GRAMMATICAL BOUNDARIES IN PHONOLOGY

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Abstract: This paper is divided into two main parts: (1) on grammatical boundaries in generative phonology, including an overview of boundaries in the phonology of French, and (2) which concentrates on the evidence for grammatical boundaries, and where both French and Danish examples are discussed. This bipartition is mainly made for expository reasons, and there is a considerable overlapping in the contents of the two sections.

1. Grammatical boundaries in generative phonology

1.1 Boundaries in relation to syntax

Within the transformational-generative paradigm questions like the following are central for the discussion of boundaries: By which convention(s) are boundaries inserted? Are they inserted on the basis of the syntactic surface structure alone (possibly in the readjustment component), or does the insertion of boundaries depend on information which is available only on deeper syntactic levels? If the latter is the case, are the boundaries moved (by movement-transformations) together with the material they delimit, or are they left behind? How are the boundaries affected by the readjustment rules? I shall not try to discuss these and similar questions here (let alone try to answer them), since this approach implies the serious danger

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of over-axiomatising empirical issues (cf. Derwing 1973, Linell 1974). I.e., so long as the theory of transformational-generative grammar is not more well-established empirically than seems to be the case for the moment, the answers to the questions raised in this paragraph must remain equally uncertain. It seems wiser to me to take an alternative point of departure as mentioned below.

1.2 Boundaries in relation to phonology

1.2.1 Inventory of boundaries

According to the principle of 'Occam's razor', no more structure should be postulated than is necessary to account for the observed data. Concerning boundaries, the 'null-hypothesis' which, accordingly, should be tried before we move to more complex hypotheses, is that no grammatical boundaries are phonologically relevant. Each proposed distinction in boundaries (i.e. each new boundary type introduced) must be separately justified on purely phonological grounds.

1.2.2 Function of boundaries in phonological rules

According to Chomsky/Halle 1968, boundaries are units (in the phonological string) which are cross-classified by distinctive features (viz. the features [word boundary (WB)] and [formative boundary (FB)]). In addition to # ([+WB, -FB]) and + ([−WB, +FB]), they operate with a = ([−WB, −FB]), a boundary

1) Furthermore, the use of syntactic surface structure (SS) in phonology also implies the danger of circularity, since facts of pronunciation (e.g. intonation and stress) are sometimes used as clues for SS.

2) Thus I do not accept an argument like the following: We can define a large number of different boundary types on grammatical grounds, and each of these boundaries is potentially a phonologically relevant boundary which can be used at will (without any 'cost', i.e. added complexity) by the phonological component, since the input to phonology is the syntactic component (possibly via the readjustment component).
the postulation of which has been (justly) criticized from many sides (apparently Chomsky/Halle do not consider the possibility of a boundary [+WB, +FB]). If a specific boundary is mentioned in the SD of a phonological rule, it only applies to strings containing the mentioned boundary at the indicated place. Apart from that, all occurrences of + in the input string to a rule are irrelevant for the application of the rule, whereas all occurrences of #, on the other hand, block its application (unless, of course, a # is included in the SD at the appropriate place).

McCawley 1968, in contradistinction to Chomsky/Halle 1968, proposes that boundaries be (linearly) ordered in a strength-hierarchy. The main function of boundaries is, according to him, that they serve to define the domain of rules. Thus, each phonological rule has a certain boundary as its "rank", and each occurrence of a boundary of this rank as well as of a stronger one serves to delimit (on one side) the extension of each chunk to be compared with the SD of the phonological rule. This has become known as the ranking function of boundaries. I think it is more or less agreed today that McCawley's hierarchical model of boundaries is superior to the SPE-model.

Stanley 1973 distinguishes between three functions of boundaries with respect to phonological rules: (1) rules ranked by a certain boundary (or stronger ones), i.e. the function proposed by McCawley; (2) rules delineated by a certain boundary (or stronger ones), e.g. the rule which devoices final obstruents in German; and (3) rules requiring a specific boundary in their SD. Stanley furthermore argues that if rules are formulated by means of variables, e.g. the mentioned final devoicing rule not as: [-son] → [-voi] / # but instead as: X [-son] RANK: # ↓ [-voi]

(where X indicates that segments may occur at the left-hand side
of the environment and, consequently, the lack of a variable to the right of [-son] indicates that the obstruent must be final in the relevant chain [---#], then (1) and (2) above reduce to one type. (According to the conventions of Chomsky/Halle, on the other hand, rules of type (2) reduce to type (3), since stronger boundaries than # are symbolized by a sequence of #'s; the SD [-son]# is thus also satisfied by [-son]# # etc.)

The examples adduced as support for Stanley's type (3), i.e. rules requiring a specific boundary in their SD, seem dubious to me: they are mostly taken from the analysis of English stress and vowel shift by Chomsky/Halle, and their account of these phenomena seems dubious by any standard. Thus, it may be concluded that the only well-established function (or at least the central function) of boundaries is ranking, presupposing, as already mentioned, that variables are used in the notation of phonological rules, in the way suggested by Stanley.

1.3 An example: boundaries in French phonology

1.3.1 Inter-word boundaries

The 'null-hypothesis' concerning inter-word boundaries, i.e. that no inter-word boundaries are phonologically relevant, has never, to my knowledge, been seriously proposed. Nor have other very simple hypotheses, e.g. that all inter-word boundaries have the same phonological effect.

Selkirk (1972) found a distinction between two types of inter-word boundaries which she (following Chomsky/Halle 1968) formulated as # (separating words in a 'liaison-context'; they may be called 'weak word-boundaries') and # #(separating words in a 'non-liaison context'; they may be called 'strong word-boundaries'). She found that the notion 'liaison-context' was relevant for the application of several phonological rules. (I shall not discuss her evidence here.)
Selkirk viewed her results as a striking support of the basic claims by Chomsky/Halle concerning boundaries, in the following two respects: (1) There is (in French) only a distinction between # and -=#, which follows from Chomsky/Halle's principles of #-insertion (where # is inserted on both sides of a major lexical category, i.e. N, V and A, and on both sides of categories dominating a major lexical category), together with their principles of reduction of sequences of #''s longer than two. (2) She found, in agreement with the principles of Chomsky/Halle, that there was never more than one # between a non-major lexical category and an adjacent major lexical category belonging to the same phrase, e.g. between a preposition and a following noun in a prepositional phrase, or between an article and a following noun in an NP. In order to account for the liaison-phenomena which are highly dependent on style level (briefly: the higher the style, the more instances of liaison), she had to introduce a number of rules with the effect of reducing # # to # # in a given style, under certain grammatical conditions. E.g. the sentence le petit homme prend un instrument affreux is in labelled bracketing notation:

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S [ [ le [ petit ] [ homme ] ] [[ prend ] [ un [ instrument ] [ affreux ] ] ] ]
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It receives the following boundary structure (in two tempi) according to the Chomsky/Halle principles (taken over by Selkirk):

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# # le # petit # # homm # # # prend # # un # instrument # # affreux # # # #

# # # #
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In casual style, a rule reduces # # to # between an A and a following N in an NP (i.e. petit # # homme -> petit # homme);
in higher styles, # # is reduced to # also between V and NP in a VP (i.e. prend # #un → prend # un); only in a very high style, however, is # # reduced to # also between an N and a following A in an NP (i.e. instrument # #affreux → instrument # affreux) (these facts of pronunciation can be found in most traditional textbooks, by Grammont and others).

I have three observations to make on this issue:
(1) Selkirk's evidence, of course, does not at all concern the specific two-step derivation of boundaries by Chomsky/Halle (cf. Wurzel's (1970) alternative one-step derivation, containing features taken over from Bierwisch 1966). It only concerns the general claim that not more than two different types of sentence-internal inter-word boundaries may occur. (2) According to Chomsky/Halle/Selkirk it should be completely excluded, in any level of style, that # # could occur between an adverb in their theory belonging to a non-major lexical category, and the adjective (or participle) it modifies. This is true of très (très aimable has obligatory liaison, cf. the old spelling convention très-aimable), but in casual spoken French there need not always be liaison after bien (bien évident), and after beaucoup liaison is quite often not made (beaucoup aimé).
(3) According to several investigations of "word-reduction"-phenomena (e.g. by Wolfgang Dressler and Håkon Eriksson, cf. Linell 1974, p. 67 ff (with references)), it appears generally to be the case that the more casual or "reduced" the style level becomes, the more grammatical boundaries lose their effect. But in Selkirk's framework, exactly the opposite is the case: the higher and more distinct the level of style becomes, the more instances of # # are reduced to #. This problem will be taken up in section 2.5 below.

The sentence boundary can be phonologically relevant also in French, as discussed by Dell (1973). I propose the notation # # # for a sentence boundary, in agreement with the notations # # and # for strong and weak sentence-internal inter-word
boundaries, respectively. This notation directly shows the rank of the sentence boundary (cf. section 1.2 above); and according to the Chomsky/Halle conventions it codifies the hypothesis that a process taking place before a word-boundary also applies if the word is sentence-final, whereas a process taking place only sentence-finally does not apply word-finally if the word occurs in the middle of the sentence.

1.3.2 Intra-word boundaries

The 'null-hypothesis' can be easily dismissed. Dell 1973 uses the plus sign (+, i.e. 'morpheme boundary') for all word-internal boundaries, and no others. If this use of + is considered to be an automatic consequence of the definition of +, it is of course empirically vacuous and hence infalsifiable. But if, on the other hand, it is considered to be a testable hypothesis, it can be rephrased like this: "all word-internal boundaries have the same phonological effect, and this differs from the effect of all inter-word boundaries". This interesting hypothesis cannot stand up to the testing (see below).

Lisa Selkirk (1972) operates with a word-internal boundary =, in addition to +. = is supposed to occur between prefixes like in-, con- and learned stems, thus accounting for the dropping, she suggests, of the prefix-final nasal before stems beginning with a sonorant consonant, e.g. illégal, commémoratif. I find this use of = no better motivated than the similar use of = in English by Chomsky/Halle, since these learned formations are predictable, by the very fact that the stem is [+savant], a categorization which is needed anyhow to account for a lot of learned morphology in French (and to introduce the boundary =!), cf. native words like immangeable [ɪmæʒabl].

In a forthcoming paper, I have discussed word-internal grammatical boundaries in French extensively. In the present paper, I shall therefore limit myself to a brief summary, and refer the reader to Basbøll forthcoming for further discussion and documentation.
I propose a distinction between two types of word-internal grammatical boundaries in French, which can be symbolized by + and #, respectively. + is considered irrelevant for the application of phonological rules proper (as a consequence, no phonological rule contains a + in its SD). + may be relevant only for principles of structuring the phonological chain, i.e. for morpheme structure conditions and for principles of phonological syllabification. #, on the other hand, can block certain phonological rules (see below), and, as the notation implies, the word-internal occurrences of # have the same phonological effects as the # occurring between words in a 'liaison-context', as will be further clarified below.

The principles predicting the occurrence of # vs. + are: # occurs after prefixes and before the (obstruent) endings /z/ and /t/. (/t/ is the 3rd ps. ending, and /z/ the non-third (i.e. 1st and 2nd) ps. ending, as well as the plural ending in nouns, adjectives etc.; these endings can thus be defined grammatically, and the phonological characterization is probably only to be considered a short-hand device, cf. Basbøll forthcoming. It should not be excluded a priori, however, that an obstruent can more easily be separated phonologically from the rest of the word.) + occurs before (other) suffixes. # occurs after proclitics and before enclitics, except that there is only a + before an enclitic subject pronoun. This can be (informally) abbreviated in the following formula for a 'major phonological word' in French (see below) - the notation presupposes that none of the # -reduction rules (# # → # in a given style under certain grammatical conditions) proposed by Selkirk (see section 1.3.1 above) have been applied:

# #(proclitic#)ₜ (prefix#)ₜ stem (+suffix)ₒ (#\{z\₁ \})ₜ \{(+#enclitic subject) \} # (# #)ₜ (# #enclitic non-subj.)ₒ
(o means that the content of ( ) is present zero, one or more times.) - The formula is slightly inaccurate in one respect: a form like parlé-je, which is # #parl+e # z # ʒe # # (I argue in Basbøll forthcoming that the personal ending /z/ should be present in the underlying form (and later be deleted by the truncation rule), but whether this claim is true or not, is completely irrelevant in the present context) immediately after the application of subject-clitic-inversion (which is, according to Kayne, a syntactic transformation distinct from the other clitic movement transformations), is converted into # #parl+e+z+ʒe # #, i.e. all internal # 's are reduced to + in such forms, cf. Basbøll forthcoming.

This model should be interpreted in relative (as opposed to absolute) terms: it predicts e.g. that there is a stronger boundary between prefix and stem than between stem and suffix, and, in parallel fashion, that there is a stronger boundary between a verb and an encliticized object pronoun, compared to an encliticized subject pronoun. E.g. in most styles a stem-final high vowel is desyllabified before a suffix beginning with a vowel (e.g. niant, maniaque [ŋjä, manjak]), but not a prefix-final high vowel before a stem beginning with a vowel (e.g. antiatomique, biannual [ætiatomik, bianjuɛl], not *[ätiatomik, bianjuɛl]); and there are no styles which permit glide formation in the latter but not in the former case. Similarly, in many styles there is vowel harmony between a stem and a suffix (under certain phonological conditions), e.g. cédant [sedã, sedã], but not between a prefix and a stem (under identical phonological conditions), e.g. prétend [pɛtetã], not *[pɛtetã]; and there are no styles which permit vowel harmony in the latter but not in the former case. This offers evidence for the stronger boundary between prefix and stem compared to stem and suffix. But it does not, of course, exclude that in much more reduced styles there can be glide formation and vowel harmony in all the situations mentioned.
Our parallel treatment of prefixes and proclitic "words" is supported e.g. by the identical treatment of *en* in both functions, compare *enivrer*, *en avril* [ānīvrs, ānāvrs], *emmener*, *en Mauritanie* [āmns, āmowrsːni].

The independent status of the endings */z*/ and */t*/ is shown by the fact that the part of the word before these endings is in all respects treated as if it occurred independently, e.g. with respect to schwa-treatment and stress. One may also refer to the pronunciation [zami] (in non-standard French) for *amis* which suggests that */z*/ is reanalysed as a plural-prefix. Finally, a great simplification of French verb morphology is obtained by the proposed analysis.

The particularly tight connexion between a verb and an encliticized subject pronoun is indicated by the following facts: (1) */ə*/ is regularly deleted in *-je*, *-ce*, etc. (*suis*-je, *est*-ce [suːiːʒ, ēs], etc.), whereas it bears the word-stress and is never deleted in e.g. *prends*-le, *sur ce*, *parce que* and others. (2) Vowel harmony may occur, even in relatively high styles (acceptable to Grammont!) in *est-il*, *es-tu* [etːil, etːy], but only if the enclitic is subject. (3) The distinction between */e/, *ε/, */a*/ is always neutralized in favour of *ε* in phonologically closed syllables (a notion which is defined in Basbøll forthcoming). If the vowel is immediately followed by *, the syllable is never (phonologically) closed. Thus there is neutralization in favour of *ε* in *parlé*-je (près.), *parlai*-je (ps. simple), *parlais*-je (impft.), all pronounced [pærːɛːʒ] (with vowel length conditioned by the following homosyllabic *ʒ*, which agrees well with the hypothesis that *je* is treated as a suffix); on the other hand, */ə*/ is kept as */ə*/ in *parles*, *parlent*, */parl+ə* ≠ */z*, */parl+ə* ≠ */t*/.
1.3.3 Ranking of some French phonological rules

The boundaries discussed here, i.e. the sentence boundary \# \# \#, the strong word boundary \# \#, the weak word boundary (identical to the strong word-internal boundary) \#, and the morpheme boundary (i.e. the weak (or irrelevant) word-internal boundary) +, define four possible ranks of phonological rules (principles of structuring, in the case of +) in French.

A fifth boundary, of a different type, is the syllable boundary $ (cf. Basbøll 1974). Thus we have established five possible ranks, each defining the extension of a phonological chain which can serve as the domain for phonological processes. Below I shall enumerate these five phonological chains and in each case mention one or more processes which can apply to the chains in question. As mentioned in section 1.3.2 above, increasing "word-reduction" implies that more and more processes apply to longer and longer chains (corresponding to a decreasing effect of the boundaries in question). This phenomenon is disregarded in the following, where we only consider a rather distinct level of style (with a high degree of segmentalization, cf. Linell 1974, p. 66 ff).

1. 'Phonological sentence'. Rules of rank \# \# \#: phenomena in the beginning and end of (phonological) sentences, concerning schwa-dropping (cf. Dell 1973); in lower levels of style, certain "word-reductions" (such as assimilations) apply with the phonological sentence as their domain.

2. 'Major phonological word'. Rules of rank \# \#: liaison and stress ('accent du syntagme'); the 'major phonological word' includes pro- and enclitics.

3. 'Minor phonological word'. Rules of rank \#: word stress, vowel harmony and glide formation. 'Minor phonological words' are the parts of the 'major phonological words', e.g. 'bound pronouns' (except encliticized subjects) and particles,
but also, according to the present definition, prefixes and the endings /z/ and /t/ (and the rest when all these morphemes are subtracted from the 'major phonological word', viz. a stem or a stem plus suffix(es)).

(4) The morpheme (or formative). There are no phonological rules proper of the rank +, but morpheme structure conditions (MSC) have + as their rank. It should be emphasized, however, that MSC are "abstract rules" and thus of dubious (psychological) relevance. (The principles of phonological syllabification (as proposed in Basbøll forthcoming) have # as their rank, but under very restricted conditions they pay attention to a + in their structural description.)

(5) The syllable. Rule of rank $: "closed syllable adjustment", i.e. the neutralization of /e, e, e/ in phonologically closed syllables in favour of e. On more concrete levels, the syllable seems to play an even more important role (cf., e.g., Schane 1973, p. 52 ff). It may be added that phonetic syllables represent a structuring of the linguistic expression (Hjelmslev's term) so that it becomes easier to en- and decode (whereas grammatical boundaries merely represent a projection of higher level information onto the sound chain).

These ranks seem to occur frequently in other languages, and it might be possible to identify them on a cross-linguistic basis, including their function as domain for rules. E.g. the 'phonological sentence' may be defined as the maximal domain for rules, and the 'minor phonological word' as the minimal domain of phonological rules proper, disregarding the syllable which can be defined on independent grounds. The 'major phonological word' can then be characterized by means of its relative position in between the 'phonological sentence' and the 'minor phonological word'. The morpheme (or formative), just like the syllable, can be defined independently of its function as a rule domain. Let me finally mention that the
notions 'pro- and enclisis' seem to be relevant in many languages, and they follow in a natural way from the use of ranks discussed here.

Note that the rules mentioned under (1), (2) and (3) above represent productive processes, not abstract morphemic relationships.

2. Evidence for grammatical boundaries in phonology

2.1 Descriptive convenience

If the postulation of a given grammatical boundary only serves to define the domain of one rule it is, of course, circular. But if several rules require the same boundary structure, which furthermore does not complicate the description of any other rules, then a simplification of description can be obtained by using boundaries (as in the French example). Notice that this "simplicity" argument makes no claims as to psychological reality of the boundaries in question.

Within the generative paradigm, it would be considered very important whether the boundaries postulated are part of a universally proposed inventory, and, more generally, whether the principles of boundary structure follow (at least in part) from 'linguistic theory'. Thus it would not be considered circular, within this paradigm, to operate with a grammatical boundary which only had an effect on one phonological rule, if the occurrence (and location) of this boundary could be predicted from the theory (boundaries should not be postulated on the basis of phonological criteria alone, i.e. in the absence of any syntactic-semantic evidence for some sign boundary at the given location).
2.2 Independent definability of the boundaries

In the case of French, the boundaries can be defined independently of their phonological impact (which motivated the phonological use of the boundaries in the first place); this definition, furthermore, does not presuppose knowledge of individual lexical items: it only refers to notions like 'prefix, suffix, subject (and possibly obstruent)'. These notions are probably learnable (cf. Derwing).

2.3 Speculations on linguistic evidence of a non-phonological kind

In French, prefixes seem to be phonologically more independent of the stem than suffixes. This may be related to the following observations: (1) prefixes (in French) often appear to have more content than suffixes, (2) suffixes typically change the word-class of the stem (while not affecting the meaning of the stem), in contradistinction to prefixes, (3) prefixes are often lexically identical to separate words (e.g. par, pour, de, à), in contradistinction to suffixes.

There is a distinction between *il y a* meaning 'he (etc.) has there' and 'there is', respectively: [i i a] (*son argent, à la banque*) vs. [i i j a] (*du monde ici*). This difference in pronunciation agrees with an analysis of the former case as *(il #) y #a*, where *y* is an independent word, meaning 'there' (standing for "à+PRO" under certain conditions), and where any other combination of subject-verb might have occurred instead. In the second case I suggest an analysis *(il+)y+a*, in agreement with the completely frozen behaviour syntactically and semantically, cf. that *il y a* is often referred to as a 'particle' (in agreement with its lack of declinability in number and person).
2.4 Manifestation of boundaries

Another point is that # # and # # # are probably potential pauses. This raises the further question whether all boundaries can be manifested (in a more direct way than by their impact on phonological rules like those mentioned above). If certain quantity- (and other, e.g. \( F_0 \) or intensity) relations obtain in respect to boundaries, this may 'count' (for the language user) as 'manifestation (of the boundary)'. This important issue is very much open. I thus do not agree with the (somewhat unclear) claim of Chomsky/Halle and others that all grammatical boundaries must be erased at the end of the phonological component: If the phonological component (in this context) is meant to exclude 'phonetic detail-rules', then all boundaries cannot be erased at the end of the phonological component since the phonetic detail rules undoubtedly presuppose the boundaries for their correct specification of the phonetic output (e.g. as to the quantity of initial vs. final allophones). If phonetic detail rules are included in the phonological component, on the other hand, it is hard to see that the output of this component could be the mentally relevant phonetic structure, since we do not generally perceive the mentioned quantity relations as such, but instead use this information to structure the sound chain. (A quite different problem here is the distinction between languages like French and German, where phonetic syllabification is highly dependent on word boundaries in German but not in French. This distinction might be easier accounted for if word boundaries are erased at different levels in French and German, but this is, of course, highly speculative.)
2.5 Psychological reality of boundaries

Psychological reality of phonological constructs is no well-defined property: it has several 'layers', and the question can be approached by different means which need not give uniform results (cf. Linell 1974 with references). The general problem cannot be dealt with here. Concerning boundaries, one aspect of the question is the analyzability of complex forms which might be revealed by means of psychological tests.

As already mentioned, there is a formal distinction between the function of boundaries with respect to level of style pointed out in section 1.3.1 above, viz. that # # are reduced to # in higher styles according to Selkirk's description of liaison, whereas word reductions (belonging to lower style levels) normally become more and more radical when boundaries are weakened (or erased). It is common for liaison and word reduction that absence of segments belongs to lower (as opposed to higher) styles. It is also common for liaison and word reduction that application of the rule belongs to lower (as opposed to higher) styles, which seems to be the normal case for optional rules (in agreement with the diachronic fact that people who do not have a "new" pronunciation generally find it "vulgar"). Thus, what is common to the two cases has to do with the process of "reduction", not with the environment in which it occurs. The formal distinction can be reduced to the fact that the # -reduction rule in a case like C # # V → C # V bleeds the truncation rule which applies to C # # (and to C # C), but not to C # V (whereas a boundary deletion will normally feed other rules). The psychological relevancy of this observation is not clear, but the possibility should be examined that the optional phonological rules (in casu: truncation (i.e. non-liaison) as well as word reduction processes) are more relevant psychologically than # -reduction rules of the type proposed by Selkirk. This seems rather plausible to me.
Below, I shall briefly discuss some Danish examples from the standpoint of productivity, and furthermore mention data from sound change and optional rules which appear to suggest the reality of some but not all intra-word grammatical boundaries.

2.6 An example: some suggested evidence for some grammatical boundaries in Danish phonology

2.6.1 The distinction between # and ##

In Danish (like in French) there seems to be a distinction between "strong" and "weak" word boundaries (which can be symbolized by # # and #, respectively). 'Minor phonological words' are pro- and encliticized, i.e. become members of a 'major phonological word', e.g. på # gåden, gør # det (there even exists a particular encliticized form of det, viz. [əð] (together with [de]) with special stødconditions, cf. gør det [gɔrdə, gɔrdø, gɔrdəð]). That enclitics behave like parts of the major phonological word, not only with respect to stress, is shown by the optional rule (in conservative Danish) gd → xd: fægt, kog+t, skæg # t, fik # det [fɛg/xd, kʌg/xt, sɡɛ?g/xd, fɛg/xdə], which never applies across # #; i.e., the only inter-word boundaries which allow the rule to apply before them, are the boundaries before enclitics. The distinction between # # and # will not be considered any further here (notice that it is difficult to use intonation and stress as direct evidence for this distinction, since these suprasegmental phenomena may be directly dependent upon the syntactic structure, without the use of grammatical boundaries; cf. Rischel's demonstration (1972) that compound stress can be deduced from the syntactic surface structure without any "cycle").
2.6.2 The distinction between + and #

(i) Preliminaries

With respect to stress, there is a distinction between compound stress (i.e. the normal stress pattern of compounds and of derived words with a heavy native suffix like -hed, -dom, -skab) and non-compound stress (the elsewhere case). If compound stress must be assigned in terms of boundaries, an additional boundary (which does not, of course, explain anything) should be set up for this purpose. I leave this issue open here.

Throughout this discussion, we have presupposed the location of all sign boundaries known, and this is, of course, an oversimplification. Within the present framework where the distinction between + and # is supposed to represent the distinction between a phonologically irrelevant and relevant boundary, respectively, this problem is not too serious, since the dubious sign boundaries (if they are recognized at all) will generally be instances of + (i.e. phonologically irrelevant).

(ii) Examples of the proposed boundary structure

I suggest that the boundary # occurs e.g.: (1) before stems (i.e. between the parts of a compound, and between a prefix and the stem, e.g. sól # skin, úd # qâ, be # vîse); (2) before (primary or secondary) stressed native suffixes, e.g. ven # ïnde, dûm # hêd (before the primary-stressed suffix inde, certain conservative varieties of Danish only seem to have +, cf. lererinde [lɛ(:)ʌðnə, lɛ(:)ʌðnə]; before secondary-stressed suffixes, which are always native, # appears to be obligatory); (3) before certain obstruent endings, like /t/ (neuter) and /s/ (genitive).
On the other hand, the boundary + occurs e.g.:

1. before foreign stressed suffixes like åt, i, ist, isse (e.g. lektorat, perfidi, kontorist, abbedisse);
2. before unstressed native suffixes like sel, ne (inchoative), me, re (iterative) (e.g. fødsel, gulne, fedme, bladre);
3. before certain obstruent endings like /t/ (substantivizing).

(iii) Some descriptive evidence

The syllable boundary between two vowels (with intermediate consonants) belonging to different morphemes always occurs at the morpheme boundary if it is #, but not necessarily if it is + (in that case the location of $ depends on the sequence of segments). All rules having the syllable as their domain (cf. Basbøll 1974) thus support the different "phonological strength" of the proposed boundaries.

The case of long vowels occurring before a hetero-morphemic cluster in conservative standard Danish are highly restricted (cf. Brink/Lund forthcoming). Our proposed boundary structure restricts this occurrence to $C \neq C$-sequences (furthermore there are a handful of isolated roots with $VCC$, but there are heavy restrictions on the clusters allowed).

According to Rischel 1970, forms with the ending /t/ either undergo both vowel shortening and consonant gradation (e.g. jagt, stift; cf. jage, stiv), or none of them (e.g. vagt, adj., lavt; cf. vag, lav, adj.). He proposes that the mentioned processes constitute "one complex rule" (although its two "parts" have no intrinsic connection). Within the present framework vagt, adj.: jagt, sb. are vag $\neq t$, jag+t, and both rules (i.e. vowel shortening and consonant gradation) are of the rank #. vag $\neq t$ [væː?yd] is treated as vag [væː?y], and jag+t [jagd] as a monomorphemic word like tragt [tʁɔːgd].
(iv) Productivity

The natural psychological interpretation of the proposed distinction jag+t : vag#t (adj.) is that the latter is formed productively from vag plus t, whereas the former is stored as a unit (this does not exclude that the language user may be able to perceive the morphological relationship between jage and jagt, but it suggests that the relation is an abstract one). Notice that the neuter /t/ is a productive ending in the linguistic sense, i.e. it can be added to recent loanwords (and to constructed nonsense-words). The substantivizing ending /t/, on the other hand, is unproductive, and the relation between the morphological pairs in question is often not transparent, or at least not unambiguous (both semantically and phonologically), e.g. grave 'dig' : grøft 'ditch', skrive 'write' : skrift 'writing' (although a certain relatedness of sense may be felt in such cases, the nouns in question must generally be considered lexicalized on purely semantic grounds, cf. below).

Productivity is thus a complex phenomenon, and the term 'productive' has been used in different senses. In the following I try to illustrate some different aspects of 'productivity', but I do not know to which degree they ought to be split up or coalesced, i.e., I do not claim that the different aspects below suggest a natural logical system.

When we consider the nature of the linguistic process, e.g. in a psycho-linguistic test situation, we may ask: Is the free form XY (where X and Y are morphemes belonging to the same word) formed productively by the speaker in the given situation, e.g. is the form XY in a concrete test situation formed productively or taken directly from the 'lexicon'? There is hardly any doubt that this question can be investigated empirically, e.g. if the ending Y can be adjoined to constructed nonsense-words, then it is productive, in this sense, at least in the test situation.

If the ending Y can be adjoined to constructed nonsense-words (i.e., if it is productive, in the present sense), we might
try to investigate whether the free form XY is constructed, in the speech situation, by rule or by analogy. E.g., if a reference paradigm presented in connection with the test significantly influences the results, this may be taken as indicative of the importance of analogy, at least under such test situations. (Pilot tests of this type have been made by John Ohala.)

And although there are undoubtedly enormous problems in undertaking tests which are representative of the normal speech situation, I think, nevertheless, that the question whether rule or analogy is used at a given occasion is a genuine empirical problem.

If a given linguistic device is not used productively in the above sense, I think it is quite misconceived (i.e. bad research strategy, in the present state of our knowledge) to investigate further into the "psychological reality" of the device in question and to make hasty conclusions on the speakers' awareness or non-awareness of this linguistic device.

The term 'productive' is very often used about a linguistic 'device' (e.g. an ending) in the sense 'which can be added to new words which enter the language'. This is what I call 'the linguistic sense (of 'productivity')'. It is an open question whether this phenomenon is identical to one or both aspect(s) of productivity mentioned above. The very fact that rule-productivity and analogy-productivity might, in principle, be distinguished in the test situation leaves room for doubt (and investigation!) concerning the precise nature of 'productivity in the linguistic sense'. To find out whether a given linguistic device is productive or not in this sense, we need not make psycho-linguistic tests, but we should investigate the lexicon of the language during a certain span of time (it is clear that the situation can be found that certain meanings of an ending which is completely productive with regard to its phonological shape and morphology, are unproductive).
Finally, the words 'productive' and 'predictable' sometimes appear to have been used interchangeably, but this seems to me an unhappy choice of terminology since, in principle, these concepts are distinct: an ending like -ning (in Danish) is productive (cf. kodning 'coding', (ned)frysning 'freezing (back)'), but its meaning is not (completely) predictable (cf. skabning 'creature', vejning 'weighing', holdning 'attitude'), and it seems unrevealing to speak of homonymy in the case of the (de-verbal substantivizing) suffix -ning as -ning₁, -ning₂, etc.¹ These forms are better accounted for by assuming that skabning, holdning, etc. are lexicalized, i.e., the meaning of these specific forms must be available in the lexicon (although they are completely regular as to pronunciation).¹

This is not the place for a general discussion of the linguistic uses (and misuses) of the term 'lexicalization'. I should only like to point to a completely different way of using this term, in addition to the use made above which was, roughly, that a linguistic 'entity' is lexicalized if it contains unpredictable features (one may thus speak of lexicalization for phonological, morphological, syntactic and/or semantic reasons, or, more briefly: an entity may be phonologically, semantically etc. lexicalized, in the present sense).²

¹) Similarly, the lexicon must contain information as to the preterite form mødte 'met', with an (optional) short vowel as opposed to fødtte 'bore', since the former word is phonologically unpredictable although it is semantically predictable. In a sense, the form mødte might thus be termed 'lexicalized (phonologically)'.

²) This very general use of the term 'lexicalization' may, of course, be partitioned into a number of special types of lexicalization, e.g. the case (which is particularly interesting from the phonological point of view of the present paper) that a grammatical boundary is (exceptionally) ignored for phonological purposes, as we saw in words like jagt discussed above (cf. compounds like ståltråd 'wire' [sdål'traːd]).

a) Also in cases where several of the meanings of an ending are productive (e.g. the nominalizing suffix -er), this ending is, of course, semantically unpredictable (even when only the productive meanings are taken into consideration).
The quite different use of 'lexicalization' alluded to above occurs when one claims that a certain meaning can (or cannot) be lexicalized, in the sense 'qualify as a lexical entry' (e.g., with an example discussed by Richard Carter, the meaning 'be in a certain bodily position' can be lexicalized in English (stand, sit, etc.), but not in French (être debout, être assis, etc.), cf. also the universal constraints on 'possible lexical items' discussed by James McCawley in connection with kill = cause-become-not-alive). It should be noticed that this sense of 'lexicalization' might also cover phonological and morphological structure (since the notion 'possible lexical entry' includes phonological etc. aspects), although the term has most often been used covering semantic constraints only.

Finally, one word of caution concerning the psychological reality of boundaries. Even if a form like färdes 'move' [fₐrdəs] is analyzable to the native speaker into /fₐrd/+a+/s/ (cf. the preterite form färdedes [fₐrdəðəs]), it evidently does not follow that färdes is formed productively from /fₐrd/ plus /a/ plus /s/, and even less that the stem /fₐrd/ is psychologically related to certain other forms, like fard 'travel' [fɛːrd]. It can only plausibly be said, I think, that the (psychological) analyzability of a complex form is a necessary condition for it to be formed productively by rule.

(v) Sound change

Sometimes the term "analogy" is used in a wide sense referring to all cases where a sound change is not purely phonetically conditioned, if the "identity of morphemes" can account for the apparent exceptions, also when the crucial sounds belong to different words in the chain (e.g. Brink/Lund forthcoming). Within the present framework this is not to be considered analogy, but is a regular consequence of the fact that sound change generally does not affect sentences but smaller (probably separately stored)
units. Given the proposed sound change $X_A \rightarrow X_B$, where $X$, $A$ and $B$ are sounds (or classes of sounds), we can investigate which sequences of $X$-boundary-$A$ are turned into $X$-boundary-$B$, and which are not. From this investigation a certain domain of the sound change can be established, and this may shed light on the (psychological) reality of grammatical boundaries in phonology. Most often, recent sound changes in Danish seem to be blocked by the occurrence of $\#$ (within the present framework), i.e. they do not apply across the boundaries between the parts of a compound, etc. For example (cf. Brink/Lund forthcoming), the (diachronic and synchronic) rule $\alpha \rightarrow [-\text{grave}]$ unless before $[+\text{grave}]$ (i.e., roughly, $\alpha$ becomes $\alpha$ except before velars and labials, /r/-contexts excepted) accounts for the distinction tand 'tooth' [tan?] : tam 'tame' [tam?], etc.; but $\alpha$ does become $\alpha$ before a velar or a labial which is separated from $\alpha$ by a $\#$ according to the present framework, e.g. sofapude 'sofa cushion' [sø:fapødø:]. And the (diachronic and synchronic) rule $\alpha \rightarrow \sim/\sim$ applies in fiskeri 'fishing', malerisk 'picturesque' [fesɡær?:, mæ:laəisɡ] (although pronunciations with $[\alpha]$ can be heard); but in compounds like helleristning 'rock engraving', taskerem 'bag strap' [hɛləesdneθ, tæsgə-øm?], pronunciations with $[\alpha]$ instead of $[\alpha]$ are excluded.

When we find isolated examples of apparent compounds or phrases which do nonetheless undergo the change in question, this may be due to the fact that this compound or phrase has been lexicalized, and this can often be confirmed on semantic grounds. I shall only mention two particular (and probably uncontroversial) examples. One is the phrase hvabehar meaning '(beg your) pardon'. Although it is etymologically identical to hvad behager 'what pleases (you)' [va(ð)behæ:jəv], it is pronounced [væbehɛ:jə:]. The reduction $\alpha:(?)\gamma \rightarrow \alpha:?$ has a number of parallels (old doublet forms) which will not be discussed here. But the pronunciation [væbe-] instead of [væbe-] indicates that there should be no $\#$ between /a/ and /b/ within our framework. This agrees well...
with the fact that the phrase is completely frozen semantically and syntactically. - The other example is frokost 'lunch' which is normally pronounced [fɔɔɡʌsʌ] (or possibly [fɔɔkʌsʌ]) although it is (etymologically) compounded from fro [fɔɔːʔ] 'early' and kost [kʌsʌ] 'food' (via MLG). According to the normal principles for the pronunciation of compounds, it should be pronounced [fɔɔkʌsʌ]. Instead, it is treated as a simplex word where /ɔ/ accordingly is lowered to [o]; the weakening of /k/ to [ɡ] may be due to the reduction (from secondary stress to weak stress) of the second syllable, cf. the possible analysis of unstressed [ʌsʌ] as a manifestation of /ərsʌ/ (and cf. chokolade [ʃokɔladeʃ, [ʃoɡo-, [ʃoɡe-] etc.). The phonological treatment of the word agrees well with its semantic unpredictability ('lunch' is not semantically equivalent to 'early food'), and with the fact that the word fro is decidedly archaic.

3. Concluding Remarks

The topic of grammatical boundaries in phonology is a crucial one today when a dominating linguistic paradigm, that of generative grammar, has come under severe (and, in my view, justified) attack for empirical vacuity and unsupported and implausible psychological speculations (cf. Derwing, Linell). (Although it can still be defended as a (in some senses elegant) descriptive system.)

If the formations which generativists claim are created by rule (and thus not stored as separate items) are not analyzable (segmentable) for the native speaker, i.e., if the grammatical boundaries postulated have no psychological reality, then the generativist claims seem very weak. But if there are psychologically real (word-internal) grammatical boundaries, on the other hand, we can start investigating whether the morphemes are
abstract or concrete, etc. This investigation should, of course, employ scientifically sound methods.

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