marked passive meaning.
[45] The occurrence of non-cohering head prefixes, rather than suffixes, is in accordance with the overall preference for word-final stress in verbs.

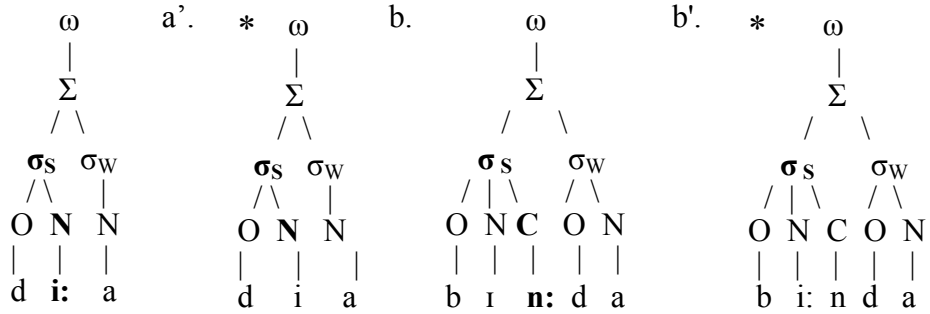
cohering suffixes signal that the word in question is not a verb (e.g. (*shy)ness*, (*meaning)ful*, (*reck)less*).

5. Swedish

The phonology of Swedish supports the relevance of head affix recognition for the prosodic organization of words. That is, the occurrence of boundary effects can be related to the presence of specific affixes, rather than to the properties of stems (e.g. frequency, relatedness to independent words). The boundary effects in question largely correspond to the effects observed in English (cf. section 2). Here I will focus primarily on Final-C effects and on relative prominence effects.

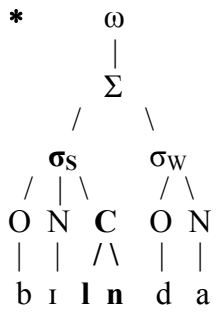
One manifestation of Final-C effects in Swedish concern violations of regular quantity patterns observed in simplexes, which are characterized by so-called complementary length. The notion "complementary" refers to the fact that each stressed syllable includes either a long vowel or a long postvocalic consonant. Significantly, the site of length is predictable in many cases such that a stressed vowel in word-final or prevocalic position is necessarily long, whereas a stressed vowel preceding a cluster which does not occur word-initially (with the exception of obstruent-liquid clusters) is necessarily short. These particular constraints on the distribution of length appear to indicate determination by syllable structure: vowels are lengthened in open syllables as in (85a), ruling out the structure in (85a') whereas the postvocalic consonant is lengthened in a closed syllable as in (85b), ruling out the pattern in (85b')[46]. Clusters such as [nd], which cannot occur in onset position, are henceforth referred to as "closure clusters".

(85) a. a'. b. b'.

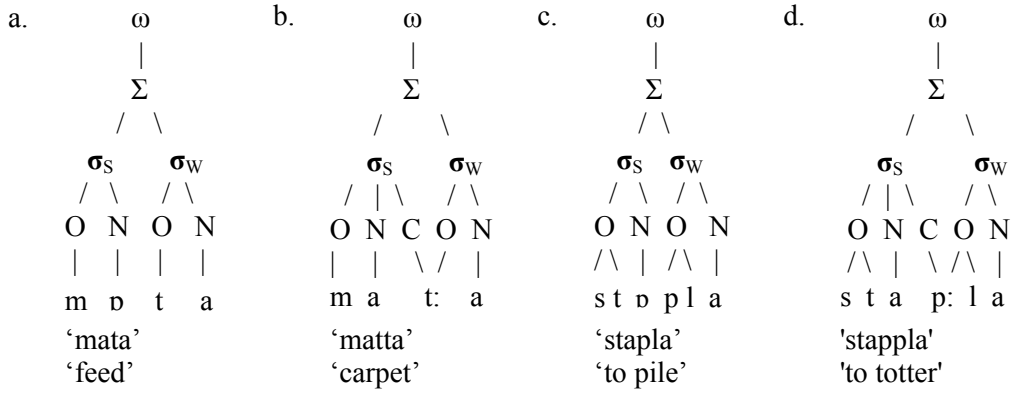


As in English, consonant clusters are not permitted in coda position, ruling out the structure illustrated in (86):

[46] According to the transcriptions in Hedelin's pronunciation dictionary (1997) postvocalic consonants are lengthened only in pword/foot-*final* position. By contrast, in Svenska Ord (1992), all such consonants are transcribed as long in stressed syllables. I follow the latter convention here.

(86) 

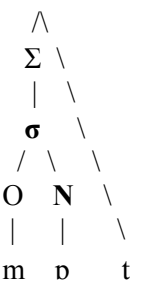
The description of length as a function of syllable structure can also be extended to cases where a vowel is followed by a single consonant (cf. (87a,b)) or a cluster with increasing sonority (cf. (87c,d)). In such cases the relevant length contrasts can be related to ambisyllabic versus non-ambisyllabic structure of the postvocalic consonant as is shown below:

(87) 

Occurrences of long vowels before a consonant in word-final position are analyzable as Final-C effects, assuming that the distribution of length concerns the phonological and not just the phonetic level.[47] On this view, vowel length in pword-final syllables results from the non-association of the pword-final consonant with the coda position. I will not discuss the various proposals of how to represent the special status of pword-final consonants[48] but tentatively associate such consonants directly with the pword-node as in (88). As was noted above, the special status of pword-final consonants also explains the occurrence of word-final clusters. Given the representation in (88c) there is no complex coda since the relevant consonants are not jointly associated with the coda position:

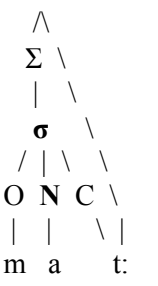
[47] Recall that the notion "Final-C effect" refers to the observation that pword-final consonants exhibit only the phonetic, but not the distributional, properties of coda segments.
[48] For discussion, see Hall 2002.

(88) a.



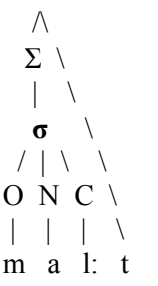
'mat' 'food'

b.



'matt' 'faint'

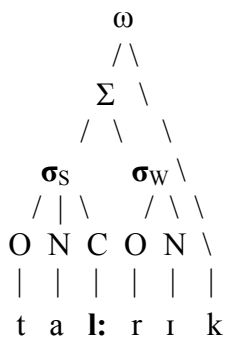
c.



'malt' 'malt'

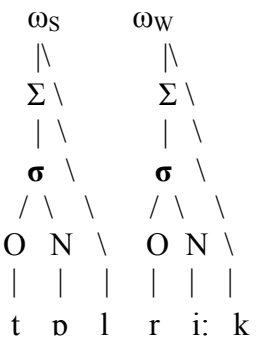
Word-internal Final-C effects indicative of complex morphological structure are demonstrated in (89b). Note that [lr] is a closure cluster inducing regular length of [l], rather than the preceding vowel, as in (89a). Vocalic length in (89b) qualifies accordingly as a Final-C effect, indicating the presence of a pword boundary, and hence a morphological boundary, after [l]. The word *talrik* is indeed a compound, consisting of the constituents *tal* 'number' and *rik* 'rich':[49]

(89) a.



'tallrik' 'plate'

b.



'talrik' 'numerous (number-rich)'

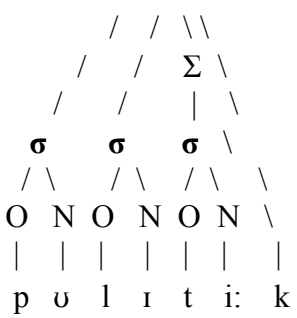
Turning now to the second type of boundary effect investigated here, relative prominence effects, we find that in Swedish the relation among two pwords within a morphological word is always strong-weak, regardless of the morphological or semantic properties of the word-internal constituents:

(90) If: $[\omega\omega]_{WORD}$ Then: $[\omega_S\ \omega_W]_{WORD}$

Relative prominence effects are easily detected because a pword usually contains only one foot, which comprises the rightmost syllable(s). The syllable heading that foot has main stress within the pword and undergoes lengthening as is shown in (91a). It is accordingly both the presence of two feet, manifested in two lengthening sites, and the weak prominence of the word-final foot, which show that *talrik* repeated in (91b) consists of two pwords. As in English, the evidence for word-internal pwords from relative prominence and from Final-C effects correlate systematically.

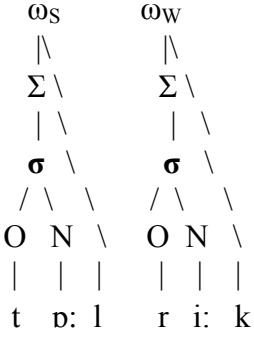
[49]According to the transcriptions in Hedelin, only lax vowels occur in unstressed syllables as in the final syllable in *tallrik*.

(91) a.



'politik' 'politics'

b.



'talrik' 'numerous (number-rich)'

Investigating now the phonological evidence for word-internal morphological structure in Swedish derivational morphology we again find the occurrence of boundary effects to be tied to the presence of specific non-cohering head affixes. All relevant suffixes are consonant-initial and include those which form a separate foot (and presumably a separate pword) listed in (92a), henceforth referred to as H-AFF-1, and those which lack stress and begin with a coronal sonorant in the left column in (92b). These suffixes are referred to as "recognized" suffixes below. Words with other suffixes exhibit no Final-C effects, which may indicate lack of suffix recognition:

(92)

		Recognized head suffixes	Unrecognized head suffixes
		<----------	---------->
a.	H-AFF-1	-bar, -lös, -full, -lek, -mål -sam, -het, -dom, -skap	
b.	H-AFF-2	-na, -nad, -ning, -lig, -ling	-ma, -ja, -ga, -ka, -ska, -sa, -sel

The subclassification of head affixes into those which form separate feet/pwords (H-AFF-1) and those which lack stress is supported by the evidence from lengthening in (93). In the words in (93a) each suffix includes either a long postvocalic consonant or a long vowel. By contrast, none of the (historical) suffixes in the words in (93b) is subject to lengthening (cf. *Svenska Ord* 1992).

(93) a. H-AFF-1

vérk[sàm:] 'verksam' 'effective'
sjúk[dὸm:] 'sjukdom' 'illness'
kráft[fɵl:] 'kraftfull' 'powerful'
ˈöm[sὶn:t] 'ömsint' 'tender'
rét[bˈɒ:r] 'retbar' 'irritable'
slˈäkt[skˈɒ:p] 'släktskap' 'kinship'
kˈär[lὲ:k] 'kärlek' 'love'
klár[hὲ:t] 'klarhet' 'clarity'
tíd[lˈö:s] 'tidlös' 'timeless'
slágs[mὸ:l] 'slagsmål' 'fight'
frˈåg[vὶ:s] 'frågvis' 'inquisitive'
ˈönsk[vˈɒ:rd] 'önskvärd' 'desirable'

b. H-AFF-2

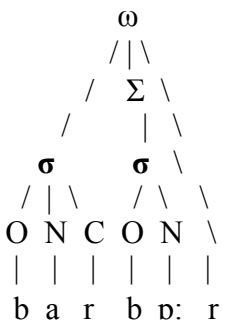
týst[nad] 'tystnad' 'silence'
ˈöv[nɪŋ] 'övning' 'practice'
sˈär[lɪŋ] 'särling' 'individualist'
lˈämp[lɪ(g)] 'lämplig' 'suitable'
kˈän[səl] 'känsel' 'perception of touch'
fét[na] 'fetna' 'to become fat'
fét[ma] 'fetma' 'fatness'
skíl[ja] 'skilja' 'to distinguish'
stád[ga] 'stadga' 'to consolidate'
jˈäm[ka] 'jämka' 'to adjust'
hˈäl[sa] 'hälsa' 'health'
vˈät[ska] 'vätska' 'fluid'

The question of whether or not a suffix forms a separate pword appears to be largely conditioned by segmental form and historical origin. All stressed suffixes in (93a)

consist of (s)CVC(C) sequences and typically originate from word-final compound members.[50] By contrast, (s)CV-suffixes are always stressless. The CVC-suffixes in (93b) differ from those in (93a) in that they are (historically) vowelless (i.e. *-sel* < *-sl* cf. Tamm 1897:79) or bimorphemic, consisting of *-n/-ing*, *-l/-ing* and *-na*/*-d*, respectively. Synchronically, these etymological facts are reflected in the presence of reduced vowels: epenthetic schwa in *-sel* and the corresponding raised allophone [ɪ] before high consonants in *-ning* and *-ling*.[51]

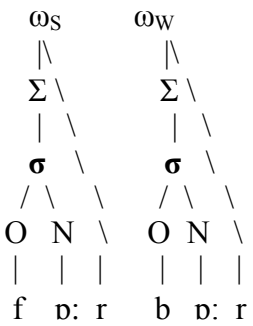
As in English, stress on a suffix appears in itself to ensure recognition, even if the suffix in question is unproductive. Recognition of the stressed suffixes in (93a) is demonstrated by regular relative prominence effects illustrated in (94). Specifically weak stress on the word-final foot in (94b) indicates that relative prominence is determined by the rule in (90).[52] The evidence from relative prominence correlates with the presence of two feet, manifested in two lengthening sites. By comparison, the word in (94a) illustrates the regular phonological form characteristic of simplexes. This word consists of a single pword dominating a single foot, which consists of the word-final syllable. This syllable alone is subject to lengthening.

(94) a.



[barbar]$_N$ 'barbarian'

b.



[[far]$_{ROOT}$[bar]$_{HEADSUFF}$]$_{ADJ}$ 'passable'

Additional examples are given in (95). The words in (95a) illustrate the regular prosody expected in simplexes or in words with cohering (i.e. vowel-initial) suffixes, respectively.[53] These words consist of single pwords dominating a single foot and consequently contain a single long segment. By contrast, each word in (95b) contains one of the head suffixes in (93a), which form separate pwords.[54]

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[50]The boundary between compound members and affixes is notoriously fuzzy.

[51] Perhaps the reduction of *-lig* also involves a bimorphemic analysis, based on the independent suffix *-ig*.

[52]Alternatively, one could assume that the suffixes form a separate foot not integrated into the pword of the stem (e.g. (far)$_\omega$(bar)$_\Sigma$), where weak prominence would follow from the rule that a constituent occupying a lower position in the prosodic hierarchy has less prominence than a higher constituent. Crucially, this assumption, too, implies a word- internal pword boundary indicative of complex morphological structure.

[53] In (95) I have analysed as simplexes some words where others might posit morphologically complex structures (and possibly vice versa). The question of whether or not for instance the noun *kastrull* contains a suffix *-ull* (in analogy to nouns like *schatull*, *ampull*) is irrelevant as long as the suffix is vowel-initial. This is because vowel-initial suffixes are cohering with the result that the structure of the relevant words corresponds to the structure of simplexes. What matters is that none of the words in (95a) is a compound or includes a recognizable consonant-initial suffix.

[54] In the prosodic representations, indicated by parentheses, I have ignored the process of supradentalization characteristic of standard Swedish, whereby [r] followed by a dental consonant is

(95) a. (skandalǿ:s)$_{\omega}$ 'skandalös'
[[skandal]$_{ROOT}$[øs]$_{HEADSUFF}$]$_{ADJ}$
'scandalous'

(sʊlɪdɪté:t)$_{\omega}$ 'soliditet'
[[sʊlid]$_{ROOT}$[itet]$_{HEADSUFF}$]$_{N}$
'solidity'

(ɛsk͜ʉlʊ́:p)$_{\omega}$ 'eskulap'
[eskulap]$_{N}$
'medical doctor' (humorous)

(kʊpé:k)$_{\omega}$ 'kopek'
[kʊpek]$_{N}$
'kopeck'

(kɔlɛstərʊ́:l)$_{\omega}$ 'kolesterol'
[kolestərol]$_{N}$
'cholesterol'

(dɪrɛktrí:s)$_{\omega}$ 'direktris'
[[direktr]$_{ROOT}$[is]$_{HEADSUFF}$]$_{N}$
'woman manager'

(mansʊ́:rd)$_{\omega}$ 'mansard'
[mansard]$_{N}$
'attic'

(teləgrám:)$_{\omega}$ 'telegram'
[telegram]$_{N}$
'telegram'

(kastrʊ́l:)$_{\omega}$ 'kastrull'
[kastrul]$_{N}$
'saucepan'

(labʏrín:t)$_{\omega}$ 'labyrint'
[labyrint]$_{N}$
'labyrinth'

b. (mʊ́ːka)$_{\omega}$(lʊ̀:s)$_{\omega}$ 'makalös'
[[maka]$_{ROOT}$[løs]$_{HEADSUFF}$]$_{ADJ}$
'matchless'

(ɧˈʏl:dɪ)$_{\omega}$(hè:t)$_{\omega}$ 'skyldighet'
[[ɧyldi]$_{ROOT}$[het]$_{HEADSUFF}$]$_{N}$
'duty, obligation'

(bʉ́:r)$_{\omega}$(skʊ̀p)$_{\omega}$ 'burskap'
[[bur]$_{ROOT}$[skap]$_{HEADSUFF}$]$_{N}$
'burgership'

(stʊ́:r)(lè:k) 'storlek'
[[stʊr]$_{ROOT}$[lek]$_{HEADSUFF}$]$_{N}$
'size'

(slák:s)$_{\omega}$(mò:l)$_{\omega}$ 'slagsmål'
[[slaks]$_{ROOT}$[mol]$_{HEADSUFF}$]$_{N}$
'fight'

(dɪstrík:t)(vì:s) 'distriktvis'
[[distrikt]$_{ROOT}$[vis]$_{HEADSUFF}$]$_{N}$
'districtwise'

(ɛ́l:sk)$_{\omega}$(væ:rd)$_{\omega}$
[[elsk]$_{ROOT}$[verd]$_{HEADSUFF}$]$_{N}$
'lovable'

(sé:də)$_{\omega}$(sàm:)$_{\omega}$ 'sedesam'
[[sedə]$_{ROOT}$[sam]$_{HEADSUFF}$]$_{ADJ}$
'modest, decent'

(lás:t)$_{\omega}$(fˆəl:) 'lastfull'
[[last]$_{ROOT}$[ful]$_{HEADSUFF}$]$_{ADJ}$
'depraved'

(ló:g)$_{\omega}$(sìn:t)$_{\omega}$ 'lågsint'
[[log]$_{ROOT}$[sint]$_{HEADSUFF}$]$_{ADJ}$
'mean'

The prosodic structures in (95) can accordingly be taken to indicate the recognition mechanism in (96), which has been established for English in section 3:

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merged into a single supradental consonant. In the morphological representations, indicated by square brackets, I have omitted quantity and quality distinctions between vowels, assuming that all such distinctions are determined by syllable and foot structure.

(96)	Input:	Head affix recognition	"Rest" => root
	[barbár]$_{N}$	-	-
	[fárbàr]$_{ADJ}$	[fár[bàr]$_{H\text{-}AFF\text{-}1}$]$_{ADJ}$	[[fár]$_{ROOT}$[bàr]$_{H\text{-}AFF\text{-}1}$]$_{ADJ}$

Aligning the boundaries of both roots and affixes classified as H-AFF-1 with pword boundaries will then yield the correct output forms as is shown in (97).

(97)	Alignment	Output
	([barbár]$_{N}$)$_{\omega}$	(barbɒ́ːr)$_{\omega}$
	[([fár]$_{ROOT}$)$_{\omega}$([bàr]$_{H\text{-}AFF\text{-}1}$)$_{\omega}$]$_{ADJ}$	(fɒ́ːr)$_{\omega}$(bðːr)$_{\omega}$

Importantly, there is no alternative explanation for the correlating contrasts between the two phonological structures in (95a) and (95b). Specifically, paradigm uniformity constraints, which could in principle be invoked to account for vocalic length in *f*[ɒ́ː]*rbar* (cf. *f*[ɒ́ː]*ra* 'fara' to go'), do not explain the contrast in relative prominence between (95a) and (95b). Moreover, similar Final-C effects (i.e. vowel lengthening before a cluster with decreasing sonority) also occur in cases where no semantically related word exists which could potentially license vocalic length. For instance, vowel length in *b*[ʉ̶ː]*rskap* 'burgership' cannot be a PU-effect, since the only potential source for such an effect, the word *b*[ʉ̶ː]*r* 'cage', is unrelated.

Turning now to the suffixes classified as H-AFF-2 in (92), which do not form a separate foot, the bipartition into recognized versus unrecognized affixes is based on Final-C effects alone. Specifically, it can be shown that complex coda clusters or long vowels before closure clusters are stable when preceding a suffix with an initial coronal sonorant, but not before other unstressed suffixes. The examples in (98) illustrate the occurrence of Final-C effects in cases where "irregular" vowel length or coda clusters could not potentially constitute paradigm uniformity effects. This is because the relevant roots fail to correspond to semantically related words.

(98)	[fɒ́ːl+na] 'falna'	'to die down, fade'
	[vóːl+nad] 'vålnad'	'apparition, ghost'
	[ansέːn+lig] 'ansenlig'	'considerable, large'
	[hέmːp+ling] 'hämpling'	'linnet'

The analysis of "deviant" phonological structure in (98) as boundary effects based on the recognition of a head affix is illustrated in (99). The claim is again that the existence of base words which could potentially license vocalic length such as [steːl] 'stel' 'stiff' is not crucial for the presence of quantity 'violations' in the derived words. This is because the same sort of 'violation' is also seen in cases like *falna*, where a semantically related base word is lacking.

(99)	Input:	Head affix recognition	"Rest" => root
	[sté:lna]$_{V}$	[sté:l[na]$_{H\text{-}AFF\text{-}2}$]$_{V}$	[[sté:l]$_{ROOT}$[na]$_{H\text{-}AFF\text{-}2}$]$_{V}$
	[fɒ́ːlna]$_{V}$	[fɒ́ːl[na]$_{H\text{-}AFF\text{-}2}$]$_{V}$	[[fɒ́ːl]$_{ROOT}$[na]$_{H\text{-}AFF\text{-}2}$]$_{V}$

The word-internal morphological structure in (99) serves as the basis for alignment, as is shown in (100). As a result, the deviant vowel length is expected to be stable in historical perspective, regardless of potential PU-effects.

(100)	Alignment	Output	
	$([[[\text{sté:l}]_{\text{ROOT}}]_{\omega}[\text{na}]_{\text{H-AFF-2}}]_{\text{ADJ}})_{\omega}$	$((\text{sté:l})_{\omega}(\text{na})_{\sigma})_{\omega}$	'to stiffen'
	$([[[\text{fɒ́:l}]_{\text{ROOT}}]_{\omega}[\text{na}]_{\text{H-AFF-2}}]_{\text{ADJ}})_{\omega}$	$((\text{fɒ́:l})_{\omega}(\text{na})_{\sigma})_{\omega}$	'to die down, fade'

The crucial role attributed to suffix recognition in (99) is supported by the fact that verbs containing any of the (historical) unstressed suffixes not beginning with a coronal sonorant conform to the regular patterns occurring in simplexes. That is, vowels in closed syllables are short and coda clusters are absent, regardless of the phonological structure of the corresponding historical base words. Vowel length alternations resulting from the absence of word-internal boundaries in such cases are illustrated in (101). In the right column I list the etymological base words.

(101) a. -ma

$(\text{fét:ma})_{\omega}$ 'fetma' 'fatness'	cf. [fe:t] 'fet' 'fat'
$(\text{s´øt:ma})_{\omega}$ 'sötma' 'sweetness'	cf. [sø:t] 'söt' 'sweet'

b. -ga

$(\text{víd:ga})_{\omega}$ 'vidga' 'to widen'	cf. [vi:d] 'vid' 'wide'
$(\text{glød:ga})_{\omega}$ 'glödga' 'to make red-hot'	cf. [gløːd] 'glöd' 'live coal'
$(\text{nød:ga})_{\omega}$ 'nödga' 'to force'	cf. [nø:d] 'nöd' 'need'
$(\text{stád:ga})_{\omega}$ 'stadga' 'to consolidate, steady'	cf. [stɒ́:d] 'stad' 'stead'

c. -ja

$(\text{smør:ja})_{\omega}$ 'smörja' 'to smear'	cf. [smø:r] 'smör' 'butter'
$(\text{fér:ja})_{\omega}$ 'färja' 'ferry'	cf. [fɒ́:ra] 'fara' 'to go'
$(\text{vél:ja})_{\omega}$ 'välja' 'to choose'	cf. [vɒ:l] 'val' 'choice'
$(\text{kvél:ja})_{\omega}$ 'kvälja' 'to nauseate'	cf. [kvɒ:l] 'kval' 'pain, torture'
$(\text{tém:ja})_{\omega}$ 'tämja' 'to tame'	cf. [tɒ:m] 'tam' 'tame'
$(\text{vén:ja})_{\omega}$ 'vänja' 'to get used to'	cf. [vɒ:n] 'van' 'experienced'

d. -sa

$(\text{ɕøk:sa})_{\omega}$ 'köksa' 'kitchen-maid'	cf. [ɕǿ:k] 'kök' 'kitchen'
$(\text{h´ɛl:sa})_{\omega}$ 'hälsa' 'health'	cf. [he:l] 'whole'

e. -ska

$(\text{grøn:ska})_{\omega}$ 'grönska' 'verdure'	cf. [grø:n] 'grön' 'green'
$(\text{brøs:ka})_{\omega}$ 'brådska' 'hurry'	cf. [bro:d] 'bråd' 'hasty, busy'
$(\text{vɛ́t:ska})_{\omega}$ 'vätska' 'fluid'	cf. [vo:t] 'våt' 'wet'

f. -ka

(hál:ka)$_{\omega}$ ‘halka’ ‘to slip (and fall)’	cf. [hɒ:l] 'hal' ‘slippery, evasive’
(svál:ka)$_{\omega}$ ‘svalka’ ‘coolness’	cf. [svɒ:l] ‘sval’ ‘cool’
(dʏr:ka)$_{\omega}$ ‘dyrka’ ‘to adore’	cf. [dy:r] ‘dyr’ ‘dear, valuable’

g. -sel

(hœ́r:səl)$_{\omega}$ ‘hörsel' 'hearing'	cf. [hœ́:ra] 'höra' 'to hear'
(ɕœ́r:səl)$_{\omega}$ ‘körsel' 'transport (with horse and carriage)'	cf. [ɕœ́:ra] 'köra' 'to drive'
(stʏ́r:səl)$_{\omega}$ ‘styrsel' 'steering, control'	cf. [sty:ra] 'styra' 'to steer'
(ʏ́r:səl)$_{\omega}$ ‘yrsel' 'dizziness'	cf. [y:ra] 'yra' 'dizzy'
(vár:səl)$_{\omega}$ ‘varsel' 'foreboding, warning'	cf. [vɒ:r] 'var' 'cautious'
(jǿs:əl)$_{\omega}$ ‘gödsel’ ‘manure, fertilizer’	cf. [jǿ:da]$_{A}$ ‘göda’ ‘to feed up’
(bét:səl)$_{\omega}$ ‘betsel’ ‘bridle’	cf. [bí:ta] ‘to bite’

Given the lack of evidence for any sort of internal pword boundary the (historically) derived words in (101) are represented as single pwords.

The relevance of suffix recognition for the phonological form of words is especially striking in the word pairs in (102a-d), which were historically derived from identical bases (i.e. [fe:t 'fet' 'fat', [svɒ:l] 'sval' 'cool', [grø:n] 'grön' 'green, and [glø:d] 'glöd' 'live coal', respectively). In addition to relating to the same etymological base the word pairs in (102) exhibit comparable postvocalic consonant clusters, all of which qualify as closure clusters.

(102)

a.	((f[**e:**]t)$_{\omega}$na)$_{\omega}$	'to fatten'	(f´ɛ**t:**ma)$_{\omega}$	'fatness'
b.	((sv[**ɒ:**]l)$_{\omega}$na)$_{\omega}$	'to cool down'	(svá**l:**ka)$_{\omega}$	'coolness'
c.	((gr[**ø:**]n)$_{\omega}$ling)$_{\omega}$	'kind of carp'	(grø**n:**ska)$_{\omega}$	'verdure, green foliage'
d.	((gl[**ø:**]d)$_{\omega}$ning)$_{\omega}$	'glow, embers'	(glø**d:**ga)$_{\omega}$	'make red-hot'

The words in the right column (102) match the canonical forms of simplexes, where the coda of a stressed syllable contains a single long consonant, and are consequently represented as single pwords. The central empirical claim is that long vowels in such a phonotactic environment (i.e. before a 'closure cluster') can persist only if the postvocalic consonant is immediately followed by a pword boundary, as in the left column in (102).[55] Crucially, the presence of the pword boundary presupposes the parsing process, specifically the process of head affix recognition illustrated in (103). The subscript 'R' stands for the category 'ROOT'. The input words are represented orthographically to demonstrate that lack of suffix recognition will result in short root vowels in these cases, regardless of the quantity patterns in the input words. The lengthening site in the output forms is boldfaced in (103)

[55]The notion 'persistence' concerns primarily the process of language acquisition, referring to the likelihood that a child encountering a given output feature (e.g. a long vowel) will replicate that feature in her own speech. The impact of persistence is seen most clearly in historical perspective (cf. the discussion of English head prefixation above).

(103)	Input:	Head affix recognition	"Rest" => root	Alignment
a.	$[fetna]_V$	$[fet[na]_{H\text{-}AFF\text{-}2}]_V$	$[[fet]_R[na]_{H\text{-}AFF\text{-}2}]_V$	$([([\mathbf{fet}]_R)_\omega[na]_{H\text{-}AFF\text{-}2}]_V)_\omega$
	$[fetma]_N$	-	-	$([\mathbf{fet}ma]_N)_\omega$
b.	$[svalna]_V$	$[sval[na]_{H\text{-}AFF\text{-}2}]_V$	$[[sval]_R[na]_{H\text{-}AFF\text{-}2}]_V$	$([([\mathbf{sva}l]_R)_\omega[na]_{H\text{-}AFF\text{-}2}]_V)_\omega$
	$[svalka]_N$	-	-	$([\mathbf{sval}ka]_N)_\omega$
c.	$[grönling]_N$	$[grön[ling]_{H\text{-}AFF\text{-}2}]_N$	$[[grön]_R[ling]_{H\text{-}AFF\text{-}2}]_V$	$([([\mathbf{grön}]_R)_\omega[ling]_{H\text{-}AFF\text{-}2}]_N)_\omega$
	$[grönska]_N$			$([\mathbf{grön}ska]_N)_\omega$
d.	$[glödning]_N$	$[glöd[ning]_{H\text{-}AFF\text{-}2}]_N$	$[[glöd]_R[ning]_{H\text{-}AFF\text{-}2}]_N$	$([([\mathbf{glöd}]_R)_\omega[ning]_{H\text{-}AFF\text{-}2}]_N)_\omega$
	$[glödga]_V$			$([\mathbf{glöd}ga]_V)_\omega$

Similar types of prosodic contrasts can be illustrated with pairs consisting of a word with a stressed H-AFF-1-suffix and a word with an 'unrecognizable' suffix. The words in (104) are etymologically related to the simplexes [vɒ:r] 'var' 'cautious', [dy:r] 'dyr' 'dear, expensive', [jɛm:n] 'jämn' 'even' and [nʊ:d] 'ond' 'evil, sore', respectively.

(104)					
a.	$(\text{vɒ}\mathbf{:r})_\omega(\text{sàm:})_\omega$	'cautious'	$(\text{vá}\mathbf{r:}\text{səl})_\omega$	'foreboding, warning'
b.	$(\text{dý}\mathbf{:r})_\omega(\text{bɒ:r})_\omega$	'costly'	$(\text{d}\mathbf{Ýr:}\text{ka})_\omega$	'to adore'
c.	$(\text{jɛ}\mathbf{m:n})_\omega(\text{hè:t})_\omega$	'evenness'	$(\text{jɛ}\mathbf{m:}\text{ka})_\omega$	'to adjust'
d.	$(\text{ú}\mathbf{n:d})_\omega(\text{sìn:t})_\omega$	'malevolent'	$(\text{ú}\mathbf{n:}\text{ska})_\omega$	'malice'

Again, the words in the right column (104), which include a single long coda consonant, match the canonical forms of simplexes and are therefore represented as single pwords. The 'anomalies' observed in the left column in (104), including long vowels before sonorant-obstruent combinations, complex coda clusters, and weak word-final feet, indicate the presence of internal pword boundaries. The contrast in the prosodic structures of these cognates thus supports the key role attributed to suffix recognition shown in (105).

(105)	Input:	Head affix recognition	"Rest" => root	Alignment
a.	$[varsam]_A$	$[var[sam]_{H\text{-}AFF\text{-}1}]_A$	$[[var]_R[sam]_{H\text{-}AFF\text{-}1}]_A$	$[([\mathbf{va}r]_R)_\omega([sam]_{H\text{-}AFF\text{-}1})_\omega]_A$
	$[varsel]_N$	-	-	$([\mathbf{va}rsel]_N)_\omega$
b.	$[dyrbar]_A$	$[dyr[bar]_{H\text{-}AFF\text{-}1}]_A$	$[[dyr]_R[bar]_{H\text{-}AFF\text{-}1}]_A$	$[([\mathbf{dy}r]_R)_\omega([bar]_{H\text{-}AFF\text{-}1})_\omega]_A$
	$[dyrka]_V$	-	-	$([\mathbf{dy}rka]_V)_\omega$
c.	$[jämnhet]_N$	$[jämn[het]_{H\text{-}AFF\text{-}1}]_N$	$[[jämn]_R[het]_{H\text{-}AFF\text{-}1}]_N$	$[([\mathbf{jämn}]_R)_\omega([het]_{H\text{-}AFF\text{-}1})_\omega]_N$
	$[jämka]_V$	-	-	$([\mathbf{jäm}ka]_V)_\omega$
d.	$[ondsint]_A$	$[ond[sint]_{H\text{-}AFF\text{-}1}]_A$	$[[ond]_R[sint]_{H\text{-}AFF\text{-}1}]_A$	$[([\mathbf{ond}]_R)_\omega([sint]_{H\text{-}AFF\text{-}1})_\omega]_A$
	$[ondska]_N$	-	-	$([\mathbf{ond}ska]_N)_\omega$

The claim is again that suffix recognition is the crucial prerequisite for the persistence of the boundary effects. That is, the word-internal morphological structure in (105) serves as the basis for the alignment of morphological and prosodic boundaries, which is crucial for the stability of both the 'deviant' vocalic length and the 'deviant' consonant clusters in historical perspective.

Unlike the data examined so far, where the presence of boundary effects correlates systematically with the presence of specific head affixes, there are some cases of phonological anomalies in words containing an "unrecognized" suffix. Characteristic of these cases, boldfaced below, is both the coalescence of a voiced and a voiceless obstruent and the existence of variants with canonical sound patterns:

(106) ?[**bli:dka**] ~ (blíd:ka)$_{\omega}$ /(blít:ka)$_{\omega}$ 'blidka' 'to appease'
[**klé:dsəl**] ~ (klét:səl)$_{\omega}$ 'klädsel' 'dress, attire'
[**ví:gsəl**] ~ (vík:səl)$_{\omega}$ 'vigsel' 'wedding'
[**blý:gsəl**] ~ (blÝk:səl)$_{\omega}$ 'blygsel' 'shame'
[**drý:gsəl**] ~ (drÝk:səl)$_{\omega}$ 'drygsel' 'extensiveness'
[**trí:vsəl**] ~ (tríf:səl)$_{\omega}$ 'trivsel' 'well-being'

The intervocalic consonant clusters tend to undergo regressive voicing assimilation to conform to the canonical sound patterns of Swedish, in which case quantity patterns conform as well. For literate speakers the "anomalous" clusters have an independent source in spelling pronunciations which also accounts for the association of the boldfaced variants with careful, perhaps slightly hyperarticulated speech. Assuming that these clusters play a crucial role for the irregular quantity patterns observed in the boldfaced variants in (106) two explanations come to mind. First, the presence of such clusters could enhance suffix recognition, resulting in boundary effects (Final-C effects) in the relevant words. Second, the presence of such clusters could trigger recognition of relatedness to other words in the paradigm, giving rise to paradigm uniformity effects. The latter analysis is supported by the fact that each occurrence of 'anomalous' quantity patterns in (106) correlates consistently with the existence of a semantically related word, which could potentially license vocalic length. The relevant base words are listed in (107b):

(107)

a.	b.
[bli:dka] 'blidka' 'to appease'	[bli:d] 'blid' 'mild'
[klé:dsəl] 'klädsel' 'dress, attire'	[klé:da] 'kläda' 'to dress'
[ví:gsəl] 'vigsel' 'wedding'	[vi:ga] 'viga' 'to wed'
[blý:gsəl] 'blygsel' 'shame'	[blý:g] 'blyg' 'shy'
[drý:gsəl] 'drygsel' 'extensiveness'	[drý:g] 'dryg' 'lasting, ample'
[trí:vsəl] 'trivsel' 'well-being'	[trí:vas] 'trivas' 'to get on well'

I tentatively conclude then that the phonology of the boldfaced variants in (106) is best analysed as a spelling pronunciation (of the intervocalic consonant cluster) in combination with paradigm uniformity effects (affecting quantity patterns). On either analysis the cases in (106) conform to the basic generalizations suggested by the Swedish data, which are consistent with the conclusions based on English:

- Swedish words exhibit correlating deviations from canonical sound patterns which match the boundary effects established for English (e.g.

Final-C effects, relative prominence effects) and indicate the presence of word-internal pwords.

- Pword boundaries align systematically with the boundaries of morphological constituents, determined by head recognition.

- A prerequisite for the recognition of the relevant head affixes concerns phonological form. In Swedish, both stress (H-AFF-1-suffixes) and initial coronal sonorants (H-AFF-2-suffixes) fulfill the condition for the recognition of head suffixes. Other (consonant-initial) suffixes are not recognized.

- Roots have no status other than 'rests', which remain after head affixes have been identified.

As in English, there is also a correlation between phonological factors for recognizing unstressed suffixes (i.e. the presence of initial sonorants) and productivity. The similarity between English and Swedish further extends to the correlations concerning head affixation versus modifier-head structures discussed at the end of section 4. In (108) I illustrate the relevant correlations by comparing the adjective *urusel* 'extremely bad', which consists of the modifier *ur-* and the head *-usel*, with the verb *erövra* 'conquer', which consist of the head prefix *er-* followed by the root *-övra*:

(108)	Output	$[[ur]_{MOD\text{-}AFF}[usel]_{HEAD}]_{WORD}$	$[[er]_{H\text{-}AFF\text{-}1}[övra]_{ROOT}]_{WORD}$
	Correlating affix properties:	paradigmatic variability syntagmatic autonomy	No paradigmatic variability less syntagmatic autonomy
	Prosodic properties:	$(\text{ʉ́}\text{:r})_{\omega}(\text{ʉ̀}\text{:səl})_{\omega}$ ("crisp boundaries")	$(\text{ǽ}\text{:r})_{\omega}(\text{ə̀ : vra})_{\omega} \sim (\text{ǽ}\text{:r}\text{ə̀ : vra})_{\omega}$ (possible fusion)
	Semantic properties:	necessarily inherent meaning	possibly no inherent meaning
	Affix function:	Semantic modification	Word class marking (verb)

Head prefixes and head suffixes in Swedish are alike in that some form a separate pword (e.g. *er-*) whereas others do not (e.g. *för-*, *be-*). This motivates the subclassification of the prefix *er-* in (108) as H-AFF-1. The classification into modifier-head structures versus head affix-root structures is based on the parsing rules introduced above:

(110)	Input:	Recognition of - head - head affix	2. "Rest" => - modifier - root
	$[urusel]_{ADJ}$ 'extremely bad'	$[ur[usel]_{HEAD}]_{ADJ}$	$[[ur]_{MODP}[usel]_{HEAD}]_{ADJ}$
	$[erövra]_{V}$ 'to conquer'	$[[er]_{H\text{-}AFF\text{-}1}övra]_{V}$	$[[er]_{H\text{-}AFF\text{-}1}[övra]_{ROOT}]_{V}$

Modifying prefixes can be freely omitted ('paradigmatic variability') whereas head affixes cannot be omitted. Paradigmatic variability correlates with 'syntagmatic autonomy', as is shown by the semantics and the prosody of the complex words. It is true that *ur-* means 'extremely' in combination with adjectives (e.g. *urfånig* 'extremely silly', *urgammal* 'extremely old') but 'initial, original' in combination with nouns (e.g. *urskog* 'virgin forest', *urinvånare* 'original inhabitant'). However the meanings in question, whether treated as cases of homonymy or polysemy, cannot be inferred on the basis of syntagmatic structure alone but must be considered inherent properties of the relevant modifying prefixes. By contrast, no clear meaning can be associated with the head prefix *er-* in *erövra*, despite the etymological relatedness to the modifying prefix *ur-*. Relative syntagmatic autonomy of the modifying prefix vis-à-vis the head prefix is also supported by prosodic evidence. That is, while both type of prefixes can form separate pwords the head affix tends to fuse with the root, forming a single domain of syllabification.[56] By contrast, the boundaries of modifying prefixes are consistently crisp, such that the prefix-final consonant cannot be syllabified as the onset of the following vowel. As in English, the relevant contrasts correlate with distinct affix functions. Whereas modifying prefixes contribute to the meaning of the complex word in a compositional fashion the primary function of head affixes is to mark membership in a word class.

6. Summary and discussion of related psycholinguistic work

In the present article I have discussed some implications of strictly prosodic evidence for underlying morphological structure and concomitant parsing procedures. It has been demonstrated that certain word-internal phonological boundary signals co-occur systematically and indicate the presence of coinciding morphological and prosodic boundaries. Specifically the presence of pword boundaries has been shown to indicate the relevance of head recognition in compounds (e.g. recognition of *warm* in *lukewarm*) and words derived by modifying prefixation (e.g. recognition of *polite* in *impolite*),as opposed to the relevance of affix recognition in words derived by head affixation (e.g. the recognition of *be-* in *begin*). Whereas head recognition involves paradigmatic knowledge, i.e. knowledge of (meaningful) relation to other words in the mental lexicon, the recognition of head affixes concerns the syntagmatic level only. In general, meaning plays a minor, if any, role for the recognition of head affixes but phonological form may be relevant.

The specific parsing mechanism indicated by word prosody is not necessarily to be understood as modeling the "online" processing of speech. Instead, this mechanism might affect the (initial) analysis of words and the prosodic form in which these words are subsequently stored, with no concomitant claim that such words are decomposed each time they are encountered in speech.

The question of what factors are relevant for the morphological analysis of words has also been addressed in psycholinguistic work. Below I will discuss some

[56] Prosodic fusion does not result in conformity to the structure of simplexes since the accent structure resulting from the previous complex pword structure (initial main stress, weak stress on the word final foot, cf. the rule in (90)) is retained. The resulting highly irregular prosodic structure is presumably unstable.

conclusions by Hay (2001),(2002) focusing on those which are inconsistent with the conclusion reached by interpreting the evidence from word prosody.

Hay's main claim is that "decomposability" of words is determined by relative frequency, meaning that a word is likely to be decomposed if the base is more frequent than the complex form. Hay's notion of decomposition conflates syntagmatic and paradigmatic analysis as she considers complex words to be items which can be "broken down" into components consisting of base words and affixes. By contrast, I have argued for a distinction between 'base words', which are paradigmatically related to but distinct from complex words in the mental lexicon, and notions such as 'roots' and 'affixes', which are components contained within complex words. Since frequency is a property of words, and not of roots or affixes, it can be relevant only to paradigmatic analysis. Indeed, the prosodic evidence does not support Hay's claims regarding the decomposability of complex words based on relative frequency. Compare the examples in the right column in (111), which according to Hay favor decomposition because the frequency of the base exceeds the frequency of the complex word as opposed to the examples in the left column in (111), which according to Hay favor non-decomposition because the frequency of the base is less than the frequency of the complex word (cf. Hay 2001:1048). The frequency data are based on the CELEX corpus.

(111)

word A	freq.	Base freq.	analysis:	word B	freq.	Base freq.	analysis:
abasement	6	2	[abasement]	enticement	3	64	[entice][ment]
alignment	57	44	[alignment]	adornment	41	75	[adorn][ment]
rueful	14	9	[rueful]	woeful	14	68	[woe][ful]
hapless	22	13	[hapless]	topless	27	3089	[top][less]
listless	42	19	[listless]	tasteless	30	402	[taste][less]

The claims regarding the analysis of the complex words given in (111) are based on speaker intuitions of perceived 'complexity', based on an experiment conducted in writing. The notion of complexity conveyed to the subjects was semantically based, involving the potential breakdown of words into "smaller, meaningful units" (Hay 2001:1048). However, there is no evidence that semantics or relative frequency play a crucial role in the decomposition of words derived by head affixation into constituent parts. Given that *-ment, -ful*, and *-less* are among the 'recognized' English head suffixes, I predict that *all* words in (111) are analysed as consisting of a root and a head affix as is illustrated with some of the relevant pairs in (112):

(112)

Input:	Head affix recognition	"Rest" => root
$[abasement]_{N}$	$[abase[ment]_{H\text{-}AFF}]_{N}$	$[[abase]_{R}[ment]_{H\text{-}AFF}]_{N}$
$[enticement]_{N}$	$[entice[ment]_{H\text{-}AFF}]_{N}$	$[[entice]_{R}[ment]_{H\text{-}AFF}]_{N}$
$[rueful]_{ADJ}$	$[rue[ful]_{H\text{-}AFF}]_{ADJ}$	$[[rue]_{R}[ful]_{H\text{-}AFF}]_{ADJ}$
$[woeful]_{ADJ}$	$[woe[ful]_{H\text{-}AFF}]_{ADJ}$	$[[woe]_{R}[ful]_{H\text{-}AFF}]_{ADJ}$
$[listless]_{ADJ}$	$[list[less]_{H\text{-}AFF}]_{ADJ}$	$[[list]_{R}[less]_{H\text{-}AFF}]_{ADJ}$
$[tasteless]_{ADJ}$	$[taste[less]_{H\text{-}AFF}]_{ADJ}$	$[[taste]_{R}[less]_{H\text{-}AFF}]_{ADJ}$

Aligning the outputs of the morphological parsing with prosodic boundaries yields internal pword boundaries, resulting in the output forms below (cf. the transcriptions in Wells (2000)):

(113)	Output		Output	
	((əbéɪs)$_{ω}$mənt)$_{ω}$	'abasement'	((ɪntáɪs)$_{ω}$mənt)$_{ω}$	'enticement'
	((əláɪn)$_{ω}$mənt)$_{ω}$	'alignment'	((əd´ɔ:rn)$_{ω}$mənt)$_{ω}$	'adornment'
	((rú:)$_{ω}$fəl)$_{ω}$	'rueful'	((wóʊ)$_{ω}$fəl)$_{ω}$	'woeful'
	((h´æp)$_{ω}$ləs)$_{ω}$	'hapless'	((t´ɑ:p)$_{ω}$ləs)$_{ω}$	'topless'
	((l´ɪst)$_{ω}$ləs)$_{ω}$	'listless'	((téɪst)$_{ω}$ləs)$_{ω}$	'tasteless'

The presence of internal pword boundaries in *all* words in (113) is supported not only by Final-C effects (cf. *abasement, alignment, listless*) but also by Containment effects (cf. *rueful*, discussed in (53),(54) and *hapless*, where the glottalization of [p] indicates strict coda syllabification, despite the following liquid). The parallel prosodic structures in *abasement* and *enticement* are also supported by the evidence from regressive voicing assimilation. Within pwords there is a strong tendency for the coronal fricative to be voiced before voiced consonants (cf. *pla*[zm]*a* 'plasma', *co*[zm]*opolitan* 'cosmopolitan' *a*[zm]*a* 'asthma'), but this tendency does not affect the root-final [s] in *abasement* and *enticement*, due to the intervening pword boundary.

The prosodic evidence thus clearly supports the analogous representations in (112). These findings are not surprising as the irrelevance of frequency to the syntagmatic analysis of words derived by head affixation has been demonstrated extensively above. Recall the presence of word-internal boundary effects in English *begin, relent, desire*, which cannot be associated with any base at all, as opposed to the absence of boundary effects in words such as *laughter* and *knowledge*, which relate to base words with far higher relative frequency but lack recognizable head affixes.

The most significant structural evidence cited by Hay in support of the relevance of relative frequency to morphological analysis concerns the noun *government* (cf. Hay 2002:542ff). This noun, being more frequent than its base *govern*, is assumed to be treated as a simplex. In support of this analysis Hay cites the formation *governmental*, as opposed to ungrammatical formations like **employmental* or **eagernessal*, the latter of which are claimed to be ruled out by a restriction of *-al*-suffixation to simplex words. Hay's analysis of the relevant restrictions in *-al*-formations in terms of morphological complexity is inconsistent with the prosodic evidence, which clearly indicates the complexity of the noun *government*. Specifically, the lack of stress on the closed penultimate syllable in conjunction with the Final-C effect indicate the presence of a word-internal pword boundary (i.e. ((góvern)$_{ω}$ment)$_{ω}$). This structure in turn supports the recognition of the suffix *-ment* described below:

(114)	Input:	Head affix recognition	"Rest" => root
	[góvernment]$_{N}$	[góvern[ment]$_{H\text{-}AFF}$]$_{N}$	[[góvern]$_{ROOT}$[ment]$_{H\text{-}AFF}$]$_{N}$

Given the analysis in (114) the restriction on *-al*-suffixation observed by Hay must have other explanations. The illformedness of **eagernessal* is in accordance with the general ungrammaticality of attaching a cohering (vowel-initial) suffix to a non-cohering (consonant-initial) suffix. Additional examples, some of which further demonstrate the irrelevance of relative frequency to the restriction in question, are given in (115):

(115) *(kind)$_{\omega}$ness+y
*(grate)$_{\omega}$ful+ize
*(fear)$_{\omega}$less+ish
*(reck)$_{\omega}$less+ity
*(hard)$_{\omega}$ship+ish

The existence of *-al*-suffixations based on *-ment*-derivations such as *governmental, developmental* or *argumental* is accordingly exceptional, perhaps explained by the fact that the suffix combination *-mental* is independently licensed in English (e.g. pairs of loanwords like *instrumental - instrument*, *ornamental - ornament*). The contrast in acceptability between **eagernessal* along with the other cases listed in (115) vis-à-vis *governmental* is accordingly explained by the absence of words which would license the relevant suffix combinations.

Consider next the contrast in acceptability between *governmental* and *employmental*, which Hay again explains in terms of relative frequency. Hay points out that the wellformedness of *governmental* versus **employmental* is not sufficiently explained by the resulting stress clash in **emplòyméntal.* This is because there are additional unattested words where stress clash would not be a problem (e.g. **nourishmental*, **managemental*) (cf. Hay 2002:544). However, the fact that there are many *-ment*-formations with root-final stress (e.g. *amázement*, *endéarment*) may play a role in stifling the productivity of *-mental* formations in general. Indeed *-al*-suffixation is also unacceptable based on words such as *testament* or *armament*, which would be simplexes on Hay's analysis.[57]

While there is no evidence for the relevance of relative frequency for the syntagmatic analysis of words derived by head affixation, relative frequency can be expected to be relevant for the analysis of compounds and words derived by modifying prefixation. This is because the analysis of such words crucially involves the recognition of a head corresponding to a paradigmatically related word. The evidence from word prosody indeed indicates a fundamental difference between the data in (111) involving head affixation, where differences in relative frequency play no role, and the data in (116) adopted from Hay (2001:1047), which involve modifying prefixation and the differences in relative frequency are relevant.

(116)

word A	freq.	Base freq.	analysis:	word B	freq.	Base freq.	analysis:
incongruous	55	3	[incongruous]	invulnerable	23	400	[in][vulnerable]
impatient	227	114	[impatient]	imperfect	50	1131	[im][perfect]
inanimate	34	4	[inanimate]	inaccurate	53	377	[in][accurate]
immobile	55	11	[immobile]	immodest	13	521	[im][modest]
immutable	40	4	[immutable]	immoderate	6	223	[im][moderate]

[57] The phenomenon that potential stress clashes in a fair subset of relevant coinages can stifle the productivity of suffix-combinations in general is well-attested in English. For instance, the lack of productivity of *-ity* with regard to adjectives in *-ive* can often be related to potential stress clashes (e.g. **abùsívity, *attràctívity, *constrùctívity*), a cause which may explain the general unacceptability of native *-ív-ity*-suffixation (e.g. **prìmitívity, *pòsitívity, *lùcratívity*). Similarly, the suffix combinations *-íst-ic*, *-ál-ity*, or *-ós-ity*, all of which have initial stress, lack full productivity. By contrast, the combinations *-abíl-ity, -ific-átion*, or *-iz-átion*, which never involve stress clashes, are entirely productive.

The relevance of frequency is reflected in the transcriptions given in Wells (2000), who lists a variant with stress on the prefix for all adjectives in the right column in (116), where the base is more frequent than the complex word, but, with the exception of *immutable*, does not list such a variant for the adjectives in the left column. These transcriptions indicate the prosodic structures in (117) (cf. the discussion of *iN*-prefixation above):

(117)

Output		Output	
(ɪŋkɑ:ŋgruəs)$_{\omega}$	'incongruous'	(ɪn)$_{\omega}$(vʌlnərəbəl)$_{\omega}$	'invulnerable'
(ɪmpeɪʃənt)$_{\omega}$	'impatient'	(ɪm)$_{\omega}$(pɜ˞fɪkt)$_{\omega}$	'imperfect'
(ɪnænəmət)$_{\omega}$	'inanimate'	(ɪn)$_{\omega}$(ækjərət)$_{\omega}$	'inaccurate'
(ɪmoʊbəl)$_{\omega}$	'immobile'	(ɪm)$_{\omega}$(mɑ:dɪst)$_{\omega}$	'immodest'
(ɪm)$_{\omega}$(mju:təbəl)$_{\omega}$	'immutable'	(ɪm)$_{\omega}$(mɑ:dərət)$_{\omega}$	'immoderate'

The structures in (117) indicate that heads are consistently recognized only if they occur more frequently than the complex word. This is plausible because the head in a complex word can be recognized only if it is known to the hearer, and relatively higher frequency would enhance the probability that the relevant word is established in the mental lexicon.[58] The data hence support the recognition process in (118):

(118)

Input:	Head recognition	"Rest" => modifier
[incongruous]$_{N}$	-	-
[invulnerable]$_{N}$	[in[vulnerable]$_{HEAD}$]$_{N}$	[[in]$_{MOD}$[vulnerable]$_{HEAD}$]$_{N}$

The fact that the stress in *immutable* indicates complexity may relate to the productivity of *-able*-suffixation, which possibly suffices to secure knowledge of the head *mutable* in the mind of the hearer.

To summarize, the parsing mechanism presented here has clear implications for the relevance of word frequency. In particular, it is predicted that relative frequency should be crucial for morphological analyses involving knowledge of paradigmatic relations, including the recognition of heads as described in 3.1.1. This is because the existence of a (paradigmatic) base can affect recognition only if the relevant word is known by the hearer. By contrast, the frequency of the (historical) base relative to the frequency of the complex word is predicted to be irrelevant in the case of head affixation as described in section 3.1.2. This is because head affixations are analysed on the basis of affix recognition, without recourse to paradigmatic knowledge.

[58] Cf. the example *handkerchief* discussed in footnote 19 and the examples involving modifying prefixes in (41).

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