Published in: Rohdenburg, Günter & Mondorf, Britta (eds.) 2003.
Determinants of Grammatical Variation in English. (*TiEL* 43.)
Berlin/New York: Mouton de Gruyter. 69-118.

Phonological determinants of grammatical variation in English: Chomsky's worst possible case*

Julia Schlüter

Abstract

In this paper it is argued, contra Chomsky (1995), that phonological factors like the preference for alternating syllable structures (or the avoidance of hiatuses and complex consonant clusters) and the striving for an alternating rhythm (or the avoidance of stress clashes and lapses) have the potential to (co-)determine morphological and syntactic structures wherever these are variable. Empirical support for this claim comes from analyses of corpus data from present-day and earlier forms of English and includes the presence or absence of the Middle English verbal ending *-n*, the variants of the indefinite article *a/an* preceding *h*-initial words, the distribution of the participial forms *lit* and *lighted*, and the restrictions bearing on attributive constructions and sentence adverbs negated by *not*. Building on the tentative assumption that alternating patterns are universal tendencies conditioned by neurophysiological facts, an interactive activation model of language processing is sketched out and contrasted with a possible treatment of the variation phenomena in terms of Optimality Theory.

1. Introduction

Theoretical linguists in the past few decades, most notably Noam Chomsky, have successfully worked towards elaborating maximally general and consistent theory-internal derivations of morphosyntactic structures. In recent years, their interest has extended to the empirical aspects of linguistics, and in his 1995 monograph Chomsky recognizes that a model of grammar has to address a dual objective of linguistic theory, i.e. "the empirical demands posed by the problems of descriptive and explanatory adequacy and the conceptual demands of simplicity and naturalness" (Chomsky 1995: 317). In the following sections I will argue that an empirically founded model of grammar needs to assign an appropriate place to phonology and that the Chomskyan conception of the syntax-phonology interface is in need of revision.

As early as 1964, Chomsky develops a componential, tripartite model which introduces a strict separation between the modules of grammar, thus following in the footsteps of many others before him. Chomsky assigns the central role of the only autonomous and generative device to the syntactic

component: "The generative grammar of a language should, ideally, contain a central *syntactic component* and two *interpretive components*, a *phonological component* and a *semantic component*" (Chomsky 1964: 9; his italics). The qualitative distinction between a generative component functioning independently of the interpretive components, and two interpretive components which merely take in the output of the former, has biased much of linguistic theory. Influences exerted by one of the so-called interpretive components on the generative component have long been systematically excluded in the generative and many other branches of linguistics (concerning the syntax-phonology interface, see in particular Zwicky 1969; Zwicky and Pullum 1986; and Pullum and Zwicky 1988).

The above-mentioned distinction is perpetuated in Chomsky's (1995) *Minimalist Program*, where the author draws a dividing line between the cognitive system of the language faculty (the computational system for human language C_{HL}, which stores information about the language) on the one hand, and performance systems (the articulatory-perceptual system A-P and the conceptual-intentional system C-I, which access information stored in the C_{HL}) on the other hand. Crucially, these performance systems are external, or extraneous, to the language system and interact with it in a restricted fashion at two interface levels, Phonetic Form (PF) at the A-P interface and Logical Form (LF) at the C-I interface. Concerning the interaction between phonology and syntax, Chomsky (1995: 221) is doubtful about whether the requirements of the articulatory-perceptual component "turn out be critical factors in determining the inner nature of C_{HL} in some deep sense", or whether they merely manifest themselves as what he calls "imperfections", i.e. departures from what are, on minimalist assumptions, optimal configurations and deriving from the necessity to accommodate the output of C_{HL} to the requirements of the human sensory and motor apparatus (cf. also Chomsky 1995: 317).

In the absence of sufficient scientific insight into the nature of the articulatory-perceptual system, Chomsky feels justified in hypothesizing that C_{HL} is free from such extraneous requirements (1995: 223):

> ... we do not know enough about the "external" systems at the interface to draw firm conclusions about conditions they impose, ... The problems are nevertheless empirical, and we can hope to resolve them by learning more about the language faculty and the systems with which it interacts. ... *The worst possible case* is that devices of both types are required: both computational processes that map symbolic representations to others and output conditions. That would require substantial empirical argument. The facts might, of course, force us to the worst case, but we naturally hope to find that C_{HL} makes use of processes of only a restricted type, and I will assume so unless the contrary is demonstrated. (Chomsky 1995: 222–223; emphasis mine)

Alongside the development of the pivotal concern of generative linguistics, namely syntax, a generative phonology (in particular Chomsky and Halle 1968) emerged, including the branch of metrical stress theory, which studies the constraints holding at the syntax-phonology interface (e.g. Liberman and Prince 1977; Cooper and Paccia-Cooper 1980; Couper-Kuhlen 1986; Hayes 1984, 1985, 1995; Kager 1989; Kaisse 1985; Selkirk 1984). None of these studies sheds any doubt on the maxim that the relationship between syntax and phonology is unidirectional, phonology being the subordinate component. A diametrically opposed stance is taken by Berg (1988, 1998) in his processing-oriented approach to linguistic structure. He ascribes important control powers to the "articulatory and auditory bottleneck", i.e. the fact that whatever is generated by the grammar has to be converted into acoustic signals: "only that which is producible and perceptible can play a linguistic role. Any appeal to perceptual and productive principles therefore has the potential to yield explanations for language structure and change" (Berg 1998: 23).

The aim of this paper is to take up Chomsky's challenge and to provide some basic information about the conditions imposed by what he calls the "external" system of phonology. I would, however, like to argue that there is no distinction between external and internal systems as such, since indisputably the computational system and the articulatory and auditory aspects of language are ultimately based on the functions of neural networks. In section 2, some neurological and neurolinguistic insights will be summarized that can – in the sense of Berg (1998) – contribute an avenue to explain phonological requirements imposed on language.

The emphasis will, however, be laid on the empirical evidence for phonological influences on the grammar of English. Thus, the main part is represented by section 3, which describes a number of empirical studies illustrating the effects of two very basic phonological tendencies, viz. ideal syllable structure and the principle of rhythmic alternation. As these are presumably low-level articulatory and perceptual factors, close to the material (phonetic) aspects of language,[1] they are relatively easily amenable to a neurolinguistic explanation.

In section 4, I will outline some suggestions for a new theory of language, bringing together neuro- and psycholinguistic insights with a recent theoretical framework, viz. Optimality Theory. This innovative theory of grammar is alluded to by Chomsky, who explicitly acknowledges the possibility that optimality theoretic mechanisms are at work at the interface between the central cognitive system of language and the performance system of phonology. Thus, the sentence preceding the quotation given

above reads: "to what (if any) extent are the properties of C_{HL} expressed in terms of output conditions – say, ... conditions of the kind recently investigated for phonology in terms of Optimality Theory (Prince and Smolensky 1993; McCarthy and Prince 1993)?" (Chomsky 1995: 222).

The overriding motivation of this paper, which it shares with all of linguistic investigation, is to conclude with some stipulations for a more adequate model of language, satisfying the three conditions set up by Lamb (1999: 293):

1) operational plausibility: "the theory has to provide a plausible account of how the linguistic system it proposes can be put into operation";
2) developmental plausibility: "the theory needs to be amenable to a plausible account of how the linguistic system it proposes can be learned by children";
3) neurological plausibility: "[a] successful theory has to be compatible with what is known about the brain from neurology and from cognitive neuroscience."

That is, a model of grammar has to be 1) consistent in the rules and constraints it specifies, 2) learnable at no unlikely expense, and 3) apt to be implemented by the human neural and cognitive apparatus. Linguistic theory will only bring us closer to our goal if it respects these three conditions.

2. Neurophysiological background: the recovery cycle

Along with Berg (1998: 20), this paper argues that "[t]he form of language has to be in line with what is neurologically feasible". We can therefore expect that certain neurological facts constrain the ways in which language is realized. For ideal syllable structure and the principle of rhythmic alternation, which will be at the centre of the discussion in section 3, the neurological recovery cycle can hypothetically be claimed to constitute the conditioning mechanism. In the description of the recovery cycle I rely largely on the relevant publications by MacKay (1970, 1986, 1987), but additional evidence for the self-inhibition of neurons and nodes comes, for instance, from Berg (1998: 154) and Berg and Schade (1992: 409).

The transmission of signals in the neural network is based on the modulation of electric charges at the cell membranes of neurons (cf. Previte 1983: 160; Koester and Siegelbaum 2000: 150). As soon as the stimulation

of a neuron crosses a certain threshold, an action potential builds up, propagates itself along the membrane and spreads across synapses to other neurons connecting to the first one. The typical shape of an action potential is the following:

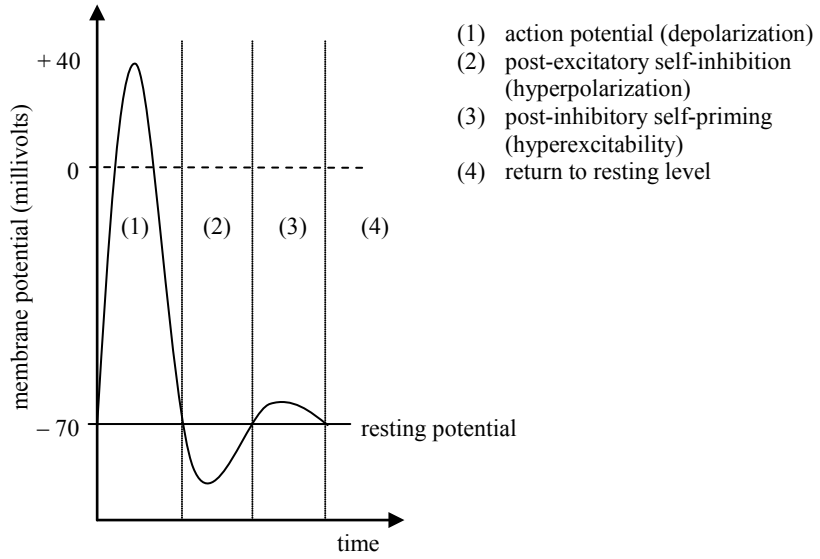

Figure 1. The typical shape of an action potential, followed by the recovery cycle (adapted from Koester and Siegelbaum 2000: 158, 161; cf. also Previte 1983: 174)

When a neuron undergoes activation, the electric charge at its membrane, which is at – 70 millivolts in the unactivated state (resting potential), is temporarily reversed to + 40 millivolts (depolarization). This action potential is followed by the so-called recovery cycle, which consists of a brief fall of the potential below the resting level (hyperpolarization), again followed by a second peak which is, however, much lower than the first one. Crucially, the excitability of the neuron after the first activation phase depends on the momentary level of the potential at its cell membrane: during the hyperpolarization phase, the neuron is harder to re-activate since the stimulus has to cross a higher threshold (post-excitatory inhibition; refractory phase), whereas during the rebound phase, the neuron is especially likely to respond to incoming activation since its threshold level is lowered (post-inhibitory rebound). It is only after this sequence that the neuron returns to its usual resting level. Let us refer to the two phases of the

recovery cycle as '(post-excitatory) self-inhibition'[2] and '(post-inhibitory) self-priming' (cf. MacKay 1987: 12).

Recent models of neural networks (cf. Lamb 1999; Berg 1998) assume that all information stored in the neural system materializes only indirectly in the myriad interconnections between neurons. A single neuron entertains numerous excitatory connections with other neurons located on superior or inferior layers (as well as inhibitory ones with neurons on the same level) (cf. Lamb 1999: 219), and it receives activation from many different sources. In the transmission of signals, all incoming potentials are processed additively: an inhibitory potential (hyperpolarization) can prevent the formation of an action potential, while previous priming can facilitate it (cf. Lamb 1999: 317). As soon as one neuron accumulates sufficient activation to generate an action potential, it transmits excitatory signals to neurons on the next layer (cf. MacKay 1987: 20). In this interplay of signals, a neuron's state of activation at a given point in time is of essential importance: a neuron in the post-excitatory inhibition phase of its recovery cycle is less likely to become activated again; it would require particularly strong incoming activation to overcome its self-inhibition. At the same time, a neuron in the phase of self-priming will become activated with an above-chance probability since only little further activation is needed to satisfy its threshold level (cf. MacKay 1987: 141).

While these processes are relatively well-established on the level of the individual neuron, their extension to linguistic sub-networks makes the argument more and more speculative (cf. Berg 1988: 205). This involves the leap from neurological facts to more speculative linguistic modelling and from neurons to higher-level units known in the literature as *nodes* (MacKay 1986, 1987; McClelland and Rumelhart 1981: 378; Dell and Reich 1981; Berg and Schade 1992) or *nections* (Lamb 1999). Nodes (as they will subsequently be designated) by hypothesis correspond to cortical columns, cylindrical groups of on average 100–110 interconnected neurons in the cortex of the brain (cf. Lamb 1999: 323, 326). They are supposed to share some central properties with neurons, such as activation and the recovery cycle. However, the differences in time scale are considerable (cf. Berg 1988: 154; MacKay 1987: 145).[3] These nodes are organized into networks which are hierarchically structured, but basically bi-directional, i.e. all nodes connect both upwards and downwards and are involved both in perception and production.[4] This makes processing of signals interactive, in the sense that later levels can influence earlier ones (cf. Dell and O'Seaghdha 1994: 412; Lamb 1999: 348, 376–377; Berg 1998: 110–116; Dell and Reich 1981: 626). In fact, interactivity will turn out to be crucial

for the argument proposed in this paper concerning the grammar-phonology interface.

The network structure is conceived of as containing nodes for different levels of linguistic structure. For example, one node will unite in itself all pathways relative to the lexeme *understand*, another one – subordinate to the first – those for the morpheme *under*, a third one those for the syllable *un*, yet another one those for all consonants, for the phoneme /n/ or for the articulatory feature *apical* (cf. the hypothetical network structures in Lamb 1999: 64 and MacKay 1987: 17, 19). In other words, all structural elements that share certain traits will converge in the same nodes, which function as "category recognizers" for individual lexemes, morphemes, syllables, phonemes, etc. (Lamb 1999: 280).[5] Evidence for the psychological reality of units at different hierarchical levels comes, for instance, from language slips and disorders (cf. e.g. Berg 1996, 1999).

It is in the context of a bi-directional model of the language system with the hierarchical structure outlined above that the function of self-inhibition becomes obvious. If connections between layers of the system work in both ways, i.e. perception and production run along the same lines, self-inhibition is necessary to ensure that internal feedback does not lead to repeated (reverberatory) re-activation (MacKay 1987: 143; cf. also MacKay 1986: 183–184). To illustrate this, imagine that the lexeme *understand* is to be produced. The morpheme node for *under* activates the subordinate syllable node for *un* (which is the correct way in production), but also the superordinate lexeme node for *understand*, as would be correct in perception, but not in production. The lexeme node will be stopped from erroneous re-activation only on the condition that it is still in its inhibition phase.

To avoid these effects, self-inhibitory phases have to last longer for nodes in the higher layers of the language system (since the way of the feedback is longer through the system and back and accordingly takes more time). MacKay (1986: 184; 1987: 144) claims that for the lowest level muscle movement nodes (which are subordinate to articulatory feature nodes like *apical*), the entire activation and recovery cycle may last only a few milliseconds. For phonological nodes, the entire cycle can last up to 300 milliseconds, with a refractory phase lasting as long as 100 milliseconds, a self-priming peak at 200 milliseconds, and a return to resting level at 300 milliseconds. For still higher level nodes, MacKay assumes, the activation and recovery cycle can take even longer. The author hypothesizes that this universal of neural action should have repercussions on the structure of languages and draws the following conclusion: "Immediate

repetition of an element should be rare, reflecting the self-inhibitory phase of the recovery cycle, but at some point following self-inhibition, repetition should become more likely than would be expected by chance, reflecting the hyperexcitability phase of the recovery cycle." (MacKay 1987: 152)

For the phenomena investigated in the main part of this paper, it should be remembered that after a node has been activated, it undergoes a refractory phase during which it cannot easily be activated again. By contrast, after a certain interval (whose duration depends on the systemic layer of the node) its repetition is more likely again. For phonological structure, this could mean, for instance, that the category recognizer node for vowels is self-inhibited for a certain time after it has been activated. Given a binary contrast between vowels and consonants, a consonant is most likely to step into the breach. While the consonant node subsequently undergoes self-inhibition, the vowel node is in turn more likely to rebound. This neural mechanism may be the origin of the universal principle known as ideal syllable structure (see section 3.1).[6] Similarly, if there are prosodic nodes for the features *stress* and *no stress* in syllables, the two syllable types may be expected to alternate: as long as the stressed syllable node is inhibited, the unstressed syllable node fills the gap; when this is obstructed in turn, the stressed syllable node intervenes. These patterns are in fact attested in actual language use and known as the principle of rhythmic alternation (see section 3.2).[7]

Note that, since production and perception are assumed to proceed along the same connections through a bi-directional network, the alternation tendencies will manifest themselves in both types of processing. Thus, the question of whether ideal syllable structure and the principle of rhythmic alternation are motivated by productive or perceptive factors receives an obvious answer: both activities are constrained by the same fundamental conditions. Considering alternating patterns from a teleological perspective (cf. Berg 1998: 79; Martin 1972: 466; Allen 1975: 84), their function is presumably to heighten the contrast between adjacent elements (segments, syllables) in continuous speech so that the constituent elements of language are kept maximally distinct and confusion is minimized. Additionally, they structure the concatenation of units so as to break sequences up into recurrent intervals, thereby facilitating perception.

At higher levels of linguistic structure, the networks involved become more and more complicated, but for my purposes, the lower levels dealing with phonological (phonotactic and rhythmic) configurations are sufficient; here, alternating patterns are clearly observable (cf. Bell and Bybee Hooper 1978: 15). The hypothesis that can be derived from the preceding outline of

neurolinguistic insights and their adaptation for linguistic network models is that the alternation of vowels and consonants as well as that of stressed and unstressed syllables constitutes a linguistic universal ultimately conditioned by principles of neural action. A comparable preference for alternating patterns of performance is also known from children's language, speech errors and aphasic speech (Ingram 1978; Menn 1978; Allen and Hawkins 1978; Blumstein 1978) as well as from domains other than speech, e.g. music, typing, handwriting and morse code (cf. Couper-Kuhlen 1986: 60; Martin 1972: 387; MacKay 1987: 93), which may be attributed to the same neurophysiological sources.

3. Corpus linguistic approach

While little that has been said so far has received sufficient empirical support to be taken for granted, the empirical studies to be described in the following sections provide ample proof of the importance of alternating patterns in language – whatever their neurophysiological motivation may be. Since we are dealing with linguistic universals, they can be expected to crop up in all languages and in all historical phases of a single language. Therefore, the data sets on which the following analyses are based are drawn from different synchronic stages of the English language. These include two studies of ideal syllable structure effects and two studies of repercussions of the principle of rhythmic alternation in several corpora from earlier forms of English as well as present-day British and American varieties (details on the corpora and editions used are given at the end of this paper).

3.1. Ideal syllable structure

In presumably all languages there is a marked tendency to favour syllables of the type CV (a consonant followed by a vowel, again followed by a consonant and a vowel, etc.) (cf. also Vennemann 1972: 216; 1988: 13–29; Blumstein 1995: 915):

> The most common pattern of concatenating phonological units is the simple alternation of consonants and vowels. The CV structure is the only syllable type that is found in every language and the first to be acquired by children. Any extension of this most basic syllable type ineluctably creates the adjacency of two consonants and two vowels. The latter situation (hiatus) is less tolerated by natural languages than the former. (Berg 1998: 79; cf. also Bell and Bybee Hooper 1978: 8–9)

Within constellations of the former type (consonant clusters), different degrees of optimality can be distinguished (cf. Vennemann 1988: 13, 21; Berg 1998: 79), but irrespective of such differentiations it will be argued that both hiatuses and consonant clusters tend to be avoided. It is obvious that ideal syllable structure is frequently violated in languages like English, but even so it can be shown to represent an ideal that is implemented wherever there is an opportunity.

In the following corpus studies, I will analyze the distribution of variants of words that differ in their phonotactic structures. This kind of variation is of course rare due to standardization and language economy (following the "one meaning – one form" principle; cf. Bybee 1985: 208), and especially so in present-day English. Consequently, before turning to a phenomenon that can be considered the only relevant one left in the current standard language, I will investigate an example from Late Middle English.

3.1.1. The forms of the verb *be* in Chaucer's language

In Geoffrey Chaucer's language, there is still ample variability in the phonotactic makeup of words. This concerns items which alternate between a form with a final vowel and one with a final consonant, e.g. the personal pronoun *I* vs. *ich/ik*, the determiners *every* vs. *everich* and *no* vs. *noon*, the attributive possessive pronouns *my* vs. *myn* and *thy* vs. *thyn*,[8] the preposition *fro* vs. *from*, and several verb forms with variable final *-n*: *be* vs. *been*, *do* vs. *doon*, *see* vs. *seen*, *go* vs. *gone*, *say* vs. *sayn*, etc.

The verbal ending *-n* will be at the centre of the present investigation. Its status in Late Middle English can be outlined as follows. Originally, *-n* was a regular and obligatory suffix for infinitives, finite verb forms of the plural (indicative and subjunctive) and past participles. However, due to phonetic erosion in Middle English, the presence of the suffix became variable, and finally, by the Early Modern English period, the variability disappeared in favour of either the suffixed form (commonly used for the past participle) or the suffixless form (infinitive).[9] Interestingly, during the phase of variability of *-n*-suffixation, syllable structure played a major role as a determinant of a characteristic variation profile.[10]

In the study summarized in Table 1, I concentrate on the *n*-less and *n*-containing forms of the verb *be* in two late-fourteenth-century texts by Chaucer (300,000 words).[11] Categories 1–4 refer to the different grammatical functions of the verb involving the variable presence of the final *-n*. Category 0 contains all examples discarded from the count because they

lack variation or because the variation is presumably determined by other than syllable structure effects.

Table 1. The form of the verb *be* in Chaucer's *Troilus and Criseyde* (1385) and *Canterbury Tales* (1387–1394)

	I *be*/*bee*		II *ben*/*been*		III total
	tokens	%	tokens	%	tokens
0 discounted examples (total)	836	95%	42	5%	878
a) subjunctive singular	510	100%	0	0%	510
b) imperative singular	51	100%	0	0%	51
c) imperative plural	10	100%	0	0%	10
d) in rhyming position	226	97%	7	3%	233
e) before verse-internal pause	39	53%	35	47%	74
1 infinitive (total)	489	56%	384	44%	873
a) before V-	12	5%	210	95%	222
b) before <h>-	8	13%	55	87%	63
c) before C-	469	80%	119	20%	588
2 indicative plural (total)	54	8%	583	92%	637
a) before V-	0	0%	159	100%	159
b) before <h>-	0	0%	19	100%	19
c) before C-	54	12%	405	88%	459
3 subjunctive plural (total)	24	67%	12	33%	36
a) before V-	0	0%	5	100%	5
b) before <h>-	0		0		0
c) before C-	24	77%	7	23%	31
4 past participle (total)	14	13%	96	87%	110
a) before V-	0	0%	39	100%	39
b) before <h>-	0	0%	8	100%	8
c) before C-	14	22%	49	78%	63
5 total of 1–4 (total)	581	35%	1075	65%	1656
a) before V-	12	3%	413	97%	425
b) before <h>-	8	9%	82	91%	90
c) before C-	561	49%	580	51%	1141

For a start, consider the total of all remaining uses in rows 5 a–c: the relevant examples are split up according to the category of the following phoneme (vowel vs. consonant). Contrary to common opinion, a third category emerges, taking an intermediate position between fully vocalic and fully consonantal status. This concerns words beginning with the

grapheme <h>. The results for the overall total (rows 5a–c in Table 1) show that *-n* is present in 65% of all cases. Depending on the category of the following phoneme, this quota may vary considerably. Before vowels, *-n* is present in 97%, before <h> in 91%, and before consonants in only 51% of all cases. All deviations from the overall total are very highly significant. While the variation profile stays the same across all different grammatical functions of the verb *be* (rows 1–4 in Table 1), with vowel-initial items at the one end, consonant-initial ones at the other, and <h>-initial ones intermediate, the respective percentages vary depending on other than phonological factors.

The status of initial <h> merits some additional comment: regarding their affinity with *n*-less and *n*-containing variants of *be*, the behaviour of <h>-initial words is close to that of vowels, but shows a significant difference of 6% for the overall total ($\chi^2 = 7.32$; df = 1; p = 0.007). Different hypotheses have been proposed to account for the systemic status of <h>. According to Dobson (1968: 991), Jordan (1974: 178–179), and Burnley (1983: 15), the Middle English grapheme was interpreted as aspiration of the following vowel; therefore, <h>-initial words are assumed by these authors to be fully vocalic. By contrast, according to Lutz (1991: 61), <h> was consonantal, but only weakly realized in Chaucerian Middle English even in accented syllables in native English words. Barber and Barber (1990: 89–90) distinguish between lexemes of Germanic and Romance origin, claiming that Germanic major class words typically retain the pronunciation of <h>, whereas in Romance loanwords <h> was usually mute. Minkova and Stockwell (1997: 43–49) are more ambivalent, drawing attention to numerous inconsistencies in Chaucer's usage. While the distinction between Germanic and Romance <h> plays a negligible role in my Middle English data (the total percentage of *n*-containing infinitives before <h> still being close to that before vowels), its importance increases towards the Early Modern English period, where its effects are unmistakable (see Rohdenburg and Schlüter 2000: 472–473).

The reason for the transitional status of <h> might be found in the fact that it is poorly integrated in the system of English phonemes: it represents the only glottal phoneme and consequently has a vulnerable standing (cf. Vachek 1964: 9–17; Berg 1998: 228). Furthermore, its articulation resembles that of vowels in that it involves no constriction of the vocal tract above the larynx (cf. Steriade 1995: 135).

A more detailed consideration of different uses of the verb *be* reveals complementary extra-phonological factors influencing the choice of phonological variants. In the instances comprised in category 1 of Table 1,

infinitival uses, final *-n* has eventually been given up (cf. present-day English). Anticipating this evolution, the average in all phonotactic contexts is much lower than in the total of all verb forms and hovers at only 44%. The sub-categories (1a–c) of vowel-, <h>- and consonant-initial subsequent words present the characteristic pattern described for the total, even if all figures are slightly lower. Especially before consonants, the innovative, *n*-less form is well established. Initial <h> again takes an intermediate position. Three illustrative examples of infinitival uses are given in (1) to (3). Note the different forms of *be* in direct coordination in different phonotactic contexts in sentence (1) and the divergent use of both forms in the same phonotactic context (preceding <h>) in sentences (2) and (3):

(1) *I ... love huntynge and venerye, / And for to walken in the wodes wilde, / And noght to* ***ben a*** *wyf and* ***be with*** *childe.* (*Canterbury Tales*)[12]

(2) *I sal* ***been halde*** *a daf, a cokenay!* (*Canterbury Tales*)

(3) *Of pokkes and of scabbe, and every soore / Shal every sheep* ***be hool*** *that of this welle / Drynketh a draughte.* (*Canterbury Tales*)

The explanation for this pattern of variation is now obvious, given the universal tendency to favour an ideal CV syllable structure wherever variants are available. On the one hand, the presence of *-n* before vocalic onsets promotes the avoidance of hiatuses, and on the other, the omission of *-n* before consonantal onsets serves the reduction of consonant clusters.[13]

In the indicative plural (category 2 in Table 1), the *n*-containing form *been* has still got the highest overall incidence. Nowadays, it has been completely replaced by *are*. Within this category, the same variation profile manifests itself between vowels and consonants. The innovative form *be* occurs exclusively preceding consonants. The rate of occurrence of the form followed by the grapheme <h> happens to be too low to give rise to variability. Three examples of indicative plural uses are given in (4) to (6):

(4) *Ye* ***been a*** *noble prechour in this cas.* (*Canterbury Tales*)

(5) *But now to ȝow, ȝe loueres that* ***ben here****, ...* (*Troilus and Criseyde*)

(6) *Pandare answerde, "****be we*** *comen hider / To fecchen fire and rennen home aȝein?* (*Troilus and Criseyde*)

Category 3 (subjunctive plural) only contains few examples, and among these none of the verb followed by an <h>-inital item. As in the indicative plural, consonants are the only environment where the vowel-final variant *be* is employed already. Compare the following examples:

(7) *Ne, parde, lorn am I naught fram ȝe ȝit,* / *Though that we* ***been a*** *day or two atwynne ...* (*Troilus and Criseyde*)

(8) *If ȝe* ***be swich*** *ȝoure beaute may nat strecche* / *To make amendes of so cruel a dede: ...* (*Troilus and Criseyde*)

The last category subsumes all participial uses of *be* or *been*. In Modern English, this verb form has retained the obligatory ending *-n*. Accordingly, in Middle English, the ending was relatively well preserved despite the general phonetic erosion, which exerted pressure on past participles just as much as on other grammatical categories. In 87% of all cases, the *-n* is still present. This is the case before all vowel- and <h>-initial words. Examples (9) and (10) correspond to present-day usage. It is only before consonants that the *n*-less form crops up occasionally, as in example (11):

(9) *And fynaly he woot now, out of doute,* / *That al is lost that he hath* ***ben*** *aboute.* (*Troilus and Criseyde*)

(10) *I trowe that to a norice in this cas* / *It had* ***been*** *hard this reuthe for to se; ...* (*Canterbury Tales*)

(11) *The knyght cam which men wenden had* ***be*** *deed.* (*Canterbury Tales*)

In conclusion, the striving for ideal syllable structure can account for a considerable part of the variation between *be* and *been* in Chaucerian Middle English. It is evident that beside the phonotactically motivated vowel vs. consonant pattern (with <h> intermediate), another pattern is increasingly asserting itself, which is grammatical in nature. This foreshadows the evolution eventually leading to a strict specialization in terms of Bybee's (1985: 208) "one meaning – one form" principle (infinitival vs. finite vs. participial verb forms). The results in Table 1 leave no doubt that both determinants contribute their share to the variable presence of the *n*-ending in forms of the verb *be*.

Crucially, a phonotactic factor has been shown to determine the presence or absence of a morpheme. Arguably, when the *-n*-morpheme is present, the form can be distinguished from certain other syntactic uses (subjunctive singular, imperative), which are always suffixless. In this

respect, the *-n* retains a grammatical function, even though it is not obligatory any more. Phonotactic tendencies thus override grammatical considerations. Concerning the Chomskyan model of the grammar-phonology interface, this implies that phonology does more than assign a phonological interpretation to strings of morphemes which it takes in from the generative component. The variable presence of final *-n* in forms of the verb *be* thus supplies a first empirical argument requiring the revision of Chomsky's theory.

3.1.2. The form of the indefinite article preceding <h>-initial words in present-day English

Let us now turn to the only comparable case remaining in present-day English: the indefinite article still boasts two variants, viz. *a* and *an*. The distribution of these two forms is largely fixed: before vowels, *an* is obligatory; before consonants, *a* is the only possibility. The case is slightly more complicated before <h>, but even here there is hardly any choice. Lexemes with an unpronounced <h> (*hour*, *honour*, *heir*, etc.) take *an*; for native lexemes with a stressed first syllable (*hand*, *house*, etc.), *a* has become obligatory in Standard English. However, certain lexemes of Romance or Greek origin, and among them particularly those with a weak first syllable still show some degree of variability (cf. Lutz 1991: 61, note 115) and therefore constitute a valuable testing ground for syllable structure effects in present-day English. Sentences (12) and (13) exemplify this variation:

(12) *Those who visit the rotunda today will file past the casket and view a photo exhibit providing* ***an historical*** *perspective of Romney's life.* (*Detroit Free Press* 1995)

(13) *"He is still* ***a historical*** *hero ... but in Russia he is a villain."* (*Detroit Free Press* 1995)

In the present-day standard language, the phoneme /h/ has been established as an (almost) fully-fledged consonant, while in dialects the situation is still very different in this respect (cf. Gimson 1994: 173–175).[14] In view of these facts, lexemes of Romance and Greek origin, which are accompanied by *an* in a non-negligible proportion of cases, merit further investigation.

The following analysis is based on four years of the British newspaper *The Guardian* and four years of the American *Detroit Free Press* with a total of about 220 million words. The 29 most frequent ones among the lexemes concerned (nouns, adjectives and their derivatives) have been split up into several groups according to the degree of prominence (defined phonemically and prosodically) of their initial syllable. Table 2 shows the categories that have been used to quantify the prominence of the initial syllable and the distribution of the variants *a* and *an* for each lexeme.

The analysis reveals a significant difference between British and American English: in British English, the selected lexemes are accompanied by *an* in 24% of all cases, whereas in American English, only 6% of the same lexemes involve *an*.

The lexemes considered are divided into six subcategories, defined by the relative phonological prominence of their initial syllable. In the analysis of a written corpus, the prominence cannot be measured acoustically, but it can be independently assessed by taking into account the amount of stress the initial syllable bears (zero stress, secondary stress or primary lexical stress) and by its prosodic weight, which is determined, among other factors, by the length and complexity of its nuclear vowel (short, long or diphthongal; for a similar categorization, albeit in a diachronic perspective, cf. Lutz 1991: 59–66). For the present analysis, I propose the hypothesis that initial <h> may fail to be realized in the lexemes under consideration, and crucially, that the quota of non-realization correlates negatively with the prosodic prominence of the initial syllable. That is, the more striking an initial syllable is, the more likely an initial <h> is to be pronounced, and inversely, the more recessive an initial syllable is, the more likely an initial <h> is to be dropped.[15] In short, the lexemes listed in Table 2 may either tend to be consonant-initial or vowel-initial, depending on the prominence of their first syllable.[16] At a closer look the different subcategories lend themselves to an interpretation in terms of ideal syllable structure.

Subcategory 1 of Table 2 contains those lexemes possessing an unstressed initial syllable with a short vowel. Arguably, the initial syllable is the weakest among the six subcategories both with regard to stress level and to the prominence of the syllable nucleus (a reduced vowel). The subtotal for this category soars to 42% of *an* in British English and reaches as much as 10% of *an* in American English. The percentage of the *n*-containing article thus peaks for this group of lexemes. The individual percentages range from 58% for *historic* to 6% for *horizon* in British English and from 22% for *habitual(ly)* to 0% for a number of lexemes in American English.

Table 2. The distribution of *an* and *a* preceding selected words of Romance and Greek origin with initial <h> in *The Guardian* for 1991–1994 and the *Detroit Free Press* for 1992–1995

	British English					American English				
	I *an*		II *a*		III total	IV *an*		V *a*		VI total
	tokens	%	tokens	%	tokens	tokens	%	tokens	%	tokens
1 unstressed initial syllable with short vowel (total)	828	42%	1157	58%	1985	116	10%	984	90%	1100
a) *historic*	417	58%	305	42%	722	59	13%	405	87%	464
b) *hysteric(ally)*	26	45%	32	55%	58	0	0%	20	100%	20
c) *habitual(ly)*	15	38%	24	62%	39	19	22%	68	78%	87
d) *historian*	81	38%	133	62%	214	2	2%	80	98%	82
e) *hereditary*	30	37%	51	63%	81	0	0%	14	100%	14
f) *historical(ly)*	163	36%	285	64%	448	30	12%	211	88%	241
g) *hilarious(ly)*	33	31%	75	69%	108	5	8%	58	92%	63
h) *horrific(ally)*	31	29%	75	71%	106	0	0%	45	100%	45
i) *hallucinatory*	3	25%	9	75%	12	0	0%	2	100%	2
j) *horrendous(ly)*	22	17%	105	83%	127	0	0%	60	100%	60
k) *heretical*	1	14%	6	86%	7	1	20%	4	80%	5
l) *hypnotic(ally)*	5	11%	40	89%	45	0	0%	10	100%	10
m) *horizon*	1	6%	17	94%	18	0	0%	7	100%	7
2 unstressed initial syllable with long vowel/diphthong (total)	11	11%	88	89%	99	1	2%	46	98%	47
a) *hierarchical*	4	17%	19	83%	23	0	0%	7	100%	7
b) *hermetic(ally)*	2	13%	13	87%	15	0	0%	5	100%	5
c) *holistic(ally)*	3	9%	30	91%	33	0	0%	25	100%	25
d) *hypothesis*	2	7%	26	93%	28	1	10%	9	90%	10
3 initial syllable with secondary stress (total)	8	8%	92	92%	100	0	0%	53	100%	53
a) *hallucination*	5	36%	9	64%	14	0	0%	5	100%	5
b) *histrionic(ally)*	1	14%	6	86%	7	0	0%	2	100%	2
c) *hypocritical*	1	4%	22	96%	23	0	0%	9	100%	9
d) *horizontal(ly)*	1	2%	55	98%	56	0	0%	37	100%	37
4 initial syllable with variable stress level (total)	78	7%	1034	93%	1112	0	0%	902	100%	902
a) *hegemony*[17]	1	14%	6	86%	7	0	0%	1	100%	1
b) *hotel*[18]	77	7%	1028	93%	1105	0	0%	901	100%	901

Table 2 (continued).

	British English					American English				
	I *an*		II *a*		III total	IV *an*		V *a*		VI total
	tokens	%	tokens	%	tokens	tokens	%	tokens	%	tokens
5 initial syllable with primary stress (total)	5	2%	268	98%	273	13	14%	82	86%	95
a) *hemisphere*	1	17%	5	83%	6	0	0%	5	100%	5
b) *homage*	2	3%	58	97%	60	13	46%	15	54%	28
c) *hierarchy*	1	2%	46	98%	47	0	0%	8	100%	8
d) *humble(r)*	1	1%	159	99%	160	0	0%	54	100%	54
6 unstressed initial syllable with /(h)j-/ onset (total)	3	1%	338	99%	341	0	0%	73	100%	73
a) *humane*	1	1%	91	99%	92	0	0%	11	100%	11
b) *humiliating(ly)*	2	1%	247	99%	249	0	0%	62	100%	62

The first syllable of the lexemes subsumed under subcategory 2 is equally unstressed, but contains a long vowel or diphthong. Consequently, the prosodic weight of the syllable is appreciably greater. The subtotal for this category is 11% of *an* in British English and 2% of *an* in American English, with single results ranging from 17% for *hierarchical* to 7% for *hypothesis* in British English. American English is insensitive to this kind of reduced syllable prominence: with the exception of a single occurrence of *an hypothesis*, unstressed syllables with strong vowels behave just like strong syllables.

Subcategory 3 involves four lexemes in which the primary lexical stress falls on a later syllable, but where the first syllable carries a secondary stress. This secondary stress results in a greater prominence of the initial syllable and has as a consequence even fewer occurrences of the determiner *an*. The British part of the corpus yields just eight instances, corresponding to 8%, for the subtotal. American English does not employ *an* in this context at all.

The lexemes in subcategory 4 are peculiar in that they may have primary stress on the first or second syllable. In British English, *hegemony* and *hotel* are preceded by *an* in a certain percentage of cases. It can be assumed that this will be the case especially in those instances where the lexemes are intended to be non-initially stressed and thus have a weak first syllable. In a written corpus, the location of the primary stress can of course not be ascertained, but variable stress on the initial syllable can be taken to

correlate with a variable probability of <h>-realization. This group of lexemes is thus intermediate in the overall prominence of their first syllables.

Subcategory 5 includes a few examples of lexemes which have initial stress but which nevertheless show rare occurrences of *an* as a determiner. This is the case in only 2% of the examples in British English. American English again has 0% of *an* for three of the four lexemes. The only exception, *homage*, which seems to oscillate between /h/-containing and /h/-less variants, is obviously lexicalized in American English as optionally containing a mute <h> (like *hour*, *honour*, *heir*, etc.).

Finally, subcategory 6 consists of two lexemes with the initial consonant cluster /(h)j-/. At least the conjunction of the two consonants should ensure that these lexemes are considered consonant-initial. But both *humane* and *humiliating(ly)* have an unstressed initial syllable, which may account for the fact that British English has the possibility of dropping the /h/ in the onset, in which case the semi-vowel /j/ seems to function vocalically in 3 out of a total of 341 occurrences in the British part of the corpus. Even so, this category has the lowest share of *n*-containing articles out of all lexemes included in this study, and American English is once more completely immune to this kind of variability.

As a general conclusion to this study, it should be remembered that, as the prominence of the lexeme-initial syllable increases, the probability of full consonantal realization of <h> increases proportionately. It is only as a corollary of this independently motivated gradual distinction that the incidence of the *n*-less indefinite article *a* decreases in proportion with the presence of an initial consonant. To illustrate this, reconsider examples (12) and (13) above. The combination of the article with the adjective *historical* has two possible realizations: /ən ɪ'stɒrɪkəl/ if the <h> is dropped, as in example (12), and /ə hɪ'stɒrɪkəl/ if it is preserved, as in example (13) (cf. Vennemann 1972: 214). In both cases, ideal syllable structure is implemented where the two words come into contact. It has been argued that the correlation between initial syllable prominence and use of *a* or *an* is only an indirect one, mediated by the probability with which the /h/-containing or /h/-less pronunciation is chosen. In a nutshell, where modern Standard English leaves a margin for variation with regard to the realization of initial <h>, this freedom is still subject to ideal syllable structure effects.

Table 2 shows that this generalization is valid for both regional varieties (British and American), with only a gradual difference: American English is less likely overall to drop the *h* and therefore has a lower percentage of *an*. While British English usage appears to be the more conservative one in

this case, the tendency to separate adjacent vowels, being a linguistic universal, is yet constant in both varieties.

3.2. The principle of rhythmic alternation

The principle of rhythmic alternation describes a prosodic tendency that is equally marked by alternating structural patterns. The structures on which this principle impinges are located in a higher systemic layer than the phonotactic alternations studied above. Working at the syllabic level, they involve the minimal units of prosody. The following quotations by Kager and Couper-Kuhlen define the basic properties of the principle (cf. also Jespersen [1909] 1965: 156; Selkirk 1984: 37; Nespor and Vogel 1989: 69):

> ... stressed and stressless syllables tend to alternate at *rhythmically ideal disyllabic distances*. Rhythmic alternation manifests itself by the avoidance of sequences of stressed syllables, as well as of long sequences of stressless syllables. (Kager 1989: 2; his italics)

> Whether the tendency for strong and weak syllables to alternate with one another is ultimately physiologically or psychologically conditioned, there is reason to believe that rhythmic alternation is a universal principle governing the rhythms of natural language … (Couper-Kuhlen 1986: 60)

Sequences of stressed syllables will be referred to as *stress clashes*, sequences of unstressed syllables as *stress lapses*.[19] Both kinds of constellation will be avoided according to the principle of rhythmic alternation.

The question of whether or not this principle is a linguistic universal is subject to debate. A well-known distinction differentiates between stress-timed and syllable-timed languages (cf. Pike 1945: 35). Martin (1972: 498), Allen (1975: 83), Bertinetto (1989: 121–123) and Nespor and Vogel (1989: 110–112), however, argue that even the so-called syllable-timed languages can ultimately be mapped onto alternating strong and weak patterns, but that certain prosodic or phonetic differences between the properties of stressed and unstressed syllables give rise to the impression that the two types of languages adhere to dissimilar prosodic patterns. If the facts outlined in section 2 do constrain prosody in the manner hypothesized, the principle of rhythmic alternation will of necessity be a universal as it is conditioned by the neurophysiological prerequisites of language. Be that as it may, English is frequently cited as a prototypical stress-timed language and as exhibiting strong effects of rhythmic alternation (e.g. Nespor and

Vogel 1989: 98; Markus 1994: 198), and can therefore be expected to constitute a worthwhile testing-ground for the efficacy of the principle.

Unlike ideal syllable structure, the principle of rhythmic alternation still has many points of attack left in present-day Standard English. Numerous morphological and syntactic variants can be adduced that comply with this principle (cf., for instance, Fijn van Draat [1910] 1967, 1912a, 1912b; Franz [1939] 1986; Bolinger 1965; Rohdenburg and Schlüter 2000; Schlüter 2001; Schlüter 2002). Examples of morphological variants that can be cited in illustration include pairs of past participles like *drunk*/*drunken*, *shrunk*/*shrunken*, *swelled*/*swollen*, *shaved*/*shaven*, *knit*/*knitted*, and *lit*/*lighted*, the latter of which will be investigated in section 3.2.1.[20] Examples of syntactic phenomena influenced by the principle of rhythmic alternation are attributive structures of the type determiner + *not* + adjective and sentence adverbs negated by *not*. These will be subjected to further scrutiny in section 3.2.2.

3.2.1. The participial variants *lit* and *lighted* in present-day English

My first study concerned with the principle of rhythmic alternation concentrates on the distribution of the participial variants *lit* and *lighted* with special attention to attributive constructions. Conventional grammars usually restrict themselves to listing both variants, at most adding the remark that attributive uses are predominantly filled by *lighted* (cf. for instance Quirk et al. 1985: 113).

The disyllabic form *lighted*, or its variant predecessors, represent the historically older forms, which have subsequently been contracted to monosyllabic *lit* (cf. Bauer 1997: 553). While the disyllabic form was still virtually omnipresent in the Early Modern English written standard, it has been undergoing a gradual replacement process promoting the contracted form since the eighteenth century. The following empirical study will be confined to British English. The database is composed of two years each of *The Times* and *The Guardian*, totalling about 230 million words. Parallel results have been obtained for American English, where the diachronic changeover from *lighted* to *lit* is not quite as advanced, but although the percentage of *lighted* is higher on average, the contrasts observed in the American data are quite as strong as those found for British English.

Table 3 shows the results of the count split up according to the syntactic functions of the participles. The total at the bottom shows that in British English, *lit* already occurs with an overall frequency of 94%. All past tense

forms, which equally oscillate between *lit* (94%) and *lighted* (6%), have been discarded from the table.

Table 3. The distribution of the participial variants *lit* and *lighted* in *The Guardian* for 1990–1991 and *The Times* for 1993–1994

	I *lit*		II *lighted*		III total
	tokens	%	tokens	%	tokens
1 attributive uses (total)	1062	92%	90	8%	1152
a) single unmodified uses	12	14%	74	86%	86
b) *lit-up/lighted-up*	6	100%	0	0%	6
c) premodified uses	1041	98%	16	2%	1057
i) prefixed uses	67	93%	5	7%	72
ii) compound forms	751	99%	10	1%	761
iii) adverb + *lit/lighted*	223	100%	1	0%	224
d) complex attributive structures	3	100%	0	0%	3
2 other uses (total)	838	95%	41	5%	879
total of 1 and 2	1900	94%	131	6%	2031

At first glance, it appears that *lighted* does not dominate so clearly in all attributive uses (row 1 in Table 3); at a total rate of 92%, *lit* reaches almost the same level as in the overall total. Can we thus infer that the claims made by grammarians are wrong? As the table shows, the attributive uses can again be subdivided into single unmodified cases, participial uses of the phrasal verb *light up*, premodified instances and complex attributive uses (i.e. cases in which *lit* or *lighted* is followed by another attributive element separating it from the noun). It turns out that *lighted* is actually overrepresented only among the single unmodified attributes, but in this category, the reversal is dramatic: the quota of the form soars to 86%.

At this point, two questions arise: firstly, why is *lighted* so strongly preferred in single attributive uses (or: what makes *lit* so objectionable here), and secondly, why is *lit* with premodification, as a phrasal verb or in complex attributive structures, however, the majority form? To address the first question, compare the prosodic contexts of the postnominal, predicative and verbal uses of *lit* in examples (14a–c) (subsumed under category 2, 'other uses') to the context in example (15a), illustrating a single attributive use:

(14) a. *Margarit's work opens with an attractive setting of a marbly floor and backdrop, with large painted tulips, handsomely* ***lit****, and her music is both Andalusian and Arab-flavoured.* (*The Times* 1994)
b. *According to their families, the men's cells are tiny, foul-smelling, and* ***dimly lit****.* (*The Guardian* 1991)
c. *Bonfires should be* ***lit*** *on still days, when there is no danger of the smoke blowing across nearby roads and decreasing visibility for drivers and pedestrians.* (*The Times* 1994)

(15) a. *I'm sure if you gave him a* ***lít cándle*** *and two sheets of newspaper he would come up with a solution to any film-lighting problem.* (*The Guardian* 1991)[21]
b. *Then they poked* ***lighted mátches*** *through and into the puddle of* ***lighted pétrol****.* (*The Guardian* 1990)
c. *So I strolled over to a nearby stall, warmed myself with a glass of barrack (apricot brandy) and watched a thin man eat a whole packet of* ***lít cigaréttes****.* (*The Times* 1994)

As is illustrated by (15a), the single attributive position entails a high probability that a stress clash occurs between the monosyllabic form *lit* and the following noun. The reason is that in most nouns stress falls on the initial syllable.[22] By contrast, in other uses, illustrated by the examples in (14), an unstressed function word or a pause commonly follows the participle. Crucially, the disyllabic form *lighted* has an additional syllable provided by the suffix *-ed*, which functions as a stress clash buffer as in example (15b). Consequently, in the rhythmically critical attributive uses, the disyllabic form *lighted* is consistently preferred.

The second question seeks to determine the regularities enabling the other attributive structures to accommodate the monosyllabic form *lit*. Note that all other attributive structures consist of plurisyllabic constructions: The past participle of the phrasal verb *light up* offers the chance to shift the stress away from the particle to the verb. In this case, the syllable *up* becomes de-stressed and functions as a buffer. Consider example (16):

(16) *Even the Hon John Byng, hardest to please of all English travellers, was impressed by the mill's appearance at night, with its rows of* ***lít-up wíndows*** *illuminating the valley as the machines clattered incessantly.* (*The Times* 1993)

Similarly, prefixed attributive uses allow the stress to shift away from the verb stem to the prefix, which is unstressed in the citation form or in sentence-final position. Confer example (17):

(17) *At night, feral dogs, rejected by families unable to feed them, roam the **únlit stréets**, occasionally savaging passers-by.* (*The Times* 1993)

Compounds involving the past participle usually carry their main stress on the first element even in their citation forms. There is thus no danger of a stress clash in sentences like (18):

(18) *The American company provides the tokens by which endless punters hope to get rich in the **néon-lit gámbling places** of Nevada.* (*The Times* 1993)

When past participles are premodified by adverbs, they form a close syntactic unit with the premodifier. In this type of constellation, the stress can shift onto the adverb, leaving the participle free to precede the noun without running the risk of creating a stress clash. The grave accent in example (19) marks this stress reduction:

(19) *As we zig zagged through the grid of streets linked by **póorly lìt álleys**, Peckham explained the workings of the criminal mind.* (*The Guardian* 1991)

Complex attributive structures break up the sequence of participle + noun as the participle is followed by an intervening second attributive element, adjoined to the first by *and* or *or*, or separated from it by a comma (indicating a pause). Consequently, there is little danger of a stress clash, as is shown in sentence (20):

(20) *After a time the juxtapositions of unrelated images in his brightly **lít, hallúcinatory páintings** lost their power to startle and unnerve.* (*The Times* 1994)

We have seen that all other than single unmodified attributive uses automatically contain more than one syllable within the attributive structure. Therefore, the final syllable of the attributive structure, preceding the (typically initially-stressed) noun, need never carry primary stress and a potential stress clash is prevented in one way or the other. As a consequence, the monosyllabic variant *lit* reaches levels beyond the 93% mark in all of these categories. What is more, its use is quasi-categorical in all but the prefixed uses, which are the closest to single attributive uses in structural terms and hence preserve a certain affinity with the disyllabic variant *lighted*.

Among the 86 single unmodified attributive examples in the corpus, there are only 12 deviations involving *lit* in prenominal position. Four out of these involve the combination *lít cigarétte*, where the noun is non-initially stressed, e.g. example (15c). Here, the use of the monosyllabic form is unproblematic and no stress clash occurs. Some of the other exceptions are explained by sentence prosody, which is superimposed on the syllabic rhythm. This case is exemplified in (15a), where *lit candle* appears in the body of the sentence and is accentually overshadowed by the following material carrying stronger stresses. Hence, the stress clash between *lit* and *candle* appears more tolerable.

In conclusion, the prosodic factor seems to be the strongest, if not *a fortiori* the only factor motivating the choice of *lit* or *lighted*: the minority variant *lighted* is used wherever there are no other means at hand to secure an alternating rhythm, since in this case, its second unstressed syllable assumes a buffer function. This is the case in single unmodified attributive uses. More complex attributive structures are less critical in terms of rhythm and are consistently associated with the monosyllabic variant *lit*. The distribution outlined above is not at all grammaticalized: there is no rule requiring the use of *lighted* in all attributive functions and the use of *lit* in all others. Instead, the selection of the variants is flexibly applied, depending on the prosodic structure of – what is known as – surface forms. This is attested by the discrepancy between single unmodified attributive uses and all attributive uses outside of these, which is motivated by rhythmic considerations rather than grammatical distinctions. Further corroboration for the productivity of this mechanism comes from the relatively frequent use of single unmodified *lit* before non-initially stressed lexemes like *cigarette*.

To come back to the implications of these results for a model of the grammar-phonology interface, the preceding analysis supplies further evidence for the claim that at least the morphological subcomponent has to be subject to phonological influences stronger than those admitted by Chomsky.[23] In section 3.1, we have seen that ideal syllable structure plays a role in determining the presence or absence of grammatical morphemes. Now we have witnessed a case in which the principle of rhythmic alternation exerts an influence on the selection of morphological variants. If phonological influences on the morphological module of grammar are problematic for the Chomskyan theory of language, such influences bearing on the core of the generative module, viz. syntax, will be even more of a problem. Two relevant phenomena will be investigated in the following section.

3.2.2. The attributive construction Det + *not* + Adj and negated sentence adverbs

The following study deals with two syntactic phenomena that I would argue – along with Bolinger (1980) – are impossible to explain without reference to phonology. Recognizing the difficulties of a purely syntactic account, Langendoen and Bever (1973) nevertheless try to explain within a generative framework why the derivation of *a not unhappy person* is possible, while the derivation of **a not happy person* is blocked. The two phrases are distinguished only by the presence and absence of the prefix *un-*. Langendoen and Bever fail to produce a convincing account for this, claiming that both constructions are ungrammatical, while only the first one is acceptable. Later articles dealing with the phenomenon, including Aitchison and Bailey (1979) and Langendoen's reply (1982), make reference to the morphological structure of lexemes like *unhappy*. They argue that the presence of a negative prefix is ultimately responsible for making their use in the construction Det + *not* + Adj + N acceptable.

In contrast to previous attempts, Bolinger (1980) claims that, in addition to certain semantic restrictions, the principle of rhythmic alternation provides the clue as to which adjectives can and which cannot be used in this kind of construction. He argues that the decisive factor is whether or not the initial syllable of the adjective following *not* is stressed: *not* itself is a stressed form, so that, if the subsequent adjective is initially stressed, a stress clash will result (cf. **a nót háppy person*); if, however, the subsequent adjective is non-initially stressed, there is no such problem (cf. *a nót unháppy person*). Thus, it is irrelevant whether the adjective contains a negative prefix or not, as long as its first syllable carries no stress.

A corpus study has been carried out to test the validity of the rhythmic criterion. The database consisted of five years of the British newspaper *The Times* (190 million words). Combinations of the most frequent determiners (*a*, *the*, *this*, *that*, *these*, *those*, *my*, *your*, *his*, *her*, *its*, *our*, and *their*) and the negator *not* were used as search strings and the adjectives following these strings were classified according to their rhythmic structure (initially stressed vs. non-initially stressed).[24]

The analysis revealed an additional factor that had an influence on the acceptability of the attributive construction Det + *not* + Adj, namely the presence of certain adverbs inserted between *not* and the adjective. Such intervening material was found in as much as 64% of all the relevant cases, thereby confirming the importance attached to it by Bolinger (1980: 57). For the effect produced by this factor, consider example (21):

(21) *But the news story had to take second place to a* ***nót very fúnny*** *joke built around a picture of the Queen coming out of an Oxfam shop.* (*The Times* 1992)

In the phrase *a not very funny joke*, the adverb *very* modifies the meaning of *funny*, but only weakly: it does not add anything substantial to the information value of the sentence. Importantly, semantic emptiness correlates with rhythmic backgrounding and de-stressing. Thus, *very* will be completely de-stressed in this context, so that it forms a rhythmic buffer between *not* and the adjective *funny*, which, bearing initial stress, would otherwise create a stress clash. The corpus yields a number of further adverbs that can take over the same buffer function as the rather frequent *very*. The list includes the items *all that*, *altogether*, *always*, *at all*, *entirely*, *especially*, *exactly*, *overly*, *particularly*, *quite*, *so* (very frequent), *terribly*, *too* (rather frequent), *wholly*, and many more. They all belong to the class of intensifiers or downtoners. Due to their semantic and syntactic dependency, even the longer adverbs in the list tend to receive only reduced stress. As in sentence (21), all cases with such intervening modifiers are therefore unproblematic in terms of rhythm. It actually seems that high-frequency elements with little semantic content like *so* (229 occurrences in the corpus examples), *too* (159 occurrences), and *very* (113 occurrences) are inserted in the construction by default for the sole purpose of avoiding a succession of two stressed syllables. By contrast, in instances where the adjective in the construction Det + *not* + Adj + N is premodified by an adverb that cannot be considered as an intensifier or downtoner inserted mainly for rhythmic purposes, a primary stress falls on the adverb itself. Hence, adverbs such as *unpleasantly* in example (22) were treated like the attributive adjectives in the count.

(22) *… which points Nagano seemed to acknowledge by adding the Valse des fleurs from Nutcracker as an encore but it accumulated a* ***nót unpléasantly*** *seasonal atmosphere.* (*The Times* 1994)

Of course, intervening material also appears with non-initially stressed adjectives, as in example (23). The most interesting cases are, however, those that have no intervening material. In these instances, a non-initially stressed adjective like *excessive* in (24) causes no problem:

(23) *There's a* ***nót altogèther succéssful*** *twist in the tale here, but it doesn't matter too much.* (*The Times* 1990)

(24) *Champagne has got such a bad press now that it is a relief to find a first-class vintage champagne, at a* ***nót-excéssive*** *price.* (*The Times* 1991)

This example also illustrates the fact that it is not the negative prefix that makes the construction acceptable: *excessive* does not have such a prefix. There are many more examples of this kind, e.g. *content*, *exceptional*, *excessive*, *invented*, *outrageous*, *overgenerous*, *over-helpful*, *overworked*, *superb*, *unique*, etc. What is more, many of these adjectives occurring in the construction Det + *not* + Adj + N do not at all possess a prefix productive in English lexical morphology. This empirical fact invalidates Langendoen and Bever's (1973), Aitchison and Bailey's (1979) and Langendoen's (1982) accounts of the phenomenon, since it disproves their premise that a negative suffix is essential for the acceptability of the construction.

Crucially, an initially stressed adjective preceded by *not* would inevitably produce a stress clash. Therefore, sentence (21) without the intervening *very* would not be possible. The hypothesis that is put to an empirical test is that all initially stressed adjectives (and adverbs) should be banned from the position directly following *not* unless they are preceded by an unstressed modifier. Non-initially stressed adjectives (and adverbs) on the other hand should be subject to no such constraint. Table 4 shows the results of the corpus analysis:

Table 4. The construction Det + *not* (+ Adv) + Adj + N in *The Times* for 1990–1994

	I		II		III
	without intervening adverb		with intervening adverb		total
	tokens	%	tokens	%	tokens
1 adjective (adverb) with initial stress	21	4%	539	96%	560
2 adjective (adverb) with non-initial stress	370	69%	166	31%	536
total of 1 and 2	391	36%	705	64%	1096

The categorization into initially stressed and non-initially stressed adjectives (adverbs) combined with the criterion 'with' or 'without intervening adverb' produces a very clear distribution: while the non-initially stressed adjectives occur without intervening material in 69% of all cases, intervening material seems to be practically obligatory for initially stressed adjectives: they are preceded by buffer elements in 96% of all cases. In the corpus there are very few exceptions, most of which can be explained away: eight of these are instances of the cricket term *not-out*, used attribu-

tively; another four are constructions with *quite*, e.g. *a not-quite minister*, *a not-quite-novelist*, etc., which can be considered as a different type; others can again be explained by overriding sentence prosody, e.g. example (25):

(25) *Alan Sugar, the* ***nót óbviously díffident*** *boss of Tottenham "what's the point of it all" Hotspur, goes into the Princess Grace hospital in London today for an operation on a shoulder he has dislocated.* (*The Times* 1994)

In this sentence, *obviously* is a sentence adverb rather than a modifier of *diffident*. Hence, it will be set off from the rest of the construction by flanking pauses, which at the same time separate the adjective *diffident* from the position following *not*, where it would be illicit due to the stress clash it would create. Possibly, the need to separate stressed syllables is the factor motivating the presence of the sentence adverb in this unusual position.

According to Bolinger, there are certain semantic restrictions additionally limiting the class of adjectives (and adverbs) that may appear in the construction under consideration. They license a "minus temporary degree adjective that is well off the center on the scale of intensification" (Bolinger 1980: 62). A superficial survey of the relevant adjectives (and adverbs) gathered from the corpus shows that these constraints are usually obeyed. However, some of the adjectives and adverbs quoted above do not pertain to the gradable class, e.g. *excessive*, *exceptional*, *invented*, *overgenerous*, *over-helpful*, *overworked*, *superb* and *unique*, which suggests that Bolinger's semantic criterion is not altogether unexceptionable. What is more, some exceptions involving adjectives and adverbs that fail to be gradable cluster around the prosodic exceptions that have initially stressed adjectives or adverbs. Consider examples (26) and (27):

(26) *Doomed ad of the week: a* ***nót léft-wing cúltured*** *Englishman wants to hear from the lady of his dreams …* (*The Times* 1993)

(27) *Stewart and Thorpe are the* ***nót-óut*** *batsmen and we have six wickets in hand, six hours of cricket to come.* (*The Times* 1994)

Sentence (26) contains a complex attributive structure whose syntax is excessively crammed as is common in personal ads; sentence (27) has an attributive use of a particle which is normally excluded from this function. Examples like these can be considered anomalous on semantic, syntactic and prosodic grounds. This fact underscores their exceptional status and in

turn corroborates the generality of the prosodic factor: rhythmic alternation can only be violated in instances which have to be considered marginal for independent reasons.

In conclusion, it seems that the violation of the principle of rhythmic alternation incurred by initially stressed items in attributive position negated by *not* is so offensive that a writer – and the same applies to a speaker – intending to use an initially stressed adjective has to resort to intervening modifiers in order to circumvent a stress clash which would make the construction ungrammatical. In contrast, all non-initially stressed adjectives (and adverbs) conforming to the semantic conditions are automatically licensed in this construction, regardless of their morphological structure.

Table 5 presents the results of a parallel study of the same corpus, employing the same corpus search strategy, with the only difference that, instead of the negator *not*, the negator *never* is chosen.

Table 5. The construction Det + *never* (+ Adv) + Adj + N in *The Times* for 1990–1994

	I without intervening adverb		II with intervening adverb		III total
	tokens	%	tokens	%	tokens
1 adjective (adverb) with initial stress	205	97%	7	3%	212
2 adjective (adverb) with non-initial stress	42	91%	4	9%	46
total of 1 and 2	247	96%	11	4%	258

This corpus search has been carried out only for the sake of comparison. No effect of rhythm was expected since *not* and *never* differ in one essential feature: the negative particle *never* has a second unstressed syllable. Thus, it never causes a stress clash with a following adjective. Compare example (28) with an initially stressed adjective and example (29) with a non-initially stressed one, both of which are unproblematic in terms of rhythm.

(28) *The second idea comes form the* ***néver símple*** *world of the Auto Windscreens Shield, formerly the Autoglass Trophy, for second and third division football clubs.* (*The Times* 1994)

(29) *Even the* ***néver-detérred*** *army of cigarette traders was missing.* (*The Times* 1994)

A look at Table 5 makes the difference to the construction involving *not* very obvious: initially stressed and initially unstressed adjectives behave practically the same. Furthermore, intervening modifiers are much less frequent as no rhythmic buffer element is needed. The importance of the principle of rhythmic alternation and its corollary, the avoidance of stress clashes, manifests itself all the more strikingly if we compare these results to those in Table 4.

The final study to be outlined in this section is concerned with a phenomenon which is closely akin to the construction Det + *not* + Adj + N. Langendoen (1982: 110) remarks that the negation of sentence adverbs by *not* is licensed only if the adverb is marked as [+ *not* ___] in the lexicon. I will, however, investigate the hypothesis that the decisive factor is the prosodic contour of the adverb: non-initially stressed adverbs should occur in this context unrestrictedly, whereas initially stressed ones should necessitate an intervening stress clash buffer. A corpus search was carried out recording all occurrences of *-ly*-adverbs directly or indirectly preceded by *not* and followed by a comma. Table 6 uses the categories familiar from Tables 4 and 5 and is based on the same newspaper corpus.

Table 6. Negated sentence adverbs in *The Times* for 1990–1994

	I without intervening adverb		II with intervening adverb		III total
	tokens	%	tokens	%	tokens
1 sentence adverb with initial stress	0	0%	11	100%	11
2 sentence adverb with non-initial stress	1635	98%	30	2%	1665
total of 1 and 2	1635	98%	41	2%	1676

A cross-check retrieving sentence adverbs without negation, such as *sadly* in example (30), shows that these are not subject to any rhythmic restrictions: initially stressed adverbs are as unproblematic as non-initially stressed ones.

(30) ***Sadly**, any of his best garden designs fell victim before he died in 1786 to the craze to make natural landscapes led by "Capability" Brown.* (*The Times* 1991)

However, the distribution in Table 6 shows that, if sentence adverbs are negated, the same restrictions apply as in the attributive construction

involving *not*: the negator is again a stressed element and produces a stress clash if followed by an initially stressed sentence adverb. Consequently, this construction does not occur even once in five years of *The Times*. By contrast, negated monosyllabic sentence adverbs do occur if they are premodified by a buffer element, as in example (31):

(31) ***Nót so sádly**, perhaps, Faber claims that the competition put £ 600,000 on net incremental sales.* (*The Times* 1993)

In the corpus, there are only 11 instances of this type, as opposed to 1665 of non-initially stressed adverbs, but this imbalance is mainly due to the extremely high frequency of *not surprisingly* (1435 instances). Even so, the discrepancy between the percentages of initially and non-initially stressed items in the database is unambiguous: conformity with the principle of rhythmic alternation seems to be a condition *sine qua non* for sentence adverbs negated by *not*.

Having investigated certain constructions involving negators followed by adjectives and adverbs, we may draw the following conclusion. The two uses of *not* followed by an attributive adjective or by a sentence adverb seem to be marginal to a certain degree: they are heavily restricted by the principle of rhythmic alternation, which has a great explanatory force in the given context. What is more, it seems to be the crucial determinant, making the use of items with one stress contour possible, but prohibiting the use of items with another stress contour. Any constellation not complying with this principle is virtually a knock-out context for the constructions discussed. We have thus witnessed a case in which the avoidance of stress clashes has repercussions in the domain of syntax proper: it is a phonological factor that exerts a decisive influence on acceptability. Such a conclusion is contrary to many claims made in the literature, especially in generative linguistics (cf. in particular Zwicky 1969; Zwicky and Pullum 1986; Pullum and Zwicky 1988). Bolinger (1980: 63) deduces from his intuitive findings, which have now been empirically confirmed on the basis of a large corpus, that the generative grammar of a language needs a phonological output filter, discarding certain sequences of morphemes generated by the syntax. This would preserve the autonomy of syntax to a certain degree, but it strengthens the role of phonology beyond that of a mere interpretive component assigning a phonological interpretation to whatever the syntactic component generates. In section 4, it will be argued that interactive activation models of language provide a more plausible way of accounting for phonological requirements imposed on grammar.

4. Chomsky's worst possible case and alternative theories of language

Though neurophysiological research is not yet very far advanced in the study of physiological processes underlying the productive and perceptive functions of language, some basic insights into the foundations of alternating patterns have been outlined in this article. Post-excitatory self-inhibition and post-inhibitory rebound are universal properties of all neural functions and presumably at the origin of alternating patterns at all levels of behaviour. Therefore, they belong to the universal conditions under which the human language faculty operates. The effects of two alternating patterns have been investigated in a number of corpus studies: Ideal syllable structure influences the presence of the *n*-ending in Middle English verbs and in the Modern English indefinite article, and the principle of rhythmic alternation plays a (sometimes decisive) role in the selection of mono- vs. disyllabic variants of past participles (e.g. *lit* vs. *lighted*) and in the grammaticality of certain marginal uses of negated adjectives and adverbs. Additionally, it has been shown that these tendencies are implemented with a high degree of flexibility: the presence of final *-n* in verb forms and in the indefinite article before <h> depends on the respective status and realization of the glottal fricative. Not every attributive participle of the verb *light* is realized in its disyllabic form, but mostly in such instances where it is unmodified itself and where it precedes an initially stressed noun. Initially stressed adjectives are not generally banned from the sequence Det + negator + Adj + N, but only if the negator happens to be a stressed monosyllable. Similarly, initially stressed adverbs are as a rule free to appear as sentence modifiers, with the only exception that they may not follow the stressed particle *not*.

These phenomena can only be given a plausible, unified account if phonological realizations are not subordinated to syntactic and morphological regularities, but interact with them in the determination of grammatical variation. The phonotactic and rhythmic shape of words and sequences of words has to be taken into account in the grammatical system proper. Hence, we can safely assume that the way language is phonologically implemented has repercussions on its grammar (both synchronically and diachronically).[25] Therefore, a theory of grammar aiming at descriptive adequacy must have a means of making morphosyntactic choices dependent on the phonological form of its output.

The question arises of how to accommodate these findings in a theory of language. As for generative grammar, it seems that Chomsky's "worst possible case" has become an empirically tested truth: his (1964) concept of

strict modularity and sequentiality is invalidated and his *Minimalist Program* (1995) needs to be heavily modified if it is to stand up to the claims of descriptive adequacy.

4.1. Interactive activation models

The advantage of these neurologically inspired models over rule- or constraint-based ones is their superior plausibility: they can be implemented on the basis of the potentials and limitations of real neural networks with comparable ease and come relatively close to actual processes in the brain.

Neural network models can be divided into serial-modular ones (distantly related to the Chomskyan componential grammar) and parallel-interactive ones (cf. Dell and Reich 1981: 611–612). In a serial model, different modules are distinguished that make use of different kinds of information and are ordered one after another. There is no temporal overlap between processing at two levels. Thus, the ready-made output of one level becomes the input of the next level and the latter can exert no influence on the former. In the parallel model, by contrast, all processing levels operate simultaneously, even if they are hierarchically ordered. Processing at a later level may begin before processing at an earlier one is completed and can influence the earlier level processes (cf. Berg 1998: 121). Given the empirical findings described in section 3, it is obvious that what is required to account for interactions between phonology and grammar is a parallel-interactive model of the type known as spreading-activation models and advocated, for example, by McClelland and Rumelhart (1981), McClelland (1987), Berg (1988, 1998), Berg and Schade (1982), Dell and Reich (1981), Lamb (1999), and MacKay (1986, 1987).

Parallel-interactive spreading-activation models tie up a number of loose ends from the previous discussion. For instance, the relevance of internal feedback can now be assessed: while in serial models, feedback is useless since decisions taken at previous levels cannot be reversed, in a parallel model it derives its *raison d'être* from the fact that decisions at the previous level are only preliminary and may still be subject to change (cf. Berg 1988: 207; 1998: 230–231). Moreover, the existence of internal feedback is precisely what necessitates the mechanism of self-inhibition to avoid reverberatory re-activation and thus indirectly underlies the alternating patterns observed in the structure of language (cf. MacKay 1987: 143).

The idea of competition is essential in a parallel-interactive network structure (cf. Berg 1998: 284; 1988: 157; McClelland and Rumelhart 1981: 378; Dell and Reich 1981: 625–627). In his outline of such a model, Berg comes to the following conclusion, which is quoted in full since it will prove pivotal for the remaining discussion:

> Owing to the connectivity of the system and the parallel information flow, many more elements are active than are eventually needed for production or comprehension. This is the system's strategy of homing in on the best solution. By more or less automatically activating many different elements, the system considers many different possibilities at the same time. The different degrees of activation of these possibilities correspond to the different 'qualities' of the hypotheses under consideration. A spin-off of parallelism and connectivity is competition in the processing system. Each utterance, whether perceived or produced, is the 'winner' in a struggle among various competitors of unequal strength. (Berg 1998: 284)

We can now use these concepts to explain the influence of phonological determinants on grammatical variation in English. Suppose a grammatical structure is being generated (i.e. activation spreads across all the nodes responsible for it). If the structure involves an infraction of the principles of ideal syllable structure or rhythmic alternation, part of the activation of the relevant nodes (the category recognizers for vowels, consonants, stressed and unstressed syllables) will be sapped due to self-inhibition. Consequently, the superior nodes receive less feedback and their activation level decreases. Crucially, if the grammatical structure under consideration has a direct competitor not involving this drawback, it will succumb to this competitor, which will ultimately be realized. Grammatical alternatives such as *be* and *been*, *a* and *an*, *lit* and *lighted* and adjectives and adverbs negated by *not* with or without buffer elements can be regarded as direct competitors. As the corpus studies show, their selection is indeed conditioned by phonotactic and rhythmic considerations. I will come back to the concept of competition in section 4.2.

Finally, note that in a layered neural network model it is not surprising that the lower systemic levels, i.e. those situated closer to the articulatory and auditory aspects of language, are more susceptible to phonological influences (cf. Berg 1998: 26): research in morphology frequently demonstrates the need to integrate phonotactic and prosodic parameters, and massive additional support comes from my corpus analyses presented in sections 3.1.1, 3.1.2 and 3.2.1. However, as section 3.2.2 demonstrates, the impact of phonology reaches more deeply into grammar, actually extending its influence to syntax proper.

4.2. Optimality Theory

Optimality Theory (McCarthy and Prince 1993; Prince and Smolensky 1993) offers an innovative concept of grammar which expressly models the interplay of quite diverse factors in the determination of linguistic output. It can be considered as a spin-off of traditional generative grammar, and Chomsky himself (1995: 222) seems not completely hostile to an optimality theoretic conception of phonological output conditions. But in principle, we are dealing here with a theory that claims to be modelling the structure of an entire grammar. Optimality Theory radically revises the generativist conception of the modularity and sequentiality of grammar emphasizing the optimality of the linguistic output.

The only two components recognized by Optimality Theory are Gen (for *generator*) and Eval (for *evaluator*). In the production of an utterance, Gen creates a set of candidate outputs on the basis of an input consisting minimally of words. The candidate set then enters Eval, which rates the well-formedness of each member of the set and selects the optimal candidate as the actual output. Eval consists of a hierarchy of constraints, which are provided by Universal Grammar and ranked on a language-specific basis. Crucially, the constraints contained in Eval are not mutually consistent. Therefore, the grammar embodies a device for resolving conflicts between constraints. For this function Prince and Smolensky (1993: 2) propose a "strict dominance hierarchy" in which the effect of every higher-ranked constraint has absolute priority over the effects of all lower-ranked constraints. In consequence, an optimal candidate output will be the one that least violates (or best satisfies) the hierarchical set of constraints defined for a particular language.

Although proponents of Optimality Theory disagree about the scope of this model, Prince and Smolensky (1993: 5) favour a conception in which Gen simultaneously produces all possible variants, which are evaluated in parallel by Eval. A logical extension of this purest form of Optimality Theory is that "there is a single constraint hierarchy, which internally ranks all constraints, whether syntactic, morphological, phonological, phonetic, or semantic. This possibility predicts interaction between components (modules)" (Archangeli 1997: 30).[26] If we accept this explanation, all problems arising from the multiple determination of linguistic outputs neatly dissolve, as the constraint hierarchy abolishes the idea of separate syntactic, morphological, phonological, etc. components. For example, particular syntactic constraints may be violated by higher-ranking phonological or morphological constraints, or vice versa.

To formalize the alternation patterns described in the empirical studies in section 3, three constraints may be appealed to that are well-known in the literature (Raffelsiefen 1996: 195, 198, 201; cf. also Plag 1999: 156; Kager 1994; Itô and Mester 1999: 189–199):

*VV: Adjacent vowels are prohibited.
*CLASH: Two adjacent stressed syllables are prohibited.
*LAPSE: Two adjacent stressless syllables are prohibited.

Additionally, we could posit a fourth constraint, militating against consonant clusters. This constraint will, however, be assigned a rank fairly low in the constraint hierarchy for English, since consonant clusters are largely tolerated by the language (cf. the quotation from Berg [1998: 79] in section 3.1).

*CC: Adjacent consonants are prohibited. (cf. Itô and Mester 1999: 199)

In conjunction, *VV and *CC promote ideal syllable structure, and *CLASH and *LAPSE implement the principle of rhythmic alternation. These constraints will need to be assigned ranks in the hierarchy that give them sufficient influence on the variation phenomena studied above.

The constraints posited in Optimality Theory are attractive in that they are considered to represent linguistic universals. Although standard Optimality Theory claims them to be part of the inborn Universal Grammar and thus not in need of further explanation, they may be reinterpreted as having a functional motivation, as proposed in Boersma (1998) and Haspelmath (1999). Thus, the concept of *optimality* can be understood in relation to the (neuro-)physiological and psychological preconditions of human language. Furthermore, the output orientation of Optimality Theory seems particularly propitious to phonotactic and prosodic requirements imposed on the phonological form of an utterance. Such conditions can hardly be assigned an appropriate place in a derivational model of grammar such as traditional generative grammar or even the *Minimalist Program*. Hence, Optimality Theory certainly has its merits as a theory of output requirements: it is apt to emancipate phonology from its status of an interpretive component and to conceptualize an interaction between phonological and other constraints.

Interestingly, Optimality Theory and the interactive activation models of language sketched in section 4.1 converge in numerous substantial aspects. Phonological constraints can be taken to define conditions of the

"articulatory bottleneck"; they state the effects of self-inhibition and self-priming of nodes in linguistic terms – albeit without reference to their physiological or psychological background. The competition between candidates with different degrees of optimality, which plays a central role in Optimality Theory, is paralleled by the competition between nodes described in the quotation from Berg (1998: 284) in the preceding section. As in Optimality Theory, neural networks are assumed to activate and evaluate many different candidate utterances in parallel. Reduced feedback, for example from self-inhibited phonological nodes, could represent a violation of a phonological constraint in Optimality Theory. Eventually, an optimality theoretic processing selects the candidate output which least violates the constraint hierarchy. This translates directly into the interactive activation network selecting the competitor which accumulates most activation, both from superordinate nodes and from subordinate ones via feedback.

Straightforward as this may seem, an optimality theoretic framework, however, raises certain expectations that are not fulfilled in empirical data such as those presented in section 3 of this paper. These centre primarily around the "strict dominance hierarchy" of constraints (Prince and Smolensky 1993: 2) – which is suspiciously devoid of a parallel in the neurolinguistic model. The insufficiencies of Optimality Theory become the more obvious the larger the empirical basis of phenomena that have to be accommodated in the theory. As limitations of space have forced me to restrict the discussion to four main phenomena, the following remarks will have to remain somewhat superficial and general. Yet, some proposals will be made to improve the design of the theory.

Note that Optimality Theory is deterministic, i.e. it predicts a unique output for every input, which can be unambiguously anticipated once the order of the constraints is known (cf. Guy 1997: 336). This characteristic weakens the theory as soon as corpus data, especially such from a single author, turn out to be variable. In the Chaucer corpus used in section 3.1.1, inconsistencies in the use of either *be* or *been* before consonantal, vocalic or <h>-onsets are anything but rare. Arguably, variation is a fundamental and systematic property of natural language and needs to be incorporated in an adequate model of grammar: "Insofar as usage statistics reflect grammatical constraints, such as sonority, stress and syllable structure, they reflect competence and should be explained by the theory of competence, … . Conversely, variable phenomena, including statistics, provide critical evidence for evaluating theories of competence". (Anttila and Cho 1998: 40)

A second problem, directly related to the first one, concerns diachronic change, for which variability is a necessary prerequisite. Taking up this challenge, Nagy and Reynolds (1995), Anttila (1997), Anttila and Cho (1998: 32–40), and Boersma (1998: 330–346) develop partial-ordering models of Optimality Theory that can include change, variation and usage statistics. While standard Optimality Theory requires that all constraints be totally ranked, they propose that two or more constraints may fail to be strictly ranked with respect to each other. This translates into a variable hierarchy which produces a variable output. Now the question arises of whether the theoretical construct of a constraint hierarchy is useful at all. As already mentioned, there is no anatomical or physiological parallel to a linear ordering. Rather, the successful competitor is identified in a network of interacting influences, all of which contribute their share to its activation level and to its eventual realization. Thus, the constraint hierarchy could profitably be replaced by a constraint network.

Finally, the strictly hierarchical constraint ranking of standard Optimality Theory runs into problems as soon as the perspective is widened to include a complete description of all grammatical sentences of a language. In many cases, English has to tolerate an infraction of ideal syllable structure or of the principle of rhythmic alternation because no alternative solutions are available. For instance, a constantly high rank of a constraint disfavouring stress clashes would disqualify an implausibly high proportion of candidate outputs in favour of a variant violating a host of lower-ranking constraints but satisfying the constraint *CLASH. To palliate this drawback, a quantification of constraint rankings as the one conceived in Guy (1997: 339–341) is proposed. Here, constraints are weighted according to their position in the hierarchy and the respective weights of all the constraints that a candidate output violates are added up. As a result, a candidate violating one important constraint, but satisfying many unimportant ones can nevertheless be selected. Thus, the modified model of Optimality Theory according to Guy (1997) comes closer to the additive treatment of incoming potentials in language processing in neural networks and possesses a greater descriptive adequacy.

5. Summary

The discussion in this paper has centred around a number of corpus analyses which testify to the importance of two phonological determinants of grammatical variation. Ideal syllable structure and the principle of

rhythmic alternation play a crucial, though frequently unrecognized role in the morphology and syntax of English. The examples that were chosen include the following:

1) the variable presence of the morpheme *-n* in Middle English verbs;
2) the selection of *a* or *an* before <h>-initial lexemes;
3) the choice of mono- or disyllabic past participles of irregular verbs; and
4) the acceptability of adjectives and adverbs negated by *not* in certain marginal uses.

It has been argued that the serial-modular model of grammar propagated by Chomsky (1964) and perpetuated in his *Minimalist Program* (1995) is inadequate. Chomsky's (1995: 223) cautiously expressed hopes to the effect that requirements of the sensorimotor apparatus exert no influence on the computational system C_{HL} have been falsified by empirical evidence.

The neurophysiological recovery cycle has been proposed as a possible explanation for the dominance of alternating patterns in human behaviour, including language. In the context of interactive activation models of language, this factor accounts for characteristic properties of empirically verifiable facts, such as the existence of self-inhibition, two-way interactions between higher and lower layers in a neural network model of language, competition between candidate utterances and the avoidance of variants violating the alternation of vowels and consonants or stressed and unstressed syllables.

Optimality Theory may be credited with the meritorious attempt to abandon the overly restrictive componential model of grammar and to lay more emphasis on the output (in other words, the phonological form) and the articulatory and auditory requirements imposed on it. Nevertheless, an essential feature of Optimality Theory, namely the strict dominance hierarchy of constraints, has incurred substantial criticism.

In conclusion, it has been shown that in certain respects Optimality Theory is not very distant from the interactive activation models developed by neuro- and psycholinguistics. Research in these areas is unfortunately not very far advanced, especially concerning higher-level determinants of grammatical variation. Even so, the paper has suggested that both linguistic and neurocognitive theory-building can profit from cross-fertilization between the two disciplines. What is more, empirical studies represent a relevant touchstone for linguistic theory (cf. also Hudson 1997), as they have the power of supporting or disproving claims derivable from any conception of the language system.

Notes

* The work on which this article is based is supported by the Deutsche Forschungsgemeinschaft (DFG, grant No. RO 2271/1–1). I also thank Donka Minkova and the editors of this volume for their helpful comments on a previous version of this paper.

1. Effects of the preference for rhythmic alternation are also observable at deeper levels of grammar, notably the lexicon: Lexical stress rules show a clearly discernible tendency to create alternating stress patterns around the primary stresses of lexemes, e.g. *húrricàne*, *Monòngahéla* (Chomsky and Halle 1968: 78, 114). Chomsky and Halle's stress rules are, however, restricted in domain to the word, and the authors admit that their description is not sufficiently general (Chomsky and Halle 1968: 117; cf. also Allen 1975: 80). The rhythmic effects to be investigated in this paper are exclusively located at the phrase level and thus beyond Chomsky and Halle's scope.
2. A hyperpolarization process deriving from a different source, but producing a similar effect to self-inhibition is inhibition from other neurons via inhibitory connections (cf. Berg and Schade 1992: 409; Lamb 1999: 219).
3. For the possible neurophysiological background of self-inhibition in nodes, see MacKay 1987: 145; for empirical support for the recovery cycle, see MacKay 1986: 177–183; 1987: 150–152.
4. Although this view is the one which is most frequently endorsed, it is far from uncontested; cf. Lamb (1999: 127), who favours a model with different phonological components for perception and production.
5. Note, however, that there is no such thing as a node representing the lexeme *understand*, another one representing the phoneme /n/, and yet another one representing the feature *apical*. Such formulations are simplifications since the information is merely stored in the interrelations of a node with other nodes (cf. Lamb 1999: 375).
6. Forced to elaborate on the binary contrast, we would probably have to use the concepts of sonority peaks versus sonority troughs rather than vowels versus consonants to allow for the numerous cases of syllabic consonants in English (cf. e.g. Ladefoged 1982: 222; Gimson 1994: 52). For the purpose of this paper, however, the consonant-vowel distinction will prove sufficient.
7. For this model to work it is not necessary to assume pairs of antagonistic nodes (one for vowels as opposed to one for consonants and one for stressed syllables as opposed to one for unstressed syllables respectively). It would be sufficient to postulate a node for the feature-bearing element only (e.g. one for the realization of a consonantal constriction and one for the realization of stress on a syllable). The characteristic phases of the recovery cycle (with self-inhibition and self-priming) will account for the preference for alternating patterns by themselves.
8. For comparable results concerning the phonotactically motivated distribution of possessive pronouns in several Early Modern English corpora, confer Schendl (1997), Busse (2000: 234–257) and Rohdenburg and Schlüter (2000: 469–478).
9. The subjunctive is generally obsolescent in Modern English. Note that the weak verb *say* now as of old uses the dental suffix to form its past participle.
10. Confer Dobson (1972: cxxxvii), who remarks on a version of the Early Middle English text of the *Ancrene Riwle*: "Infinitives normally retain *-n* before a vowel or *h* or *in pausa*, but lose it before a consonant."
11. In their prefaces, the editors of the Chaucer texts forming the basis of the electronic editions profess that they treated the spelling of original manuscripts conservatively. Yet

the reader should be warned that a random check of the first 200 occurrences of the forms of *be* in the electronic edition of the Hengwrt Manuscript of the *Canterbury Tales* (edited by Stubbs 2002) revealed that about 7% of the occurrences have been altered (i.e. *be* is found instead of *be(e)n* in the manuscript or vice versa). The changes are mostly, but not exclusively, in the direction of the hypothesis to be tested. Pending further research, it can be hoped that the findings reported in this section are so robust as to stand up to these limitations.

12. The bold print in the examples is my addition and is used to mark the focussed-on portions of the text.
13. A parallel account is provided by Minkova (2000), who interprets alternations between consonants and vowels as an effect of a filled-onset constraint, requiring all syllables to have an initial consonant. Accordingly, the examples in sentence (1) syllabify as /be.na/ and /be.wɪθ/.
14. Analyses denying the full consonantal status of /h/, for example the one presented in Ladefoged (1982: 33–34), are considered by Lass (1996: 133) to be "excentric".
15. Confer Minkova (2000: 512) for a similar conclusion concerning the variable presence of an epenthetic initial glottal stop in vowel-initial lexemes of Old English.
16. There are additional factors influencing the (non-)pronunciation of <h> which have not been controlled for in the present analysis due to the high number of examples. These include the degree of contextual givenness of the <h>-initial lexeme, the presence of (contrastive or other) accent, its general frequency, the string frequency for adjective-noun combinations, the speaker's age, register, linguistic affectations, and possibly some others.
17. The *OED (Oxford English Dictionary)* (s.v. *hegemony*) gives pronunciation variants with stress on either the first or the second syllable.
18. According to the *OED* (s.v. *hotel*), an old-fashioned British English variant of *hotel* has a mute <h> (like *hour*, *honour*, etc.); according to Cassidy and Hall (1991: 1126, s.v. *hotel*), Southern and Southern Midland varieties of American English have forms with stress on the first syllable.
18. Depending on the linguistic background of the researcher, the notion of *stress lapse* is variously defined as a sequence of two (cf. Kager 1993: 393; Raffelsiefen 1996; and Plag 1999: 156) or three (cf. Selkirk 1984: 49; Nespor and Vogel 1989: 83; and Kager 1995: 382) unstressed syllables. It is agreed that the presence of only one unstressed syllable separating two stressed ones represents an ideal constellation. The avoidance of sequences of more than one unstressed syllable is a matter of degree: two unstressed syllables will be avoided less strongly than three.
20. This empirical study is inspired by pertinent remarks drawn from several authors (e.g. Fijn van Draat 1912a: 27–39; Franz 1986: 166–168; Bolinger 1965: 145–147) concerning the distribution of mono- and disyllabic participial variants and subjects their mainly intuitive judgements to an empirical test.
21. Acute accents are used to indicate the location of the primary stresses. Further down in the presentation, grave accents mark secondary or reduced stress levels.
22. A count has revealed that 79% of the 1,000 most frequent nouns according to Francis and Kučera's (1982: 465–532) word list are initially stressed (or monosyllabic); if the token frequency of these lexemes is taken into consideration, the probability that a randomly chosen noun will be initially stressed rises to as much as 85%.
23. The choice of *lit* or *lighted* cannot be relegated to the Chomskyan (1995: 229) morphological subcomponent, as this component merely takes in word-like units (consisting of one or more morphemes) that are the output of the computational compo-

nent C_{HL}. C_{HL} itself draws on information stored in the lexicon, conceived of as a list of words and their idiosyncrasies. Thus, for the participle of *light*, the lexicon should supply the dominant irregular form *lit* and make an additional participle marker *-ed* superfluous. The morphological subcomponent is sensitive to the phonological shapes of the units it processes, but is not powerful enough to add new morphological material not present in the output of C_{HL}.

24. A few restrictions had to be made. Several constructions of the form *a not a* + Adj + N and of the form Det + *not quite as/so* + Adj + N were discounted as rhythmic alternation is secured by other means in these cases. Similarly, examples in which the adjective slot of the construction was filled by material from a different grammatical class (e.g. a noun as in *her not-cricket methods*) are discarded as idiosyncratic. However, the count includes cases with nominalized adjectives (e.g. *the not so sures*, *the not quite poor*, *the not so young*, etc.) as they seem to obey the same restrictions. Hyphens and spaces between the constituents of the construction are treated identically as they appear to be inserted or omitted subject to no recognizable convention.
25. The diachronic effects of ideal syllable structure and of the principle of rhythmic alternation on language evolution have only been hinted at in the discussions of synchronic distributions of grammatical variants. See Rohdenburg and Schlüter (2000) for a more detailed analysis of the diachronic dimension and Berg (1998: 285–293) for a psycholinguistic perspective on language variation and change in an interactive activation model.
26. Confer also the conclusions reached in Kager (1996), Kager and Zonneveld (1999) and Selkirk (2001), where the authors acknowledge the possibility that phonological constraints dominate morphological or syntactic ones and successfully base their analyses on such intermodular interactions.

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