*Phonology* **17** (2000) 187–235. Printed in the United Kingdom
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# *Against ambisyllabicity**

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Many phonological phenomena require reference to information beyond the immediate context of segments and boundaries. Most commonly, the SYLLABLE has been employed as an additional phonological context, but determining the exact nature of syllables and their boundaries has proved notoriously difficult. One approach is to add resyllabification (Selkirk 1982, Borowsky 1986) or ambisyllabification (Kahn 1976, Gussenhoven 1986, Rubach 1996) to basic syllabification in an attempt to account for phenomena where syllabification alone is inadequate. In this paper we argue against this approach and argue for a second approach, the PROSODIC approach. The essence of the prosodic approach is that there is a HIERARCHY of prosodic categories, of which the syllable is one, any one of which can serve as the context for phonological rules. Essentially, the argument is that prosodic categories, independently required for a wide variety of phonological processes, are sufficient for accounting for all the phenomena that resyllabification or ambisyllabification have been used for, whereas the reverse is not true. Resyllabification and ambisyllabification are invoked ad hoc for certain phenomena and cannot account adequately for the full range of processes that can be understood in terms of prosodic categories. Resyllabification and ambisyllabification are therefore superfluous and can be dispensed with, indeed *must* be dispensed with, in an explanatory theory of phonology.[1]

We will first, in §1, outline the fundamental assumptions of the prosodic theory that we will use, introducing certain modifications to the theory as outlined in Nespor & Vogel (1986). We will then discuss the relevance of experimental and anecdotal evidence for syllabification in §2. §3 will be

* This is a considerably revised and expanded version of a paper originally presented at the Montréal–Ottawa–Toronto phonology workshop in February 1997 at the University of Toronto. I am grateful for the comments of the audience on that occasion. Margaret Stong-Jensen carefully read through numerous drafts and gave me many important suggestions. I thank Carlos Gussenhoven for providing me with a copy of his 1986 paper and Caroline Smith for a reference for §2. The editors, an anonymous associate editor and several anonymous reviewers for *Phonology* also provided many critical comments which have helped me to sharpen my ideas in a number of places. Any remaining errors are my own.

[1] We will not specifically argue against resyllabification, which seems to be much less of an issue than ambisyllabification. The conclusion that the prosodic approach is superior to both resyllabification and ambisyllabification still holds, however.



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devoted to a reanalysis of some English phenomena that Rubach claims requires ambisyllabicity – all will be shown to yield to a prosodic analysis with no loss, and in some cases a gain, of generality. §4 will be devoted to an analysis of the English stop allophones, where greater generality will be gained by adopting a prosodic approach over an ambisyllabicity approach. §§5 and 6 will discuss similar phenomena in German and Danish, respectively, where again a prosodic approach is shown to be superior to one using ambisyllabicity. Finally, §7 will summarise our conclusions.[2]

## 1 Prosodic phonology

Prosodic phonology is developed most thoroughly in Nespor & Vogel (1986). I will present a somewhat modified version of their theory that reflects more recent developments. The basis of the theory is a prosodic hierarchy, where in principle one or more of each unit is contained in the next higher unit. We will assume the prosodic categories in (1).[3]

(1) *Prosodic hierarchy*
utterance (U)
intonation phrase (I)
phonological phrase ($\varphi$)
clitic group (C)
prosodic word ($\omega$)
foot (F)
syllable ($\sigma$)
mora (m)
segment

Of these categories, the clitic group is least well motivated and is problematic in various respects. Because of the layering of the hierarchy, each clitic group is assumed to contain one or more phonological words, each of which contains one or more feet. A foot in turn is defined as a unit containing one and only one stressed syllable. If a clitic within a clitic group consists of a phonological word, this implies that the clitic itself is stressed, while, by definition, clitics are unstressed. Fortunately, we do not need to refer to the clitic group, since none of the phonological phenomena that Nespor & Vogel use to justify this category arises in the ambisyllabicity debate. We will appeal to other categories in the prosodic

[2] The arguments are cast within a derivational approach rather than within a constraint-based approach such as Optimality Theory. Since we are primarily concerned with *representations*, this does not affect the results. In §4.3 we note some of the difficulties involved in accounting for English stop allophones in OT.

[3] Nespor & Vogel (1986) do not regard the mora or the segment as part of the hierarchy. I include these for completeness; the full justification is given in the text. Notice that I use the symbol m for mora, reserving the symbol $\mu$ for morpheme, its original use (McCarthy 1981).

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hierarchy, especially the utterance, the prosodic word, the foot and the syllable.

The prosodic hierarchy is constrained by the STRICT LAYER HYPOTHESIS (Selkirk 1984: 26, Nespor & Vogel 1986: 7), given in (2).

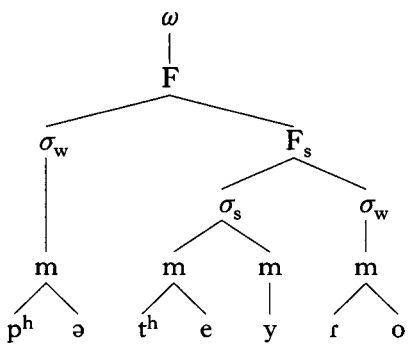
(2) a. A given non-terminal unit of the prosodic hierarchy, $X^p$, is composed of one or more units of the immediately lower category, $X^{p-1}$.

b. A unit of a given level of the hierarchy is exhaustively contained in the superordinate unit of which it is a part.

The Strict Layer Hypothesis is an intuitively natural restriction that is almost definitional of the hierarchy. Still, it cannot be maintained absolutely. The ambisyllabicity debate is part of the larger question of how (2) can be relaxed, in that an ambisyllabic element constitutes a violation of (2b). In fact, we will see that violations of both (2a) and (2b) must be allowed, but not by allowing ambisyllabicity.

One example where relaxation of (2) is required, which will be important in later discussion in this paper, concerns the status of word-initial unstressed syllables in English, for example, the first syllable of *potato*. Does this syllable belong to a foot, and how is it structured? Several answers have been given to this question. Kiparsky (1979) assumes that this syllable forms a 'stressless foot' on its own, which violates the definition of a foot as a unit containing one and only one stressed syllable.[4] McCarthy & Prince (1993a, b) assume that such syllables are parsed directly by the prosodic word, a violation of (2a). The third solution, which we will adopt here, is that a stressless syllable is adjoined to an adjacent foot (Hayes 1982, Jensen 1993). This adjunction gives rise to the structure in (3) for *potato*, where (2a) is violated in a different way (a foot dominates a syllable and another foot), but in which all syllables are footed and each foot contains one and only one stressed syllable.

(3)




[4] Kiparsky assumed Liberman & Prince's (1977) feature [±stress] in addition to feet, making such a representation possible. The elimination of this feature, giving the feet the sole burden of distinguishing stressed from unstressed syllables, means that this option is no longer available.

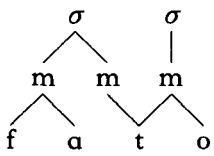
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The possibility of adjunction, and with it of nested feet, allows us to distinguish maximal and minimal categories. A MAXIMAL FOOT is a foot that is not dominated by another foot, such as the top foot in (3), which is immediately dominated by the prosodic word. A MINIMAL FOOT is a foot that does not dominate another foot. This terminology will be useful in formulating certain phonological rules in §§3 and 4.[5]

It is only the adjunction approach represented in (3) that allows a completely general solution to the problem of English stop allophones, as we will show in detail in §4. To anticipate, we will show that foot-initial position is where voiceless stops in English are aspirated; the *p* and the first *t* of *potato* are both foot-initial and are shown as aspirated in (3). The second *t* is shown as a flap in (3), typical of non-foot-initial alveolar stops in the environment [−consonantal] __ V. We regard strict layering as the unmarked state of the prosodic hierarchy, with exceptions arising from language-specific requirements such as the adjunction of stray syllables required for English.

The inclusion of the segment and the mora in the prosodic hierarchy implies that these units also are strictly layered, insofar as this is possible. On this view the mora replaces the CV or X skeleton of earlier theories. One situation where strict layering is violated on the segment level is gemination. A representation like (4) can be used to represent Italian *fatto*, where a single root node, *t*, is attached to two syllables by virtue of attachment to two moras, thus functioning both as a coda to the preceding syllable and an onset to the following syllable, violating (2b).[6]

(4)




The representation in (4) for geminates gives rise to an immediate problem for ambisyllabicity, since an identical representation has been proposed for ambisyllabic segments, such as for the *t* in English *butter*, where flapping is observed. Borowsky *et al.* (1984), although not explicitly working in a moraic model, implicitly regard an ambisyllabic segment as moraic. Specifically for English they propose that the *t* in *atom* undergoes gemination, which conditions Flapping. In a similar vein, they regard vowel-initial words as having an empty initial C slot, which, by spread-

[5] Hayes (1995: 108ff) rejects adjunction within the bracketed grid theory. He does not, however, offer an account of the segmental processes that refer to adjoined structures.

[6] The precise syllabic and moraic structure follows Hyman (1985) and Zec (1988) and involves minimal violation of (2). Other versions of moraic theory attach onsets directly to the syllable, in violation of (2a). Nothing depends on these details of syllable structure, however.

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ing to a word-final consonant in a preceding word, provides a geminate structure in phrases like *hit Ann*, which also provides the context for Flapping. Rubach (1996) also implicitly regards ambisyllabic segments as moraic; in order to account for distributional restrictions on stressed short vowels, he regards stressed syllables as bimoraic, where the second mora arises by ambisyllabic linking to a following onset. It is undesirable to have the same representations for gemination, a strengthening phenomenon, and for ambisyllabicity, where the weakening effect of flapping is observed. Borowsky *et al.* (1984) actually consider this ambiguity to be a virtue in their analysis of Danish, in that they propose a gemination rule that produces geminate structures under stress to account for certain segmental phenomena. We reanalyse their Danish material in §6 using prosodic structure, specifically the foot, with no resort to gemination or ambisyllabicity. Thus, representations like (4) are never ambiguous; they can only indicate geminate structures.

There is little doubt that representations could be constructed to differentiate between geminate and ambisyllabic structures. For example, one could exploit Selkirk's (1986) two-root theory of length for gemination or simply join the left branch attached to the *t* in (4) directly to the first syllable in an ambisyllabic representation, rather than through the medium of a mora (violating (2a)). Such proliferation of representations raises another problem, in that it allows for the possibility that a single language could have both ambisyllabic and geminate consonants, a possibility that does not appear to occur.[7] Indeed, Blevins (1995: 232) argues that one should not allow ambisyllabicity in addition to syllabification of an intervocalic consonant exclusively to the syllable to the left and exclusively to the right: 'until such minimal three-way phonological contrasts are demonstrated, a theory without access to ambisyllabic representations is to be preferred on grounds of restrictiveness'. We go further, in denying both ambisyllabic representations and resyllabification of a single consonant to its left. Such representational manipulations are unnecessary if reference is made to higher prosodic structure, which is independently needed. The representation in (4) can then be reserved unambiguously for geminate structures.

## 2 Experimental evidence

There have been a certain number of psycholinguistic studies on syllable structure in English, some of which have been interpreted as supporting ambisyllabicity. There are also informal, anecdotal reports of native-speaker intuitions. Rubach (1996: 219ff) discusses evidence of the latter variety. He notes that there are four environments where ambisyllabicity might arise, listed in (5).

[7] Thanks to a reviewer for pointing out this problem.

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(5) a. V́CV (the preceding syllable is stressed [and has a short vowel])
happy, hobby, hammer

b. VCV́ (the following syllable is stressed)
suppose, attack, aroma

c. V:CV (the preceding vowel is long [and stressed])
notice, pony, isolate

d. VCV (both vowels are unstressed)
poli**cy**, priv**acy**, divini**ty**

Rubach notes that only in (5a) do speakers have strong intuitions that the consonant is ambisyllabic. Yet for his ambisyllabicity rules to work properly, all three of (5a, c, d) have to be considered ambisyllabic. It is clear that informal native-speaker intuitions of ambisyllabicity do not support Rubach's appeal to this concept. (We will consider the details of Rubach's rules in §3.) Rubach claims that the intuition of ambisyllabicity in cases like (5a) is strengthened by the distributional restriction on stressed short vowels, that is, the impossibility of *words* such as *[tɪ], *[tɛ], *[tæ], *[tʊ], *[tɒ] or *[tə]. He interprets this as the impossibility of such *syllables*, so that *happy*, for example, has [hæp] as its first syllable (assuming ambisyllabic [p]), not *[hæ]. But this distributional argument is rather weak, in that such syllables are excluded in Rubach's account only when stressed. They are perfectly possible when unstressed, as in the first syllable of the words in (5b), where Rubach specifically regards the medial consonant as belonging exclusively to the second syllable. (Of course, in unstressed syllables, the vowels are reduced, in (5b) to schwa; in other words [ɪ] and [ʊ] are possible as reduced vowels, at least in RP.) The American pronunciations of words like *raccoon* [ˌɹæ'kun] are counter-examples to Rubach's distributional restriction. The first syllable [ɹæ] has secondary stress and a short lax vowel and is open: the medial [k] cannot be ambisyllabic, because of the stress on the second syllable. This reliance on stress suggests that the distributional facts should be explained in terms of a unit higher than the syllable: the foot. A restriction that a foot must contain (at least) two moras captures the distributional facts without any appeal to ambisyllabicity.[8]

Experimental evidence that relies on speakers' intuitions comes to conclusions similar to those of Rubach's informal survey. Rubach (1996: 218) cites Fallows' (1981: 311) statement that intervocalic consonants may 'have properties that are both onset-like and coda-like' as supporting ambisyllabification. Fallows had her subjects, children in two age groups (4–5 years and 9–10 years), repeat words saying the 'first part' or 'last part' twice. For example, *chipmunk* would be repeated as *chipchipmunk* or *chipmunkmunk*. If the test item were *lemon*, the response *lemlemon* would be interpreted as indicating that *m* was ambisyllabic, while the response *lelemon* would indicate that it is purely an onset. Fallows (1981: 315) reports that ambisyllabicity 'applies 22 per cent of the time', a relatively

[8] Words like *álly̰*, whose first foot is [æ], suggests that this restriction might have to be stated on the phonological word, rather than on the foot.

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low observance, but 'most often (47 per cent) with liquids and nasals'. She finds ambisyllabicity 85 % of the time following a stressed lax vowel, that is, in Rubach's environment (5a). These figures are difficult to interpret, since Fallows gives only such summary figures, and does not indicate precisely what whole set the percentages are part of.

Treiman & Danis (1988) asked subjects to reverse the syllables of spoken words. For example, *lemon* could be reversed as *monlem* (interpreted as an ambisyllabic response for the *m*), *monle* (indicating a syllable-initial response) or *onlem* (a syllable-final response). Although speakers gave all three types of response for words with stress on the first syllable, there were relatively few ambisyllabic responses. Interestingly, liquids and nasals were more frequently reported as ambisyllabic than other types of consonants. In addition, there were many more ambisyllabic responses when the intervocalic consonant is spelled with two letters (as in *comma*) than when it is spelled with one letter (as in *proper*), even if the stress was on the second syllable (as in *command*). This indicates that speakers relied on their knowledge of orthographic conventions, such as those involved in line-end word division, rather than on their intuitive knowledge of phonological syllables.

Turk (1994) reports a phonetic study in which she measured the vertical displacement and peak velocity of the upper lip during the production of /p/ and /b/ in various syllabic positions.[9] Thus this study did not rely on speakers' intuitions and so avoided the complications such intuitions entailed in the studies of Fallows and Treiman & Danis. The gestures were measured in clearly syllable-initial positions (*parable*, *repair*, *pyramidal*, *rebel* (VB)), clearly syllable-final position (*observed*, *microscope*, *captor*, *object* (N)) and in unknown (potentially ambisyllabic) positions (*rabble*, *leper*, *parable*, *caliper*). The stops in unknown position pattern with syllable-final stops in most cases; that is, they did not share characteristics of syllable-final and syllable-initial position, as would be predicted by ambisyllabicity. This is especially true for stops in the environment between a stressed and an unstressed vowel (*rabble*, *leper*), and is less clear in the environment between two unstressed vowels (*parable*, *caliper*). Turk concludes that her results do not support Kahn's theory of ambisyllabicity. Her results are consistent with either the resyllabification theory of Selkirk (1982) or the foot-based theory of Kiparsky (1979). We conclude that experimental evidence, both psycholinguistic and experimental phonetic, fails to support ambisyllabicity. Such evidence is consistent with a resyllabification approach as well as with the foot-based theory. While it has not been my intention to argue specifically against resyllabification, it is worth noting that Selkirk's version of this theory requires an ad hoc feature [±release] to distinguish flapping from glottalisation. This is because the *t* in both *atlas* and *batter* is syllable-final in her treatment, and the *t* in *atlas* is glottalised, while that in *batter* is flapped. She then goes on to discuss the conditions under which

[9] I am grateful to Caroline Smith for pointing out this reference to me.

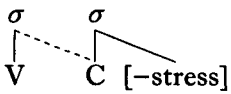
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stops may be released or not, essentially recapitulating the conditions under which stops may be flapped or glottalised. Furthermore, resyllabification fails empirically in cases like *metric*. Here, *t* is alveopalatalised by a rule that affects *t* which is followed by *r* in the same syllable (Nespor & Vogel 1986: 81). Resyllabification thus removes *t* from the context of Alveopalatalisation and indeed incorrectly predicts that *t* would be glottalised in *metric*. In addition, resyllabification fails in the cases in (32) in §4.1 below where a stop falls at the boundary of two unstressed syllables. For these reasons we pursue a prosodic approach rather than a resyllabification approach as an alternative to ambisyllabicity.

## 3 Rubach's ambisyllabicity

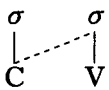
Rubach (1996) argues for two rules of ambisyllabicity in English.[10] The first is a word-level lexical rule of Coda Ambisyllabicity, basically the same as Kahn's (1976) Rule III and Gussenhoven's (1986) Right Capture (see also Clements & Keyser 1983), which Rubach formulates as in (6).

(6) *Coda Ambisyllabicity* (*word level;* Rubach 1996: 221)




Rubach's second ambisyllabicity rule is Onset Ambisyllabicity, which applies across word boundaries and so is necessarily postlexical. It is equivalent to Kahn's Rule V and Gussenhoven's Liaison. Rubach formulates this as in (7).

(7) *Onset Ambisyllabicity* (*postlexical;* Rubach 1996: 222)




Rubach analyses a number of processes in English that he claims require ambisyllabicity by either (6) or (7). These include tapping of /r/ in RP, compensatory syllabification (syllabification of a sonorant with loss of the preceding unstressed vowel), the realisation of light and dark /l/, linking /r/ in RP and schwa insertion in RP. Together with Gussenhoven's (1986) discussion of a number of other processes in RP, this discussion of RP sheds new light on our understanding of English phonology as a whole. Referring to Kiparsky's treatment of stop allophones and other processes in terms of the foot, Rubach states that 'it is difficult to see how

[10] We do not dispute Rubach's conclusion (contrary to Myers 1987 and Yip 1987) that English Shortening is not conditioned by Resyllabification or Ambisyllabification. English length alternations have been reanalysed by Alcántara (1998) as involving only lengthening (not shortening) in an OT framework.

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Kiparsky's reasoning could be extended to the rules discussed in this section' (1996: 234, n. 40). In this section we will show that it is actually quite easy to account for these processes in terms of the prosodic theory sketched in §1 of the present paper.

### 3.1 RP tapping

Rubach observes that /r/ in RP is realised as a tap [ɾ] between syllabic segments if the following syllable is unstressed, as in (8a), or if it is a linking *r*, regardless of stress, as in (8b), but not within words before a stressed vowel, or if initial or after a consonant (8c).

(8) a. [ɾ] courage, very, sorry, baron, laurel, story, period
b. [ɾ] for example, for instance, the other end
c. [ɹ] courageous, reduce, red, bright, Henry, walrus

Rubach claims that the appropriate generalisation is that /r/ is tapped when it appears in the coda. Ironically, it is possible to make this claim only because, in general, in RP, /r/ does not appear phonetically in codas. True coda /r/ appears only at the end of word before a vowel, as in (8b), where /r/ serves as a linking *r*, by virtue of Onset Ambisyllabicity. In (8a) the *r* appears as a coda only by virtue of Coda Ambisyllabicity (6). When *r* cannot be made ambisyllabic, as in (8c), it is not tapped.

In terms of prosodic categories, we can say that *r* is tapped when it is between vowels and not foot-initial. Kiparsky (1979) introduced the idea that foot-initial position is strong for consonants, analysing English aspiration of voiceless stops as occurring in precisely this environment. Kiparsky proposed that all other positions in the foot are weak, and suggested a rule that assigns the feature [+lax] to consonants that are preceded by a [−consonantal] segment within the same foot. To extend this insight to other cases of consonant allophony, I suggest instead that the correct rule is one that assigns the feature [+tense] to consonants in foot-initial position, as in (9). Consonants in other positions are [−tense] by default.

(9) *Tensing*

$$C \rightarrow [+\text{tense}]/_{F}[\ __$$

We can now account for RP *r*-tapping by the rule in (10).

(10) r-*tapping*

$$\begin{bmatrix} r \\ -\text{tense} \end{bmatrix} \rightarrow ɾ \ / \ V \ __ \ V$$

Rules (9) and (10) account for all Rubach's cases of *r*-tapping in (8). In (8a), /r/ is medial in a foot within a word. In (8b), /r/ is word-final and appears before a vowel in the following word. In neither of these cases is it marked [+tense] by (9). In both (8a, b) it is between vowels and [−tense], and so eligible to undergo tapping by (10). In (8c), /r/ is either

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foot-initial or not between vowels, and so it is not tapped. In *courageous* and *red* it is in the onset of a stressed syllable; in *reduce* it is foot-initial by virtue of adjunction, so that in these cases it is marked [+tense] by (9). In *bright*, *Henry* and *walrus* it is followed by a consonant, so that, although [−tense], it is not tapped. Therefore, no ambisyllabicity is required to account for this phenomenon.

### 3.2 Compensatory Syllabification

All varieties of English exhibit syllabic sonorants in certain environments. In many cases these can be derived from a sequence of an unstressed vowel plus sonorant consonant. For example, *atom* ['ætm̩] must have a vowel in the second syllable of the underlying representation /ætɒm/, in view of the derived form *atomic* [ə'tʰɒmɪk]. In other cases, such as *metre*, there may be no underlying vowel, in view of the derivative *metric*. Assuming that a stage with an unstressed vowel followed by a sonorant can be motivated for all such cases, a rule is required that deletes an unstressed vowel with syllabification of the following sonorant. Rubach discusses the examples in (11).

(11) a. nation [-ʃən] ~ [-ʃn̩], bacon [-kən] ~ [-kn̩], told them [ðəm] ~ [ðm̩]

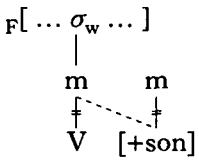
b. Italy [ɪtəɬɪ] ~ [ɪtl̩ɪ], gluttony [-tənɪ] ~ [-tn̩ɪ], nationalist [næʃənəlɪst] ~ [næʃn̩lɪst], animal [ænɪməl] ~ [ænɪml̩] ~ [ænm̩əl] ~ [ænm̩l̩]

c. comm**a**, **a**roma, rev**o**lution, Can**a**letto, **a**naemic

Rubach concludes that the sequence can be realised as a syllabic sonorant just in case the sonorant is in the coda of an unstressed syllable, either by core syllabification or by Coda Ambisyllabicity (6). This is the case in (11a, b). In (11c) the schwas (marked in bold) do not fulfil this condition, having either no following sonorant (*comma*) or a following sonorant as an onset to a stressed syllable, hence unable to undergo Coda Ambisyllabicity (6) (the others).

The same facts are accounted for in a prosodic account by a rule that makes a sonorant syllabic if it is preceded by an unstressed vowel in the same minimal foot. We formalise this rule as in (12).

(12) *Compensatory Syllabification*




*Condition:* F is minimal

The condition that the foot is minimal allows rule (12) to cover exactly the same ground as Rubach's analysis. In §1 we argued that initial unstressed syllables in English are adjoined to the following foot, producing the structure in (3), with nested feet. However, this condition also

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points to a possible empirical difference between the ambisyllabicity theory and the prosodic theory. This is that pronunciations like [ɹ̩ˈowmə], [n̩ˈimɪk] *are* possible for *aroma* and *anaemic*. Hayes (1995: 20) refers to the pronunciation [j̈ɹ̩ˈowm] for *Jerome*. The possibility of these pronunciations argues against ambisyllabicity and in favour of the prosodic theory. Because Coda Ambisyllabicity (6) requires a stressless second syllable, there is no way for /r/ to be made ambisyllabic in *aroma* or *Jerome* or for /n/ to be made ambisyllabic in *anaemic*. Therefore, there is no way for these pronunciations to be generated in Rubach's theory. In the prosodic theory, on the other hand, they are accounted for simply by dropping the requirement on rule (12) that the F be minimal. Then the *r* of *aroma* is preceded by an unstressed vowel within the (larger) foot, so rule (12) applies.

### 3.3 *l*-velarisation

According to Jones (1966), RP uses a fairly clear *l* when a vowel or *y* follows and a fairly dark *l* finally, before consonants and when syllabic. However, a fairly clear *l* is used in word-final position in phrases before a vowel, and even syllabic *l*'s can 'lose much of their darkness when a vowel follows' (1996: 91). He gives the examples *settling* and *settle it*, which have rather clear syllabic *l*'s.[11] Jones also maintains that 'the degree of clearness of the l varies to some extent with the following vowel; it is less clear when the following vowel is a back one' (1966: 90). This description in purely segmental terms (i.e. not involving syllable conditioning) seems satisfactory, except that the reference to 'a vowel or *y*' is not to a natural class, nor is the reference to 'finally, before consonants, and when syllabic'.

Rubach provides an analysis using syllable conditioning, claiming that clear *l* appears in the onset, with the word-final *l* before a vowel-initial word given onset status by Onset Ambisyllabicity (7). Rubach's RP data for clear *vs.* dark *l* is given in (13).

(13) a. Clear *l*: leap, like, million, telling, tell it, all over
b. Dark *l*: bell, belt, tell Tom, always, battle, battling

He relates the clear *l* in *million* to the possibility of [ly] as an onset in RP *vs.* the dark *l* in *always*, where *[lw] is not a possible onset. However, the claim that [ly] is a possible onset in RP (or any other dialect) is problematic. It has long been known that this sequence forms a possible onset only when the following vowel is [u]. At least since Chomsky & Halle (1968; *SPE*) this *y* in *Cy* sequences has been analysed as derived by a rule of *y*-insertion. Another analysis is that of Borowsky (1986) and Davis & Hammond (1995), in which [yu] is a diphthongal nucleus in *Cyu* sequences, where again [y] is not part of the onset. There is in fact some evidence that the underlying sequences of *Cy* are syllabified between these two segments, and that there is a constraint that disallows *Cy* sequences

[11] *Settling* can of course also be pronounced with a (clear̩) non-syllabic *l*.

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syllable-initially (Borowsky 1986: 280, Jensen 1993: 67). Palatalisation in English affects coronal obstruents followed by *y*V, but not when the consonant is initial in a foot. That is, Palatalisation affects only [−tense] consonants in the relevant environment, where Tensing (9) has not applied. For example, word-initial coronals are not palatalised, so *tune* cannot be *[čun]. Within words, the restriction of Palatalisation to non-foot initial position appears in the contrast between *perpetual*, where *t* is pronounced [č], and *perpetuity*, where [č] is not possible. In both these words there is an inserted *y*. In *per*(*petual*) the parenthesised sequence is a foot, the *t* is not foot-initial, and Palatalisation can apply. In *perpe*(*tuity*), the *t* is foot-initial, and Palatalisation is blocked. Now compare the structures of *artificiality* and *perpetuity* at the point where Palatalisation is applicable, given in (14).

(14) a. ɑrtɪ $_{\sigma}$[fɪs] $_{F}$[$_{\sigma}$[yæ]l+ɪtɪ]
b. pər $_{\sigma}$[pɛ] $_{F}$[$_{\sigma}$[tyu]+ɪtɪ]

The /y/ that appears at the beginning of the final foot in *artificiality* is underlying, not derived by *y*-insertion, and so is necessarily syllabified in a different syllable than the preceding /s/. This /s/, in turn, is eligible to undergo Palatalisation, since it is not foot-initial. The difference in syllabification in (14a, b) is responsible for the difference in the applicability of Palatalisation. This implies that words like *million* must be syllabified between *l* and *y*, since this *y* is underlying also and not inserted. That this *l* is light, even though it is syllable-final, makes it difficult to maintain a syllable-based analysis of *l*-velarisation in RP.

Rubach refers to Mohanan's (1985) proposal that dark *l* occurs in rhymes; however, this proposal does not have the same effect as Rubach's. In particular, sequences like *tell it* have a light *l* in Rubach's analysis, since the *l* occurs in the onset by virtue of Onset Ambisyllabicity, but the *l* is dark for Mohanan since this *l* is (also) in the rhyme. Mohanan's account is problematic in a different way. He proposes a resyllabification (not ambisyllabification) rule peculiar to *l* that moves this segment from word-final position into the onset of a following vowel-initial word (see also Halle & Mohanan 1985). This rule of *l*-resyllabification is the only phonological rule occupying stratum 4 of the lexicon in Mohanan's and Halle & Mohanan's account. Thus neither the rule nor the stratum has strong motivation.

In dialects other than RP, *l*-velarisation may be conditioned by prosodic units above the syllable (and the mora). 'In many North American dialects [l] is light only at the beginning of a foot, so that [l] is velarized in *valley*, *silly*, *yellow*' (Jensen 1993: 128), as well as in words like *milk*, *belt*, *dull*. Rubach could account for this dialect by saying that *l* is dark in codas, including *l* in a coda by virtue of Coda Ambisyllabicity (6). However, other North American speakers have dark *l* in words like *alarm* and *velocity*, where *l* is at the beginning of a foot by virtue of being the onset of a stressed syllable. Rubach's analysis cannot account for these facts. Our analysis accounts for this by restricting light *l* to the *maximal* foot.

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This is related to the fact that *l* can undergo compensatory syllabification in these dialects, giving the pronunciation [vl̩ˈɒsɪɪ]. Such speakers have light *l* in words like *leap*, *like*.

### 3.4 Schwa Insertion

Rubach observes that some (underlyingly) long vowels (and diphthongs) appear phonetically with a schwa offglide in the environment of a following *r*, though the *r* itself may or may not appear phonetically. We reproduce some of his examples in (15).

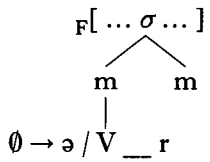
(15) [ɛə]: c**a**re, M**a**ry
[ɪə]: h**ea**r, Lib**e**ria
[ʊə]: c**u**re, P**u**ritan
[ɑyə] ~ [ɑə] ~ [ɑ:]: t**i**re, h**ie**rarchy
[ɑwə] ~ [ɑə] ~ [ɑ:]: h**ou**r, d**ow**ry

Schwa Insertion is also motivated by alternations such as those in (16), from Rubach (1996: 226); I have added the foot boundaries (parenthesised).

| | | | | |
|---|---|---|---|---|
| (16) a. | (pre(p**a**re)) | [ɛə] | (pre(p**a**rative)) | [æ] |
| | (sin)(c**e**re) | [ɪə] | (sin)(c**e**rity) | [ɛ] |
| | (sa)(t**i**re) | [ɑyə] | (sa(t**i**rical)) | [ɪ] |
| b. | (barb**a**rous) | [ə] | (bar)(b**a**rian) | [ɛə] |
| | (myst**e**ry) | [ə] | (mys(t**e**rious)) | [ɪə] |
| | (Merc**u**ry) | [yə] | (Mer)(c**u**rian) | [yʊə] |
| c. | (**i**rony) | [ɑyə] | (**i**)(ronical) | [ɑy] |
| | (p**i**rate) | [ɑyə] | (p**i**)(ratical) | [ɑy] |
| | (b**u**reau)(crat) | [yʊə] | (b**u**)(reaucracy) | [yʊ] |

Rubach formulates a rule of Schwa Insertion that inserts schwa under the second mora position of a long vowel if *r* follows in the coda. This applies straightforwardly in cases like *care*, and extends to cases like *Mary* if *r* in such words is considered to have undergone Coda Ambisyllabicity (6). Under the same assumptions, Schwa Insertion is blocked in words like *ironical* because the stress on the syllable following *r* blocks Coda Ambisyllabicity. It is equally straightforward to restate this rule without ambisyllabicity, in prosodic terms. Schwa Insertion takes place after a long vowel followed by *r* within the same foot, as in (17).

(17) *Schwa Insertion*




In this respect it is much like other rules that are said to involve either coda or ambisyllabic consonants, such as *r*-tapping, and so are subject to

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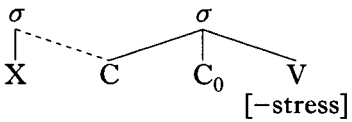
a similar kind of reanalysis. As in the other cases, this rule offers no support for ambisyllabicity.

A reviewer points out that a word like *Bayreuth*, with main stress on the first syllable, may have Schwa Insertion, which is not predicted either by Rubach's analysis or by mine. The interest of this example lies in the fact that ambisyllabicity theory is *in principle* incapable of accounting for this pronunciation, whereas the prosodic theory can simply refer to the prosodic word instead of the foot in (17), in which case Schwa Insertion would be predicted in this word for such speakers. Unfortunately, the facts are not clear. The data provided by Rubach do not concur with *Collins' English Dictionary*, where both *bureaucrat* and *bureaucracy* are given with Schwa Insertion, while neither *irony* nor *ironical* has an inserted schwa. The conditions for Schwa Insertion in Eastern Massachusetts English (see Halle & Idsardi 1997) are different still, where it applies before *l* as well as before *r*, but is limited to the end of a stem word- finally or before a stratum 2 suffix. Clearly, further study of the exact conditions for Schwa Insertion in different forms of English is needed, but, in any case, this rule supports the prosodic approach over the ambisyllabic approach.

### 3.5 Ambisyllabification and British English

Gussenhoven (1986) discusses English stop allophones, and certain other allophonic processes, with particular attention to British pronunciation. He motivates a number of modifications to Kahn's system that he claims are also true of American English. In particular, he proposes to eliminate Kahn's Rule IV (which he calls Left Capture) and to extend Right Capture (Kahn's Rule III, Rubach's Coda Ambisyllabicity (6)) so that it applies even when the first of the two syllables ends in a consonant (18).

(18) *Extended Right Capture* (Gussenhoven 1986: 130)




This formulation is intended to account for a British English process of stop insertion, which inserts a voiceless stop between a nasal and a fricative. The inserted stop takes its point of articulation from the nasal. This rule applies in (19a, b) but not in (19c, d).[12]

| (19) a. | b. | c. | d. |
|---|---|---|---|
| ponce | concert | consort | Longford |
| nymph | symphony | symphonic | |
| sense | sensitive | sensational | |
| length | tenancy | sunshine | |
| amongst | | | |

[12] In Gussenhoven's formulation the inserted stop takes its voicing from the following fricative, but he only gives examples with voiceless fricatives, hence voiceless inserted stops.

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In Gussenhoven's formulation, Stop Insertion occurs between a nasal and a continuant within the same syllable, transparently in (19a) and where the continuant becomes part of the first syllable by ambisyllabicity (Extended Right Capture) in (19b). Because of the stress on the second syllable of the words in (19c), Extended Right Capture is inapplicable and no stop can be inserted in these words. Gussenhoven exempts (19d) from Extended Right Capture by the impossibility of [ŋf] as a coda in English; this may be problematic for my alternative account, since this word constitutes a single foot. The inserted stop in turn undergoes Preglottalisation, a rule with a somewhat broader range of application than Glottalisation in North American dialects. However, its phonetic effect is the same: it adds the feature [+constricted glottis] to the stop.

In a theory that denies ambisyllabicity, we can say that Stop Insertion takes place between a nasal and a fricative in the same foot, as in (20).

(20) *Stop Insertion*

$$\emptyset \rightarrow \begin{bmatrix} -\text{cons} \\ -\text{voice} \\ \alpha\text{ant} \\ \beta\text{cor} \end{bmatrix} / [\ \ldots \begin{bmatrix} +\text{nas} \\ \alpha\text{ant} \\ \beta\text{cor} \end{bmatrix} __ \begin{bmatrix} -\text{son} \\ +\text{cont} \\ -\text{voice} \end{bmatrix} \ldots\ ]_{F}$$

To exclude *Longford*, we can either claim that this word is synchronically a compound,[13] or say that Stop Insertion requires a coronal fricative or a fricative which is homorganic with the preceding nasal.

Preglottalisation appears to be a variable rule (Wells 1982: 260). For some speakers, it applies in the same set of environments as Glottalisation in North American English, that is, in syllable codas (the *t*'s in *quite*, *quite good*, *quite likely*, *nights*, *curtsey*, *chutney*). In other cases, Preglottalisation affects syllable-initial stops which Gussenhoven takes to be ambisyllabic (the *t*'s in *mattress*, *button*, *butter*, *bottle*). Before accepting this as evidence for a rule applying to codas (including ambisyllabic codas), we must examine the relation of these environments to other allophonic processes affecting stops in British English. Deferring a consideration of stop allophones to §4, we will now consider Gussenhoven's treatment of Preglottalisation and Weakening.

Gussenhoven formulates Preglottalisation as a process that applies (variably) to stops in weak position (i.e. not foot-initial) that are not subject to Weakening. Weakening (Gimson 1980: 160) is a process whereby stops, both voiced and voiceless, turn into the corresponding fricatives in 'weakly accented intervocalic positions' in 'rapid, familiar speech'. Gussenhoven captures this by requiring a consonant to the right of a stop subject to Preglottalisation, in several of the formulations he gives of this rule. This condition is not necessary if we appeal to the complementarity of the environments for Weakening and Preglottalisation. Simply ordering Weakening before Preglottalisation, formulating

[13] This alternative is subject to the objection that the second syllable of *Longford* is not stressed.

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the latter to operate on voiceless stops in non-foot-initial position after a sonorant, will do the trick. We formulate Weakening in (21a) and Preglottalisation in (21b). The notation [%cont] in the structural change of Weakening is intended to indicate the variable nature of the change; that is, the stop assumes a certain degree of continuancy, rather than a categorial plus or minus value, in the postlexical component of the phonology.

(21) a. *Weakening*

$$\begin{bmatrix}-\text{cont}\\-\text{son}\\-\text{strid}\end{bmatrix} \rightarrow \begin{bmatrix}-\text{spr gl}\\\%\text{cont}\end{bmatrix} / [\text{XV}__\text{V} \ldots ]_{\text{F}} \qquad \textit{Condition:}\ \text{X} \neq \emptyset$$

b. *Preglottalisation*

$$\begin{bmatrix}-\text{cont}\\-\text{voice}\end{bmatrix} \rightarrow [+\text{constr gl}] / [ \ldots [+\text{son}] __ \ldots ]_{\text{F}}$$

This formulation has an additional advantage over Gussenhoven's formulation. He notes that Preglottalisation affects the affricate [č] in words like *butcher*. This affricate is not in any environment that is covered by the rule. In order to get Preglottalisation here, he proposes a rule of Affricate Gemination, which adds an additional C element on the CV tier before this segment, in effect turning it into a sequence of [tš]. The [t] part is then subject to Preglottalisation, since it precedes a consonant. This ingenious solution is not open to us, since we are not assuming a CV tier; in a moraic framework the functions of the CV tier are taken over by moras. We also have no need for such a rule as Affricate Gemination, if we assume that Preglottalisation is bled in the relevant cases by Weakening. Preglottalisation of [č] then simply follows from the fact that affricates are not subject to Weakening. It may be noted that [č] is glottalised in North American dialects as well, in such words as *butcher*. This is easily captured by extending Glottalisation (see §4) to apply in foot-medial position (i.e. not restricting it to syllable codas), and by noting that [č] is not subject to Flapping in those dialects (either because it is non-anterior or because it is strident) and thus can be affected by the revised version of Glottalisation.

Gussenhoven notes an interesting problem with the ambisyllabicity account. Many of the rules that he proposes are formulated to affect a consonant that is either syllable-final or ambisyllabic. That is, they are stated as applying to syllable-final elements, on the assumption that they also apply to syllable-initial elements that come to be syllable-final by virtue of Extended Right Capture (20). Hayes (1986), however, on the basis of a discussion of autosegmental processes in many languages, concludes that such rules often fail to apply to geminates that otherwise meet their structural descriptions. He gives the example of Spirantisation in Tigrinya, by which velar stops become fricatives after a vowel, for example, [kʌlbi] 'dog' but [ʔaxalɨb] 'dogs'. This rule fails to affect geminates, so that [fʌkkʌrʌ] 'he boasted' does not become *[fʌxxʌrʌ]. In

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order to maintain a maximally general formulation of the rule, Hayes formulates the Linking Constraint to block the application of the rule to geminates, as in (22).

(22) *Linking Constraint* (Hayes 1986: 331)
Association lines in structural descriptions are interpreted as exhaustive.

The Linking Constraint receives additional empirical support from syllabification. As Itô (1986) notes, coda conditions that restrict the content of codas in many languages are suspended in geminates. Japanese, for example, allows only nasal consonants in codas, except that geminate stops are allowed, e.g. *kappa* 'legendary being', but not **kapta* or **takap*. In order to allow rules such as his version of Stop Insertion to apply in *sense*, *sensitive* (but not *sensation*), Gussenhoven suggests that Hayes' Linking Constraint holds of association lines between the CV tier and the segmental tier(s), but not of association lines between the CV tier and the syllable tier. It is not clear to me that this has the desired effect. One of Hayes' examples is Klingenheben's Law in Hausa, which converts a syllable-final obstruent into a sonorant, as in (23a). Geminates must specifically be exempted from this rule, as in (23b), and Hayes does this with the linking constraint.

(23) a. sabroo → sawroo 'mosquito'
biyad → biyaɾ̃ 'five'
batagyee → batawyee 'twin'

b. VttV → VttV (*Vɾ̃ɾ̃V; *Vɾ̃tV)

Yet this rule is identical in all relevant respects to Gussenhoven's Preglottalisation, in that it is formulated to affect syllable-final consonants. The only difference is that Klingenheben's Law must not apply to consonants which are also syllable-initial, while Preglottalisation is supposed to apply in both these environments. The Linking Constraint cannot provide the required distinction between these two in a moraic analysis. My analysis provides the difference by stating Preglottalisation (21b) in terms of the prosodic category foot, as a result of which the problem does not arise. The Linking Constraint then correctly prevents the application of Klingenheben's Law to geminates in Hausa, but is not relevant to Preglottalisation. A similar example is syllable-final devoicing in German, discussed in §5.

## 4 English stop allophones

### 4.1 Prosodic categories

The English stops represent a classic case of allophonic variation, yet the specification of the precise environment for the appearance of the aspirated forms of the voiceless stops and for the flapped version of the

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coronals has proved rather elusive. In this section I will discuss two analyses of these phenomena that involve ambisyllabicity, those of Kahn (1976) and Gussenhoven (1986), and show that neither is fully satisfactory. I will then present an alternative, prosodic account that provides a more adequate analysis. I will need to introduce a modification to Hayes' (1982) Stray Syllable Adjunction. I will show the need for adjoining certain stray syllables to the right. I will also employ Kiparsky's (1979) insight that consonants are strong in foot-initial position (including consonants that are foot-initial by virtue of adjunction) and show that this provides a better account than any purely syllable-based analysis, even with ambisyllabicity.

There is actually some disagreement over the facts, especially as regards aspiration. Kahn (1976: 42) observes that it is necessary to consider a wide range of degrees of aspiration *phonetically*, but still recognise a binary distinction [±spread glottis] *phonologically*. For example, we might consider the scale in (24), where the bold stops run from most strongly aspirated (at the top of (24a)) to least aspirated (at the bottom of (24b)), with a categorial division between (24a), considered aspirated, and (24b), considered unaspirated.

(24) a. *aspirated*
**t**en (*emphatically stressed*)
**t**en (*normal stress*)
**t**rain
**t**emperamental
**t**omorrow

b. *unaspirated*
la**t**er
ma**tt**ress
s**t**em

Gussenhoven (1986) considers *t* to be aspirated in *later* in British English. Gimson (1980: 155) considers voiceless 'fortis' stops to be 'weakly aspirated' in these positions. We will regard this *t* as unaspirated, although the release combined with the lack of flapping in British English contributes to an impression of weak aspiration for such stops.

A complicating factor in words like *train* and *mattress* is the devoicing of the *r* that follows the stop. This devoicing is a separate process, although some authors conflate the two. Aspiration before a vowel is a period of voicelessness following the release of a stop preceding the vowel; this period may simply be a voiceless version of the following vowel. When *r* follows a voiceless stop within the same syllable the *r* is devoiced, regardless of whether the stop is in a position to be aspirated or not. If the stop is also aspirated, as in *train*, the voiceless *r*-coloured period following the release is longer than if it is unaspirated, as in *mattress*.

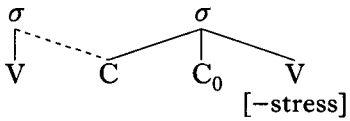
Kahn (1976) proposed an autosegmental analysis of syllable structure, linking a syllable tier to the segmental tier.[14] Exploiting the autosegmental

[14] We might mention that the autosegmental analysis of syllables differs in a fundamental way from that of, say, tone. Tone is a phonetic phenomenon that autosegmental analysis removes from the segments and assigns to a separate tier, on the basis of such properties as multiple linking and stability, while a syllable is not a phonetic property extracted from segments but rather an *organisation* of segments.

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possibility of multiple linking, Kahn proposed that certain consonants are ambisyllabic. Kahn's Rule III (25), which Gussenhoven calls Right Capture, is more restrictive than Gussenhoven's Extended Right Capture (18) in that it requires that there be a vowel preceding the consonant which is multiply linked.

(25) *Rule III* (Kahn 1976: 28); *Right Capture* (Gussenhoven 1986: 120)




In addition, Kahn proposed a rule to associate the first consonant in clusters such as *ft* in *after* with the following syllable. He calls this Rule IV (Gussenhoven's Left Capture). Before the operation of Rule IV, there is a clear syllable break between *f* and *t* in *after*, since *ft* is not a possible syllable-initial cluster in English, in terms of the basic syllabification rules. Rule IV refers to universally permitted syllable-initial clusters, and, since *ft-* is a possible initial cluster in Modern Greek *ftinós* 'inexpensive' or Russian *ftoróy* 'second', it is possible to make *f* ambisyllabic in English *after*. Gussenhoven in fact denies that Kahn's Rule IV exists in English. Gussenhoven's Extended Right Capture predicts a different syllabification for *after*, where *t* rather than *f* is ambisyllabic. Kahn also proposes Rule V, which is identical to Gussenhoven's Liaison and Rubach's Onset Ambisyllabicity (7).

Kahn's rules allow a fairly compact statement of the rules for aspiration and flapping, given in (26).

(26) a. *Aspiration* (Kahn 1976: 45)
/p t k/ are aspirated if and only if they are syllable-initial and non-syllable-final.

b. *Flapping* (Kahn 1976: 61; ordered after Aspiration)[15]
/t/ is flapped between a non-consonant and a tautosyllabic vowel.

The restriction to non-syllable-final stops in aspiration excludes ambisyllabic segments, and the ordering of Aspiration before Flapping effectively restricts Flapping to ambisyllabic elements. For example, in *potato*, the three stops are all syllable-initial. Rule III (25) attaches the second *t* to the previous syllable also, since the final vowel is unstressed. The first *t* cannot become ambisyllabic due to the presence of stress on the following vowel, while the initial *p* cannot become ambisyllabic because there is no preceding syllable. Rule IV therefore predicts that *p* and the first *t* are aspirated, while the second *t* is flapped.

While Kahn's rules make correct predictions in a wide variety of cases, they incorrectly predict aspiration in a number of words where this does

[15] We assume that /d/ is also flapped, although it is not mentioned in Kahn's rule.

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not occur. Picard (1984: 50) cites the words of (27a), in which Kahn's rules incorrectly predict aspirated *t*.[16] The parallel additional examples in (27b), with non-coronal stops, were suggested by a reviewer.

(27) a. paltry, countries, actress
b. empress, culprit, acrid

In (27a) the *t* is in each case syllable-initial by the principle of onset maximisation but cannot be ambisyllabic by (25) in Kahn's framework, because it is not preceded by a vowel. Kahn's Rule IV cannot apply to these cases because *ltr-*, *ntr-*, *ktr-* do not belong to the category of universally permitted onset clusters. We can observe that Gussenhoven's extension of Right Capture (Extended Right Capture (18)) would make these *t*'s ambisyllabic, correctly removing them from the domain of Aspiration in North American English. However, Gussenhoven's refinement of Kahn's analysis still overgenerates aspiration. With Kahn, it predicts aspiration of *t* in *Washington* (see note 16).

A crucial element in Kahn's rules for ambisyllabification is stress, which he regards as a segmental feature in the same way as *SPE*. With the rise of metrical phonology, new light was shed on the entire question of stop allophones. In metrical phonology, stress is not a property of segments but a structural property of syllables: a stressed syllable is the one marked as strong within a foot. Kiparsky (1979) observes that the stress condition on Kahn's ambisyllabicity rules could be replaced by reference to position in the foot, so that the stop allophones can be accounted for in prosodic terms without recourse to ambisyllabicity. Specifically, Kiparsky proposes a laxing rule that laxes all consonants preceded by a non-consonantal segment within a foot, which we state as (28).

(28) *Laxing* (Kiparsky 1979: 437)
$C \rightarrow [-\text{tense}] / _{F}[\ldots[-\text{cons}]__\ldots]$

Kiparsky then proposes rules for Aspiration, Flapping and Glottalisation that depend on tenseness. We restate his rules in (29).[17] In (29a, b) the prosodic domain captures syllable-initial position by requiring the consonant in the input to be the left sister of a strong node to its right. In Kiparsky's syllable structure trees, the highest division is between a weak node on the left (roughly corresponding to the onset) and a strong

[16] Picard does not discuss examples like *Washington*, which Kahn claims to have aspirated *t*. I have always been puzzled by this claim, which is certainly not true of my speech (compare the clearly aspirated *t* in *Washingtonian*). Kahn bases this claim on the presumed universal exclusion of [ŋt-] as a syllable-initial cluster. Kahn is rather vague on what clusters he regards as universally permitted or proscribed, however.

[17] I have replaced some of Kiparsky's ad hoc notations with more standard ones, e.g. I use [−tense] for his [+lax], F for foot instead of his φ, [+spread glottis] for his [+aspirated] and [+constricted glottis] for his [+glottalised]. The substance is unchanged.

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node on the right (roughly, the rhyme). The labelling of terminal nodes follows the sonority hierarchy, with *s* dominating a more sonorous segment than its sister *w*. Therefore, the context in (29a, b) corresponds to syllable-initial position before a more sonorous segment, either the nucleus or an onset sonorant. The *t* in *stop* is *preceded* by a more sonorous segment, and so is not in a position to undergo these rules.

(29) a. *Aspiration* (Kiparsky 1979: 437)

$$\begin{bmatrix}+\text{tense}\\-\text{voice}\end{bmatrix} \rightarrow [+\text{spr gl}] \,/\, \underset{\quad}{\overset{\wedge}{\quad}}\ \text{s}$$

b. *Flapping* (Kiparsky 1979: 437)

$$\begin{bmatrix}-\text{tense}\\+\text{cor}\end{bmatrix} \rightarrow [+\text{voice}] \,/\, \underset{\quad}{\overset{\wedge}{\quad}}\ \text{s}$$

c. *Glottalisation* (Kiparsky 1979: 437)

$$\begin{bmatrix}-\text{tense}\\-\text{voice}\end{bmatrix} \rightarrow [+\text{constr gl}]$$

If we consider *potato* once more, rule (28) will affect only the second *t*, making it [−tense]. Aspiration (29a) affects the [+tense] stops, namely the *p* and the first *t*. The laxed second *t* is ineligible for Aspiration, but can undergo Flapping (29b). In a word like *spit*, only *t* can be laxed by (28). Although *p* remains [+tense], it cannot be aspirated, because it is not syllable-initial. In Kiparsky's somewhat cryptic notation, Aspiration (29a) affects a tense voiceless stops that is a weak sister of a strong node to the right. Although *t* is lax, it cannot be flapped, because it is not syllable-initial, but Glottalisation applies, since, by the ordering, it affects all lax stops that have not been flapped.

The details of this analysis are not entirely correct. Picard (1984: 51) points out that the same words in (27) that are problematic for Kahn's analysis are incorrectly predicted to have aspirated *t* in Kiparsky's framework as well. In all the words of (27), *t* is preceded by a consonantal segment and so cannot be laxed by (28), and so will incorrectly be aspirated by (29a). Picard goes on to reject entirely the idea that prosodic structure is involved, and proposes an analysis that does little more than list the environments in which various stop allophones can appear. We do not have to go to that extreme, however, since there is certainly a germ of truth in Kiparsky's analysis. Specifically, we can define foot-initial position as a strong position, where aspiration occurs, while other positions in the foot are subject to weakening, either flapping or glottalisation, depending on segmental conditions and on dialectal and stylistic factors. We have already introduced a tensing rule, (9), in connection with RP *r*-tapping, which we formulated to apply to all consonants in foot-initial position. We now require the rules of (30), in the order shown (Nespor & Vogel 1986, Jensen 1993).

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(30) a. *Aspiration*

$$\begin{bmatrix}-\text{cont}\\+\text{tense}\\-\text{voice}\end{bmatrix} \rightarrow [+\text{spr gl}]$$

b. *Flapping*

$$\begin{bmatrix}+\text{cor}\\-\text{strid}\\-\text{cont}\\-\text{tense}\end{bmatrix} \rightarrow [\text{ɾ}] / [\ \ldots\ [-\text{cons}]\ __\ \text{V}\ \ldots\ ]_{\text{U}}$$

c. *Glottalisation*[18]

$$\begin{bmatrix}-\text{cont}\\-\text{tense}\\-\text{voice}\end{bmatrix} \rightarrow [+\text{constr gl}] / [\ \ldots\ [+\text{son}]\ __\ \text{C}_{\text{o}}]_{\sigma}$$

The context for Flapping is the phonological utterance (U), since flapping can occur in the stated segmental environment even at a sentence boundary. Nespor & Vogel (1986: 221ff) define the phonological utterance as the highest prosodic constituent, dominating all the intonation phrases (I) within the highest node of a syntactic tree, $X^0$. They also allow for two or more adjacent Us to be restructured, or joined into a single U when appropriate phonological, pragmatic, syntactic and semantic relations hold between the Us in question. Specifically, the sentences must be relatively short, not separated by a pause, and they must be uttered by the same speaker to the same interlocutor. In addition, they must either contain a relation of ellipsis or anaphora, or else be related implicitly by one of the logico-semantic operators *and*, *therefore* or *because*. Thus, Flapping can apply to the bold *t* or *d* of the utterances in (31).

(31) a. wa**t**er
b. aci**d**ic
c. ri**d**er
d. whi**t**ish
e. hea**d**ache
f. the whi**t**e owl
g. My brother boug**h**t a parrot.
h. A very dangerous wild ca**t** escaped from the zoo.
i. Icabo**d**, our pet crane, usually hides when guests come.
j. Have a sea**t**. I'll be right back.

There is an important empirical consequence of the foot-based analysis of stop allophones which cannot be derived in syllable-based theories, even with ambisyllabicity. The contrast in (32) was first observed by Withgott (1982).

[18] This formulation of Glottalisation does not account for the glottalised *t* before syllabic *n*, as in *button*. Notice that *t* flaps rather than glottalises before syllabic *m*, as in *bottom*, and flaps also before syllabic liquids (*bottle*, *butter*). This appears to be a problem for all analyses. Gussenhoven's analysis predicts Preglottalisation in British English in all these environments, but this appears to be correct for RP only before syllabic *n*. Cockney has glottalisation, or glottal stop, before all syllabic sonorants.

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(32) a. càpitalístic
b. mìlitarístic
sànitisátion
mònotonícity
c. Mèditerránean
Winnipesáukee
Nàvratilóva
àbracadábra

All the words in (32) have a secondary stress on the first syllable and main stress on the fourth syllable. The second and third syllables are unstressed. The stop at the beginning of the third syllable (boldfaced in (32)) is the one of interest. This stop is flapped in (32a) but aspirated in (32b, c), despite being in identical stress environments in all three cases. Withgott uses these data to motivate a major modification of Hayes' (1982) stress system for English. Hayes' analysis involves extrametricality rules, an iterative stress assignment rule, several destressing rules and a rule of Stray Syllable Adjunction. Syllables that belong to no foot, either by virtue of extrametricality or because their foot was removed by destressing, are adjoined to a foot. Hayes assumes that all such syllables are adjoined to a foot to their left, if possible, owing to a kind of structure preservation principle, since English feet are fundamentally trochaic. If it happens that two stray syllables appear word-medially, as in (*a*)*braca*(*dabra*) (after Poststress Destressing), Hayes attaches both syllables to the foot on the left. Withgott points out that the requirement that stray syllables attach to *adjacent* feet ought to have the consequence that the first stray syllable of *abracadabra* attaches to the foot to the left and the second stray syllable attaches to the right. Adjunction to the right is needed in any case, as when a word-initial syllable is made stray by destressing, as in *potato* (see (3)). Prince (1983: 88, n. 3) also notes the difference between what he calls the 'distributional' feet of words like (32c), e.g. (*abraca*) (*dabra*), and the 'felt' feet, e.g. (*abra*) (*cadabra*). The 'distributional' foot is the one derived by Hayes' rule (adjunction to the left whenever possible), while the 'felt' feet are derived by adjoining a light syllable to a following foot. Prince uses these facts to argue against foot constituents and in favour of a pure grid approach to metrical structure. It is now generally recognised that a pure grid approach is inadequate, and that constituency is required. The most popular notation is the constituentised grid of Halle & Vergnaud (1987) and Hayes (1995), but these seem to be notationally equivalent to trees,[19]

[19] Hayes (1995: 108ff) notes that trees contain more information if adjunction is employed and avoids adjunction. However, the distribution of stop allophones cannot be fully stated without adjunction structures.

A reviewer objects that trees do not represent rhythm, which requires the grid. This is incorrect for two reasons. First, grids, whether derived from trees as in Liberman & Prince (1977) or constructed directly as in Prince (1983), cannot provide *more* information than trees and so cannot represent either stress or rhythm more completely than trees. At best, grids provide a more direct visual representation of stress and rhythm than trees. One can argue in favour of grids by stating that the notation is more restrictive than trees. However, this very restrictiveness is the second reason for rejecting the grid: the grid does not adequately represent rhythm either. An adequate representation of rhythm requires grouping, such as provided by trees or by constituentised grids. In fact, even constituentised grids do not adequately represent rhythm, in the absence of adjunction – surely the 'felt' feet of Prince (1983) have to be part of any adequate account of rhythm. The 'felt' feet

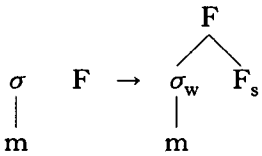
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so we can state metrical structure in terms of trees and dispense with the grid without loss of generality. It is also conceptually more uniform to represent all prosodic constituents in terms of trees.

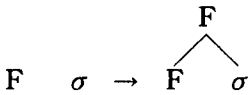
However, it can equally be argued that the 'felt' foot is the right one and the 'distributional' foot is an artefact of an incorrect analysis of adjunction. Withgott indeed claims that a light syllable is adjoined to the right, but does not adequately formalise adjunction. Therefore, she has to state aspiration as a disjunction: 'stops are aspirated when they begin a foot, and when they begin the stressed syllable of a foot' (1982: 161). This disjunction is unnecessary if adjunction is stated as Chomsky Adjunction. The original foot is preserved and a new foot is created to dominate the adjoined syllable and the original foot. We can state Stray Syllable Adjunction as in (33) in two parts, applied in this order and ordered disjunctively by the Elsewhere Condition.[20]

(33) *Stray Syllable Adjunction*

a. Adjoin a stray light syllable to an adjacent foot to the right




b. Adjoin a stray syllable to an adjacent foot to the left




Rule (9) makes consonants [+tense] at the beginning of a foot. Rule (30a) aspirates voiceless stops that are tense. This includes the *p* and the first *t* of *potato*, as already demonstrated in (3). We can now see that the third syllable in (32c) is adjoined to the foot on its right by (33a); the initial voiceless stop of this syllable is aspirated by (9) and (30a). The contrast between (32a) and (32b) is explained in terms of a cyclic derivation of stress. Specifically, in (32a), there is an initial cycle on (*capi*)*tal*, placing a foot as indicated by parentheses. By the end of this cycle, the final syllable is adjoined to the left by (33b), since this is the only place it can go. A second cycle is initiated by suffixation of *-istic*, with a foot being formed on the sequence *listic*, deforming the existing foot structure minimally. The footing is then (*capita*)(*listic*). The *t* at the beginning of the third

provided by Stray Syllable Adjunction (33) are in fact the only feet needed for stress, rhythm and segmental allophony.

[20] Both parts of (33) apply to words like *abracadabra*, which is allowed by the Elsewhere Condition since different syllables are involved. Also, a single syllable between feet may be adjoined to a monosyllabic foot to its left, for example, the second syllable of *migratory*.

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syllable is foot-internal, and eligible for flapping. In (32b) the first cycle produces two feet in (*mili*)(*tary*). After suffixation the foot on (*tary*) is removed and the structure is (*mili*)*ta*(*ristic*). At this point the syllable *ta* adjoins to the foot on its right by (33a), giving (*mili*)(*ta*(*ristic*)). In this structure the *t* at the beginning of the third syllable is foot-initial, and so aspirated.

This analysis has been given in terms of Hayes (1982) for concreteness, but it is not necessary to insist on the details of that analysis. It is important to observe the necessity of cyclicity and the modified version of Stray Syllable Adjunction given in (33).

## 4.2 Other prosodic categories

We have emphasised the importance of the foot in our analysis of Aspiration in English. Prosodic theory makes the full range of prosodic categories in (1) available as rule domains, and indeed Nespor & Vogel (1986) illustrate the use of these categories (except for the mora and the segment) in phonological rules from various languages. In English, the syllable is the domain for Glottalisation (30c) and the utterance is the domain for Flapping (30b). According to Gussenhoven (1986), it is in syllable-initial position that voiceless stops are aspirated in British English. Whether or not this is a correct description of RP, such a dialect can certainly be described in the prosodic framework, and it is reasonable to expect that dialects may differ precisely in the prosodic domains that condition certain processes. For example, there are dialects in which aspiration is more restricted than predicted by rules (9) and (30a), in which pronunciations such as those in (34) are heard, with a flap in initial position of a stressed syllable. Some of these dialects have a flap for the first *t* in (34a) but an aspirated [t$^{h}$] in (34b); other dialects have a flap in both (34a, b).

(34) a. potato [p$^{h}$ə'ɾeyɾo]
b. eighteen [ˌey'ɾiyn]

There is no explanation for these facts in a theory that regards English flapping as a consequence of ambisyllabicity, since it is precisely the initial position in stressed syllables that is excluded from ambisyllabicity, whether stated as in (6) or as in (18). Such theories could presumably adjust their statement of the rules for Aspiration and Flapping in some way, although it is difficult to see how this could be done without appealing to prosodic categories such as foot and prosodic word. Our theory restricts the domain of Aspiration (30a) to account for these dialects. If (30a) is restricted to the context where a voiceless stop is initial in the *maximal* foot, the pronunciation of *potato* as [p$^{h}$ə'ɾeyɾo] is accounted for but *eighteen* would still have an aspirated [t$^{h}$] since there are two (maximal, i.e. non-embedded) feet in this word. If (30a) is restricted to apply to voiceless stops that are initial in the prosodic word, both (34a, b) are accounted for. However, we would predict that no dialect could have

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a flap in (34b) but aspirated [$t^h$] for the first *t* of (34a), which appears to be correct.

There is additional evidence for the syllable and prosodic word as phonological categories if other processes are considered. Kiparsky (1979) correctly identifies the foot as the domain of Aspiration, but incorrectly assigns two other rules of English to the foot domain. One is a rule that devoices sonorants after voiceless consonants, illustrated in (35).[21]

(35) a. *sonorant devoiced*
cry
play
stray
mattress
Islip
eye slip

b. *sonorant remains voiced*
Atlas
ice lip

Examples like *Atlas* show that the domain of sonorant devoicing is the syllable rather than the foot, since this word contains a single foot but the *l* is not devoiced. We can state sonorant devoicing as in (36).

(36) *Sonorant Devoicing*

$$[+\text{son}] \rightarrow [-\text{voice}] / [\ldots [-\text{voice}] __ \ldots]_{\sigma}$$

The other rule is one that Nespor & Vogel call Diphthong Shortening.[22] This rule shortens the diphthongs /ɑy/ and /ɑw/ (more accurately, raises and laxes their first element) when they are followed by a voiceless obstruent, as in (37).

(37) a. *diphthong shortened*
Islip
ice lip
night rate
nitrate
mica
icon

b. *diphthong remains long*
**eye** slip
Nye trait
my car
**eye** care

Kiparsky (1979: 440) argues that Sonorant Devoicing and Diphthong Shortening cannot *both* have the syllable as their domain, since there is no single syllabification of *Islip* (short of the absurd *Isl.ip*) that provides the syllabic environment for both rules. We have seen evidence that Sonorant

[21] A reviewer points out that sonorants are not devoiced after fricatives in British English. However, the facts are as Kiparsky describe them in many North American dialects.

[22] This is actually part of a more general process that shortens any vowel in this position. Its effect is most noticeable in the case of these two diphthongs, where it is sometimes referred to as Canadian Raising. The raising of /ɑy/ is widespread in North America outside the southern United States, while the raising of /ɑw/ is more restricted to Canada and is often regarded as a diagnostic of Canadian as opposed to American English. We abstract away from this dialectal variation here, concentrating on the raising of /ɑy/.

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Devoicing is a syllabically conditioned rule. Examples like *nitrate* show that Diphthong Shortening has a domain larger than the foot, namely the phonological word, since *nitrate* contains two feet. We state Diphthong Shortening in (38).

(38) *Diphthong Shortening*

$$V \rightarrow \begin{bmatrix} -\text{low} \\ -\text{tense} \end{bmatrix} / [ \ldots __ [-\text{cons}][-\text{voice}] \ldots ]_{\omega}$$

For *Islip*, an advocate of ambisyllabicity could claim that the *s* is ambisyllabic, and thus maintain syllable conditioning for both Sonorant Devoicing and Diphthong Shortening.[23] But this reasoning cannot be extended to *nitrate*: the stress on the second syllable blocks ambisyllabification of the first *t*. This shows that a theory of syllabic conditioning of segmental rules, even augmented with ambisyllabicity, cannot deal with the full range of facts in the absence of an appeal to higher prosodic categories.[24]

## 4.3 Rules *vs.* constraints

We have set our analysis of English stop allophones in terms of rules, as do most of the ambisyllabic analyses we reject. Some suggestions have been made for dealing with this phenomenon in terms of constraints, couched in terms of Optimality Theory (e.g. Prince & Smolensky 1993). In this subsection we will consider some of these. While some of this work is suggestive, we will see that a complete analysis of stop allophones in constraint terms is not going to be straightforward. OT approaches to these questions have simply assumed ambisyllabicity and Kahn's view that ambisyllabic *t* and *d* are flapped. They do not provide an explicit account of this phonetic realisation. Constraint rankings that determine the allophonic status of stops at word juncture do not generalise to word-internal position. To achieve this, an OT account has to introduce constraints that are quite specific to aspiration and flapping. In doing so, OT too can dispense with ambisyllabicity, but it sacrifices the ability to describe these phenomena in terms of universal constraints.

McCarthy & Prince (1993a: 130–131) discuss the case of English stop allophones in OT terms. They assume with Kahn that flapping is diagnostic for ambisyllabicity in English, and they seek the junctural

[23] The *s* would be ambisyllabic by Kahn's Rule IV (Left Capture), which Gussenhoven rejects. Therefore, only some ambisyllabic theories could achieve this result.

[24] A reviewer notes that the analysis presented here relies on rule ordering and *SPE*-style rule formulations. This is a question entirely independent of the ambisyllabicity issue discussed here, since the analyses of Kahn (1976), Gussenhoven (1986) and Rubach (1996) also rely on such rule formulations and ordering. Indeed, analyses that reject such devices, such as OT, only hint at an analysis of the phenomena, and come nowhere near the empirical coverage of the rule-based analyses of this material. The next subsection shows the difficulties that arise when attempting an explicitly rule-free analysis.

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difference between the phrases *sought Ed* (with a flap) and *saw Ted* (with aspiration) in the constraint ranking ONSET ≫ ALIGN-L ≫ FINAL-C. We state these constraints in (39).

(39) a. ONSET
Syllables have onsets

b. ALIGN-L
Align (Stem-L, PrWd-L)

c. FINAL-C (McCarthy 1993)
$*V)_{\omega}$

The effect of this ranking is to allow the flap in *sought Ed* to fulfil both ONSET and FINAL-C in the optimal output form. This segment is therefore ambisyllabic, as it would be also by Kahn's Rule V or Gussenhoven's Liaison, and interpreted (through unstated phonetic interpretation) as a flap. McCarthy & Prince contrast English in this respect with Polish, where they assign the ranking ALIGN-L ≫ ONSET, disallowing any re-syllabification or ambisyllabification across word boundaries.

A major defect in McCarthy & Prince's account of flapping at word boundaries is that it cannot be extended to account for flapping within words such as *butter*. Here neither ALIGN-L nor FINAL-C is relevant. In the absence of a higher-ranked constraint demanding ambisyllabicity in this environment, NOCODA will force the medial *t* in *butter* to be exclusively in the onset of the second syllable, and therefore not flapped. Notice that Polish does not have flapping in any position. Whatever it is that allows flapping in English and disallows it in Polish must be something other than the ranking of the constraints in (39). Furthermore, this makes a unified analysis of flapping impossible, since *butter* and *sought Ed* would have distinct explanations. At least a new constraint, ranked above NOCODA, would be needed, to the effect perhaps of disallowing stressed light syllables. This still would not enforce flapping in words like *cater*, where the stop appears after a long vowel. Alternatively, an OT analysis can be proposed that relies on specific constraints on aspiration and flapping. Such constraints closely resemble the corresponding rules in our approach and their ranking reflects the ordering of the corresponding rules. It is not clear that such constraints can be considered universal. But such an OT account can dispense with ambisyllabicity, just as the rule approach does.

There is a problem too with McCarthy & Prince's assumption that the interpretation of an ambisyllabic segment can be left until 'later', in the phonetics. It was a general assumption of early OT that there were many such interpretive aspects that could be left for the phonetics, especially the interpretation of epenthetic segments. A number of considerations led to abandoning this model, which was based on the principle of containment and constraints like PARSE and FILL. I will mention just two. First, McCarthy (1995) shows that metathesis in Rotuman is better accounted for as a violation of LINEARITY, ranked below MAX, than in terms of PARSE and FILL, both of which are violated in a metathetic form. Second, in

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vowel-harmony systems, epenthetic vowels often participate in harmony, as in Hungarian, and so the constraints responsible for epenthesis must be on a par with constraints responsible for vowel quality. The Rotuman case argues for correspondence constraints relating input and output, while the vowel-harmony case argues for fully specified outputs. For English stop allophones, McCarthy & Prince rely on later phonetic interpretation to realise an ambisyllabic *t* as a flap and an onset non-ambisyllabic voiceless stop as aspirated. If we require fully specified outputs, this solution is no longer available, and flaps and aspirated and glottalised segments need to have these properties specified in the output. This implies that stop allophones in English must be accounted for in terms of constraints specific to these segmental qualities, rather than general constraints on syllable form (ONSET, etc.).

The exact formulation of the required constraints is no easy matter. We cannot simply state an alignment constraint that requires all aspirated stops to appear initially in a foot, since this would be equally unviolated by aspirated and unaspirated stops in that position. Conversely, we cannot require that all feet begin with an aspirated stop, since other segment types must be permitted in that position. Rather, the constraint seems to be one that bars unaspirated voiceless stops in foot-initial position, as in (40).

(40) ASPIRATION (constraint)

$$* \, {}_{F}[ \begin{bmatrix} -\text{cont} \\ -\text{voice} \\ -\text{spr gl} \end{bmatrix}$$

Alternatively, we could take a cue from Stanley (1967) and formulate ASPIRATION as an if–then condition. Stanley allowed for three types of morpheme structure conditions, positive constraints that state permissible structures, negative constraints like (40) that state impermissible structures and if–then conditions. ASPIRATION is stated in (41) as an if–then condition.

(41) ASPIRATION (if-then constraint)

$$\text{if:} \quad {}_{F}[ \begin{bmatrix} -\text{cont} \\ -\text{voice} \end{bmatrix} \ldots ]$$

$$\downarrow$$

$$\text{then:} \quad [+\text{spr gl}]$$

The constraint in (41) is not to be interpreted as a correspondence.[25] It is interpreted as a constraint on outputs: if a segment with the features [−continuant, −voice] occurs in the output, then this segment must be [+spread glottis].

The formulation in (41) is more like a rule than a universal constraint, and in fact closely resembles the rule for Aspiration (9) or (30a). The use

[25] Thanks to a reviewer for this clarification.

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of such constraints means that it is no longer possible to claim that phenomena such as aspiration and flapping are accounted for in terms of universal constraints like ONSET, ALIGN-L or FINAL-C. Constraints like (40) or (41) are just as specific to the phenomena in question as the corresponding rules, and so constitute no improvement over rules. It seems that many constraints proposed to deal with segmental (as opposed to prosodic) effects have this property; cf. Orgun (1996), who proposes a constraint PALATALISATION for Hausa that states 'coronal obstruents are palatalised before front vowels'. We also assume high-ranking IDENT constraints (in the sense of McCarthy & Prince 1995) on the features [continuant] and [voice], and on points of articulation, but not on [spread glottis] (whether or not specified in underlying representations). Additional constraints of the *STRUC family (a broad family of constraints that ban structure altogether, cf. Prince & Smolensky 1993: 25, n. 13) bar gratuitous insertion of [+spread glottis] in other positions.

Flapping might be handled in an exactly analogous fashion, by the if–then constraint in (42). As with rule (8b), we state the constraint in terms of the phonological utterance, without making specific reference to foot-internal position, on the assumption that FLAPPING will apply everywhere in the stated environment where it has not been bled (using ordered-rule terminology) by ASPIRATION. This more general formulation is supported by the dialects in which ASPIRATION is more restricted, as described in (34) above; in these dialects FLAPPING is correspondingly more general.

(42) FLAPPING (constraint)

if: $_{U}[\ldots [-\text{cons}] \begin{bmatrix} +\text{cons} \\ -\text{cont} \\ +\text{cor} \\ +\text{ant} \end{bmatrix} V \ldots ]$

$\downarrow$

then: $\begin{bmatrix} +\text{son} \\ +\text{voice} \end{bmatrix}$

If we now compare the pair *sought Ed* and *saw Ted*, we predict flapping in the former and aspiration in the latter if ASPIRATION is ranked above FLAPPING; we also predict flapping in *butter*. Contrary to McCarthy & Prince (1993a), we rank ALIGN-L (39b) above ONSET (39a), predicting that there is no resyllabification or ambisyllabification across word boundaries in English, exactly as in Polish, in which phrases like *mechanizm .obronny* 'defence mechanism' and prefixed forms like *roz.ognić* 'heat' are syllabified as shown.[26] Polish does not exhibit the sharp allophonic distinctions

[26] In this tableau, the constraint *STRUC stands for a family of constraints that prohibit adding extra structure or perhaps simply faithfulness constraints. It is ranked low, because the optimal candidate is unfaithful, in obedience to higher-ranked ASPIRATION or FLAPPING; however, such input properties as coronality remain unchanged.

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that are diagnostic in English for the prosodic distinctions discussed here, however.

(43)

| a. sought Ed | ALIGN-L | ONSET | ASP | FLAPPING | *STRUC |
|---|---|---|---|---|---|
| ☞ (sɔɾ)(ɛd) | | * | | | * |
| (sɔ)($t^h$ɛd) | *! | | | * | * |
| (sɔ)(ɾɛd) | *! | | * | | * |
| (sɔ$t^h$)(ɛd) | | * | | *! | * |
| b. saw Ted | | | | | |
| (sɔɾ)(ɛd) | *! | * | | | * |
| ☞ (sɔ)($t^h$ɛd) | | | | * | * |
| (sɔ)(ɾɛd) | | | *! | | * |

Having eliminated ambisyllabicity as a condition for flapping, however, it becomes difficult to justify an optimality analysis over a rule analysis. That is, the context for flapping is primarily segmental: it occurs when the coronal stop follows a non-consonantal segment and precedes a vowel. It is prosodic only to the extent that its domain is the phonological utterance. Another phenomenon where the question of rules *vs.* constraints arises is *r*-intrusion in English.

## 4.4 *r*-intrusion in English

The phenomena of *r*-linking and *r*-intrusion in non-rhotic varieties of English (RP, Eastern Massachusetts) have received much attention in the descriptive literature (Jones 1966, Wells 1982). Nespor & Vogel (1986) analyse this as a rule of *r*-insertion in a specific segmental environment, within the domain span of the utterance, as in (44).

(44) r-*insertion* (Nespor & Vogel 1986: 229)

$$\emptyset \rightarrow \text{r} \; / \; {}_{U}[ \ldots \begin{Bmatrix} \text{ɔ} \\ \text{ɑ} \\ \text{ə} \end{Bmatrix} __ \; \text{V} \ldots ]$$

This rule accounts for the appearance of *r* in (45b) as opposed to its non-appearance in (45a). The overstrike indicates etymological *r* that is not realised phonetically.

(45) a. wate~~r~~ b. wate[r]y
bea~~r~~ bea[r] ish
law law[r] abiding
ea~~r~~ ea[r] ache
fou~~r~~ fou[r] ostrich feathers
panda The giant panda[r], as you know, is an endangered species.

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McCarthy (1993) refines this with the observation that intrusive and linking *r* appear only at the end of lexical words, and not at the end of function words. For example, there is no *r*-intrusion after vowel-final function words like *gonna* (46).

(46) I'm gonna *[r] eat.
We shoulda *[r] eaten.
To add to *[r] his troubles.

McCarthy proposes that such function words are cliticised to the following word, forming a single phonological word with them.[27] If we assign the prosodic structures in (47) to the utterances in (46):

(47) $(\text{I'm})_{\omega}$ $(\text{gonna eat})_{\omega}$
$(\text{We})_{\omega}$ $(\text{shoulda eaten})_{\omega}$
$(\text{To add})_{\omega}$ $(\text{to his troubles})_{\omega}$

we can get the right results in these cases, as well as those in (45), by revising the rule as in (48).

(48) r-*insertion* (suggested refinement: features replace vowel disjunction)

$$\emptyset \rightarrow \text{r} \; / \; {}_{U}[ \ldots {}_{\omega}[ \ldots \begin{bmatrix} \text{V} \\ -\text{tense} \\ -\text{high} \\ +\text{back} \end{bmatrix} __ ] \; \text{V} \ldots ]$$

But both linking and intrusive *r* appear freely before reduced function words, as shown in (49).

(49) Cuba [r] has been in the news lately.
I saw [r] 'em.

We may suppose the prosodic structures in (50) in the examples of (49). In the case of *saw 'em* McCarthy assumes a recursive prosodic word structure, which also appears word-internally in ((*water*)*y*), ((*withdraw*)*al*), ((*bear*)*ish*) (Inkelas 1989).

(50) $(\text{Cuba})_{\omega}$ $(\text{has been})_{\omega}$
$(\text{I})_{\omega}$ $((\text{saw})_{\omega}$ $\text{'em})_{\omega}$

Nespor & Vogel do not distinguish between intrusive and linking *r*.

[27] Nespor & Vogel (1986) would assign their prosodic category clitic group to such collocations of a lexical word with a clitic element. Problems associated with the category clitic group include the fact that, by the prosodic hierarchy, it groups together prosodic words, so that the clitic as well as the lexical word would be a prosodic word and therefore contain a foot and thus stress. Since one of the defining characteristics of clitics is that they are typically stressless, this prosodic unit seems to have undesired consequences. We therefore follow Booij (1996) and many others in assuming that clitics are incorporated into the prosodic word of their hosts.

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McCarthy observes that there is one case where intrusive and linking *r* behave differently: in contrast to (46), function words that end in etymological *r* retain it in the context before a vowel, as in (51).

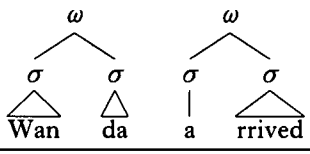
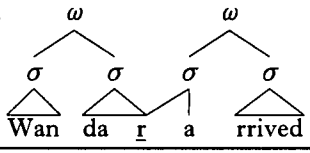
(51) They'[r]e eating. Tom and I a[r]e eating.
Tom and I we[r]e eating. Ou[r] answer was...
Thei[r] answer was... He didn't give he[r] any trouble.
...fo[r] any reason... ...eithe[r] apples o[r] oranges...
Afte[r] all... Unde[r] any circumstances...

As McCarthy observes, function words in English are usually proclitic: they attach phonologically to the following prosodic word. However, as Klavans (1985) notes, the direction of phonological cliticisation is not always the same as that of syntactic cliticisation. In particular, the reduced forms of the copula cliticise phonologically to their left, resulting in prosodic structures like $((\text{they})_\omega \text{re})_\omega$ in *they're eating*. This is no problem for the analysis so far. But $(\text{their answer})_\omega$ is presumably a single phonological word rather than a nested structure $((\text{their})_\omega \text{answer})_\omega$, so a rule-based account would presumably require an *r*-deletion rule to account for the lack of *r* in phrases like *thei*/ *comment* as well as in words like *Homer*, where an underlying *r* is motivated by the derivative *Homeric*. McCarthy's claim is that an analysis based entirely on constraints, rather than rules, can avoid this additional complication. However, his analysis requires a rule after all, as we will show at the end of this section (cf. (54)), and so appears to be more complex than an analysis that relies solely on rules. In addition, as demonstrated by Halle & Idsardi (1997), the constraint-based analysis cannot naturally be extended to accommodate Schwa Insertion. This rule has slightly different conditions in Eastern Massachusetts than in British English, the case we discussed in §3.4; nevertheless, in both dialects it stands in an opaque (counterbleeding) relation with *r*-deletion. Therefore, the best analysis is one with two word-level rules, Schwa Insertion and *r*-deletion, in that order, and a postlexical rule (44) of *r*-insertion.

McCarthy's reanalysis does not take the route of refining the rule. Rather, he analyses intrusive *r* in OT as a way of satisfying two constraints: FINAL-C (39c) and ONSET (39a). McCarthy also invokes a version of the Coda Condition that prohibits the appearance of *r* in codas (or equivalently, licenses it only in onsets). We can assume that ambisyllabic *r* does not violate the Coda Condition, either by stating that enforcement of the Coda Condition is subject to Hayes' (1986) Linking Constraint or by assuming that it is licensed in onsets, which would not be violated by its simultaneous appearance in codas. The ONSET constraint does not distinguish candidates in the cases discussed by McCarthy, so we illustrate with tableaux including only the Coda Condition (CODACOND) and FINAL-C. For example, the phrase *Wanda(r) arrived* is best realised with an intrusive *r*, as shown by tableau (52), from McCarthy (1993: 186).

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(52)

| Wanda arrived | CODACOND | FINAL-C |
|---|---|---|
| a.   | | *! |
| ☞ b.   | | |

McCarthy justifies the appeal to ambisyllabicity in part by noting that there is a phonetic difference between intrusive *r* in (53a) and onset *r* in (53b).

(53) a. I saw[r] eels (in the fish market).
Wanda[r] adduced (a crucial example).
Wanda[r] announced (her engagement).
The Shah[r] accords (with his view).
Sabah has mo[r]e oil than Saud.
I'll have anothe[r] ale.
You[r] edema.

b. I saw reels (of film).
Wanda reduced (the sauce).
Wanda renounced (her fortune).
The Shah records (Radio Tehran).
Sabah is more royal than Saud.
I'll have another rail.
Your redeemer.

McCarthy states 'that the principal difference between, say, *sawr eels* [sɔr iylz] and *saw reels* [sɔ riylz], is that the *r* of *sawr eels* is considerably more vocalic, with more energy at all frequencies. This kind of phonetic difference is not too surprising, since coda *r*s are known to be more vocalic than onset *r*s in other English dialects' (1993: 179). In fact, this phonetic evidence shows only that intrusive *r* is syllable-final, not that it is ambisyllabic. This analysis raised the possibility of a three-way distinction between no resyllabification, ambisyllabification and complete resyllabification. The phonetic facts support only a two-way distinction between no resyllabification and complete resyllabification (as in the Romance languages). McCarthy alludes to other junctural contrasts like *nitrate/night rate* and *an aim/a name*, but as we analysed these in terms of prosodic categories in §4.2, no ambisyllabicity is needed here either.

McCarthy's analysis runs into a serious difficulty when we consider the question of how candidates come to have *r* in the first place. After arguing against the possibility that the default consonant in English is *r*, McCarthy proposes a rule that inserts *r*, as in (54).

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(54) r-*insertion* (McCarthy 1993: 190–191)
$\emptyset \rightarrow$ r (*perhaps in the context* __ #)

But just what is this rule doing in an optimality analysis? According to McCarthy (1993: 191), 'the role of the rule $\emptyset \rightarrow$ r is to enlarge the candidate set in a very limited way, stipulating the phonologically unnatural phenomenon of *r* epenthesis'. Since a rule is required in any event, and an opaque (counterbleeding) order is required to extend the analysis to account for Schwa Insertion, a rule-based analysis is better motivated overall than one based on constraints. As Halle & Idsardi (1997) note, the assumption of ambisyllabicity is crucial to the constraint-based analysis, but for a solution in terms of ordered rules, intrusive *r* can simply be coda *r*. So ambisyllabicity is not needed to analyse *r*-intrusion in English.

## 5 Ambisyllabicity in German

### 5.1 Distribution of tense and lax vowels

One application of ambisyllabicity in German phonology is to account for the distribution of long (or tense) and short (or lax) vowels, discussed by Ramers (1992), Wiese (1988, 1996) and Féry (1997). While differing in detail, these authors agree that short lax vowels (except schwa) are excluded from word-final position and before another vowel. They state a general constraint excluding short lax vowels from open syllables, which, however, is too restrictive, since syllables ending in a short vowel occur before consonants. The general constraint is rescued by claiming that the consonant following a short lax vowel in such cases is ambisyllabic, in fact, a geminate, in Wiese's treatment. There are several problems with treating such consonants as ambisyllabic or geminate.

The first problem is that geminates do not exist phonetically in German. Wiese's analysis therefore requires a late phonetic rule to interpret such geminates as single consonants. In fact, the assumption of geminates has very little explanatory value, since long tense vowels contrast with short lax vowels in stressed syllables, as shown in (55). The orthographic geminates in (55b) represent single consonants phonetically.

(55) a. *Tense vowels*

| | | |
|---|---|---|
| Miete | [iː] | 'rent' |
| kühn | [üː] | 'bold' |
| Bude | [uː] | 'booth' |
| Beet | [eː] | 'flower bed' |
| Höhle | [öː] | 'cave' |
| Lob | [oː] | 'praise' |
| Nase | [ɑː] | 'nose' |

b. *Lax vowels*

| | | |
|---|---|---|
| Mitte | [ɪ] | 'middle' |
| dünn | [ʏ] | 'thin' |
| buddeln | [ʊ] | 'to dig' |
| Bett | [ɛ] | 'bed' |
| Hölle | [œ] | 'hell' |
| Topp | [ɔ] | 'masthead' |
| naß | [a] | 'wet' |

It would be more straightforward to allow an underlying contrast between tense and lax vowels (as indeed Féry's analysis does), rather than predicting the overt distinction on the basis of a covert distinction between

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single and geminate consonants which is invariably neutralised, as does Wiese's account.

The second problem is that such artificial geminates (ambisyllabic consonants) would be expected to undergo the rule of syllable-final devoicing (*Auslautverhärtung*), since by definition they are codas as well as onsets. However, voiced obstruents are freely permitted after a lax vowel before another vowel (as in *buddeln* in (55b)), so syllable-final devoicing must be blocked in the case of ambisyllabic consonants. Wiese does this with the Linking Constraint (22). However, as we saw in §3, Gussenhoven's rule of Preglottalisation applies both to syllable-final and ambisyllabic segments. Gussenhoven therefore has to reformulate the Linking Constraint, raising problems for the rules that Hayes originally proposed the Linking Constraint for. As with Preglottalisation in English, the problem of preventing syllable-final devoicing from affecting ambisyllabic consonants in German vanishes if we exclude ambisyllabicity as a structural option in German as well as in English.

A third problem concerns stress placement. Wiese (1996: 36) regards a single intervocalic consonant as ambisyllabic after a lax vowel even after unstressed vowels, in effect making all German syllables heavy. Consequently, he is unable to analyse stress in German as quantity-sensitive. As Féry (1997: 102) points out, however, in words of three or more syllables, the penult is stressed if it 'is closed by its own, non-ambisyllabic consonant', as in (56).

| | | | |
|---|---|---|---|
| (56) | Inférno | *Ínferno | 'inferno' |
| | Hibískus | *Híbiskus | 'hibiscus' |
| | Deménti | *Démenti | 'denial' |
| | Flamíngo | *Flámingo | 'flamingo' |
| | Skolástik | *Skólastik | 'scholasticism' |

Words with a single consonant (or none) between the final and penultimate vowels can have penultimate stress (57a) or antepenultimate stress (57b), even if the penultimate vowel is tense.[28]

| | | | | | |
|---|---|---|---|---|---|
| (57) | a. | Aréna | 'arena' | b. Páprika | 'paprika' |
| | | Angína | 'angina' | Brắutigam | 'bridegroom' |
| | | Muséum | 'museum' | Ánanas | 'pineapple' |
| | | Kosmétik | 'cosmetic' | Léxikon | 'encyclopaedia' |
| | | Konfétti | 'confetti' | Kólibri | 'humming bird' |
| | | | | Tétanus | 'tetanus' |
| | c. | Ámeise | 'ant' | | |
| | | Kálauer | 'pun' | | |

[28] The *i* of *Paprika* may be phonetically tense, which Féry attributes to its non-native status, while that of *Bräutigam* is phonetically lax, related to its native status. In general, unstressed vowels may be neutralised to lax. In Féry's analysis, tense vowels underlyingly have two moras, while lax vowels have one mora, but moraicity does not correlate with length. In her analysis only stressed vowels can be long. Examples like (57c), with a diphthong in the penultimate syllable, are apparently rather rare. These are the only two examples of this pattern given in Féry (1997); *Cassell's German Dictionary* gives *Kalauer* with penultimate stress.

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It is clear that 'ambisyllabic' consonants do not have the same force as true coda consonants in attracting stress to the penultimate syllable. Wiese has no account of the contrast between (56) and (57), since the penultimate syllable is heavy in both cases. Restricting ambisyllabicity to the position after stressed vowels, as Féry does, does not provide an account of the position of stress. Ramers (1992) discusses the possibility that stress is assigned on the basis of underlying representations that include geminates after the penultimate vowel, especially when this assumption is supported by the orthography (as in *Konfetti*). Since geminates do not exist phonetically in German, this move strikes me as essentially a diacritic, like *SPE*'s use of a geminate *l* in *vanilla*. One or other of (57a, b) needs to be marked for stress in underlying representations.

In addition to the restriction on the distribution of short lax vowels, German also restricts long tense vowels. In Féry's terms, in morpheme-final position, a lax vowel can be followed by maximally two moraic consonants,[29] as in (58a), while a tense vowel can be followed by at most one moraic consonant in that position (58b). In non-final position, a tense vowel cannot be followed by a moraic consonant (58c) (examples from Féry 1997: 97).

| | | | | | |
|---|---|---|---|---|---|
| (58) | a. | Lump | [lʊmp] | 'scoundrel' | *[lʊʀmp] |
| | | flink | [flɪŋk] | 'nimble' | *[flɪʀŋk] |
| | | Helm | [hɛlm] | 'helmet' | *[hɛlmp] |
| | b. | Hehl | [he:l] | 'secret' | *[he:lk] |
| | | Lohn | [lo:n] | 'salary' | *[lo:mp] |
| | | Bein | [baɪ̯n] | 'leg' | *[baɪ̯ln] |
| | c. | Metall | [me.'tal] | 'metal' | *[meɐ̯l.'tal] |
| | | kulinarisch | [ku.li'na:.rɪʃ] | 'culinary' | *[kum.li'na:n.rɪʃ] |
| | | Harmonika | [haɐ̯.'mo:.ni.kɑ·] | 'harmonica' | *[haɐ̯'.mo:t.ni.kɑ·] |

For this reason, ambisyllabicity theory restricts ambisyllabicity to a position after lax vowels. Thus, the *t* is ambisyllabic in *Mitte* but not in *Miete* since, in the latter, ambisyllabic *t* would add a third mora to the first syllable, which is not permitted in word-medial position. However, the reasoning involved in predicting vowel length and tenseness in German is faulty. Because there are some restrictions on the appearance of long and short vowels this does not mean that the distribution is always predictable. Indeed, as (55) shows, the distinction is contrastive. It can only be regarded as non-contrastive under the dubious assumption that there is an underlying distinction between simple and geminate consonants, a distinction that is always neutralised. More straightforwardly and less

[29] Féry uses the term 'moraic consonant' to refer to consonants within the syllable and dominated by a mora node. Additional consonants, always coronal, are possible outside the core syllable, and Féry attaches these to the foot or to the prosodic word, as in *Herbst* 'autumn', where *st* is attached to the prosodic word. The example in (58) use non-coronals to emphasise the restrictions on core syllables.

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abstractly, we can simply say that long and short (or tense and lax) vowels contrast, and that phonological rules neutralise this contrast in certain environments.

## 5.2 German dorsal fricatives

The distribution of the German palatal [ç] (*ich-Laut*) and velar [x] (*ach-Laut*) fricatives has been treated in a variety of theoretical frameworks. We are primarily concerned with the Lexical Phonology treatment of Borowsky (1993) and Hall (1989) and the contrasting OT account in Merchant (1994, 1996) and Noske (1996), treating [x] as ambisyllabic when it appears between vowels. We will offer an alternative account without ambisyllabicity, relying on the foot as part of the conditioning environment.

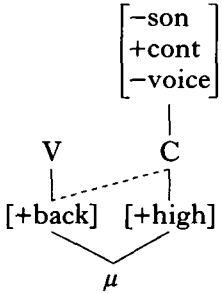
These two fricatives appear very nearly in complementary distribution. The velar fricative is restricted for the most part to the position after back vowels; the palatal fricative appears in other positions, as in (59).

(59)

| a. *velar* [x] | | b. *palatal* [ç] | |
|---|---|---|---|
| ach | 'oh!' | ich | 'I' |
| Knochen | 'bone' | Küche | 'kitchen' |
| knoch-ig | 'bony' | +ig | (adjective suffix) |
| Frucht | 'fruit' | Früchte | 'fruits' |
| Buch | 'book' | Bücher | 'books' |

In the lexical account, this results from a stratum 2 rule of fricative assimilation (FA), formulated as in (60) to apply within a morpheme (Hall 1989: 6). This account assumes that the fricative is palatal /ç/ underlyingly (Borowsky) or that it is lexically unspecified for [back] (Hall), receiving the value [−back] in contexts other than that of (60).

(60) *Fricative Assimilation* (Hall 1989: 6)




The near complementarity of distribution is disturbed by a number of (near) minimal pairs, some of which are given in (61), that are distinguished only by a velar *vs.* palatal fricative.

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(61) a. *velar* [x]
Kuchen 'cake' (monomorphemic)
rauchen 'to smoke' (*Rauch* 'smoke' + *en* (INF))
b. *palatal* [ç]
Kuhchen 'little cow' (*Kuh* 'cow' + *chen* (DIM))
Frauchen 'little woman' (*Frau* 'woman')

It is clear that the morphological structure of these words is responsible for this distinction. It is for this reason that Hall includes the requirement that the fricative and the preceding vowel belong to the same morpheme in his statement of the rule in (60). Borowsky achieves the effect of this condition by her analysis of word-level phonology applying before rather than after the morphology of that stratum. Rule (60) is applicable before the addition of the diminutive suffix, with its palatal fricative. After the addition of this affix, which creates a possible target for rule (60), the rule is no longer applicable.

However, Merchant (1994: 67) points out a number of forms that would be expected to undergo rule (60) but do not. The words in (62a) have [ç] in the environment of (60), not [x].

| | | | |
|---|---|---|---|
| (62) a. | masochist | [mɑzo:'çɪst] | 'masochist' |
| | Eunuchismus | [oɪ̯nu:'çɪsmus] | 'eunichism' |
| | eunuchisieren | [oɪ̯nu:çi'zi:rən] | 'make into a eunuch' |
| | parochial | [paroçi'al] | 'parochial' |
| | Parochie | [paro'çi:] | 'parish' |
| b. | Masoch | [mazo:x] | 'Masoch' |
| | Eunuch | [oɪ̯nu:x] | 'eunuch' |

Merchant adopts a rather roundabout analysis of these facts. First, he assumes that the velar fricative [x], when it appears between vowels, is ambisyllabic, while the palatal [ç] in this position is syllabified as an onset only. Second, he adopts the constraint ALIGN-R (McCarthy & Prince 1993a, b, Prince & Smolensky 1993), requiring that the right edge of a stem is aligned with the right edge of a syllable (63).

(63) ALIGN-R
Align (Stem-R, $\sigma$-R)

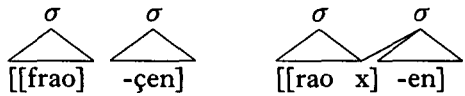
He adopts a constraint version of Fricative Assimilation (60) in which the requirement that the fricative and the preceding vowel be in the same morpheme is replaced by the requirement that they be in the same syllable. Finally, he adopts Itô & Mester's (1994) proposal that crispness of alignment is a distinct constraint from alignment itself – in other words, an ambisyllabic segment at the end of a stem counts as fulfilling the requirements of ALIGN-R. The result of this is that the dorsal fricative at the beginning of the diminutive suffix *-chen* will always be syllabified strictly as an onset, and be realised as a palatal. On the other hand, stems that end in a dorsal fricative after a back vowel will have that segment

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ambisyllabified before a vowel-initial suffix and thus realised as a velar, since it is in the same syllable as the preceding vowel. Thus the preferred syllable structures for words like *Frauchen* and *rauchen*, on this account, are given in (64).

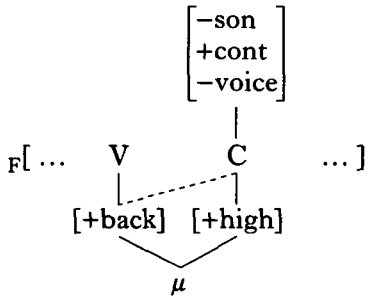
(64) *Syllabification* (Merchant 1994: 67)

a. Frauchen b. rauchen




The weak point of this analysis is the first assumption: that [x] between vowels is ambisyllabic. There is no phonetic or other evidence that the words of (61a) are syllabified differently from those of (61b). Merchant is clearly using ambisyllabicity as a diacritic; in terms of Kiparsky (1968), this is the diacritic use of a phonological feature (actually structure, in this case). A better analysis would refer directly to the difference in morphological constituent structure. Like English Aspiration and Flapping, we need also to refer to the prosodic unit foot, which is independently needed for the stress system in German. I suggest that FA should be formulated as in (65), which simply amplifies Hall's rule (60) by requiring that the assimilating elements are in the same foot as well as in the same morpheme.

(65) *Fricative Assimilation*



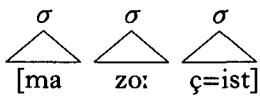

This accounts for (61) and (62) without appealing to ambisyllabicity. In addition, it has better empirical coverage than Merchant's account, as we will see directly.

The main advantage that Merchant claims for his account over earlier analyses is that it does not rely on lexical strata. In fact, the level-ordered analyses of Borowsky and Hall are unable to account for examples like (62). In these analyses *-ist* is unequivocally a stratum 1 suffix, so that the dorsal fricative at the end of the root *Masoch* clearly meets the structural analysis of Hall's rule (60) in the form *Masochist*, yet must not undergo it. Borowsky's analysis fares no better, since this suffix is necessarily added at stratum 1 before FA on stratum 2. Recall that her analysis requires

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suffixes like *-chen* to be added after FA has ceased to be applicable. Merchant suggests that using cyclic syllabification could provide an adequate account in a level-ordered framework. But Merchant's OT account does not completely dispense with level ordering. In order to get the correct results in (62) he stipulates that stratum 1 suffixes attach to roots, not to stems; and consequently, ALIGN-R 'has no jurisdiction over their internal structure' (1994: 72).[30] Therefore, the preferred syllabification of *Masochist* is as in (66), with the dorsal fricative syllable-initial (not ambisyllabic) and thus realised as a palatal.

(66) *Masochist* (Merchant's analysis)




(= is a boundary symbol, used before root-attaching suffixes)

But making this distinction between roots and stems, and classifying affixes according to which of these morphological units they attach to, is in effect a roundabout way of reintroducing level ordering. Merchant further remarks that 'since there exist both Stem- and Root-attaching suffixes which are vowel-initial, no attempt to reduce the differences to solely syllabic or prosodic well-formedness can be successful' (1994: 72). However, this statement ignores the effects of stress. The stratum 1 suffixes of German take primary stress, and as such have a different prosodic structure at the foot level, if not at the syllable level. Fricative Assimilation as formulated in (65) makes exactly this prediction, assuming the structure in (67), where parentheses enclose feet. Because the dorsal fricative is not part of the same foot that contains the preceding back vowel, FA (65) fails and the fricative remains palatal, as required.

(67) (maso)(çist)

Merchant (1994: 75) points to a sizeable class of words with [x] that are problematic for his account, which I list in (68). In these mostly monomorphemic forms, there is no stem boundary after the dorsal fricative, and so no constraint can force the fricative into syllable-final position (in addition to its expected syllable-initial position).

(68)

| | | | |
|---|---|---|---|
| Bochum | (place name) | Jochen | (name) |
| Dachau | (place name) | Sprache | 'language' |
| epochal | 'epochal' | Stachel | 'prickle' |
| (Jo)Achim | (name) | | |

Merchant's suggested analysis requires a morpheme boundary after the fricative in these cases, in order to ensure that the fricative is ambisyllabic,

[30] This is also a problematic assumption. According to the morphological hierarchy assumed in OT (e.g. McCarthy & Prince 1993a: 85), and in morphology generally, roots are also stems, so that ALIGN-R should incur a violation in the structure of (66), incorrectly predicting that the velar fricative would be preferred in this word.

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in conformity with ALIGN-R, giving a back velar as with *rauchen* (64b). This morpheme boundary is reasonably well motivated in cases like *Sprache*, where the final *-e* can be regarded as a marker of feminine gender. It is not motivated at all in the case of the names. These are accounted for naturally in my analysis on the assumption that they contain a single foot,[31] which also accounts for cases like *Sprache*, where a morpheme boundary can be posited. Cases like *epochal* are problematic for my analysis as well as Merchant's: the suffix *-al* is stratum 1 and stressed: it should therefore have a structure like (66) for Merchant or (67) for me, and so be realised with a palatal fricative. It seems likely that a second context for the appearance of the velar fricative, in addition to (65), is between back vowels. This could be stated as a constraint, though this constraint would, like ASPIRATION (41) and FLAPPING (42), have a disconcerting resemblance to a rule.

It should be noted that Merchant's use of ambisyllabicity is incompatible with the way in which this device is used in predicting vowel quality or quantity (§5.1). To account for vowel quality or quantity, a single consonant between vowels is counted as ambisyllabic after a short (or lax) vowel, on the assumption that such vowels cannot occur in (stressed) open syllables; thus, on this theory, [x] would be counted ambisyllabic in *lachen* ([laxən]). Conversely, [x] would not be counted as ambisyllabic in *rauchen* ([ʀaʊ̯xən]) or *Kuchen* ([ku:xən]), since the long vowel or diphthong occupies two moras and these do not normally occur with a following consonant in the same syllable in medial position. To account for the distribution of [x] *vs.* [ç], Merchant's account requires [x] to be ambisyllabic in both *lachen* and *rauchen*, and so no single theory of ambisyllabicity in German can account for both the distribution of vowel quality or quantity and the distribution of the dorsal fricatives. I suggest that ambisyllabicity is not involved in either of these two phenomena, and that the proper account of the distribution of the dorsal fricatives involves reference to foot structure and morphological structure.

Wiese (1996: 209–218), who employs ambisyllabicity to account for the distribution of vowel quality and quantity, explicitly denies that syllable structure is involved in Dorsal Fricative Assimilation. Wiese proposes an analysis of assimilation of the fricative to a preceding back vowel within the phonological word. He does not discuss words like *Masochist*, which are problematic in his account. For the apparent minimal pairs in (61), he adopts the idea of Bloomfield (1930) that the suffix *-chen* is a separate

[31] It is not clear to me whether *Dachau* contains one foot or two. I will assume that it contains a single foot and that German allows unstressed syllables with unreduced vowels (or diphthongs). This is consistent with Wiese's (1996: 235) analysis, where he claims that there are no secondary stresses after the primary stress. This issue is somewhat orthogonal to our immediate concerns. A related question is that *parochial* must have the foot structure (pàro)(chiál) in order for my analysis to work out right for this form, rather than, say (pàrochi)(ál). This is reminiscent of the foot assignment in English words like *militarist*, discussed in §4.1, where an irregular iambic foot is derived by adjunction, in contrast to the normal trochaic pattern of the language.

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phonological word, a proposal that figures also in Noske's (1996) account of this phenomenon. This assumption is problematic in that *-chen* shows no other characteristics of a prosodic word. By the prosodic hierarchy, a prosodic word contains a foot, and therefore a stress, but this suffix is stressless. Our account avoids this problematic assumption simply by requiring that the segments involved in Fricative Assimilation (65) be both in the same foot and in the same morpheme, a condition which is satisfied in *rauchen* but not in *Frauchen*.

We have formulated Fricative Assimilation (65) as a rule rather than as a constraint. Without ambisyllabicity, constraints of the Align family are unable to account for the German dorsal fricatives, and a rule (or constraint) more directly related to the assimilation is called for. As with English flapping, the success of OT in accounting for prosodic phenomena does not always generalise to segmental assimilations. We next turn to some phenomena in Danish which have not been treated in OT, but which raise the same sort of questions when we eliminate ambisyllabicity as a possible conditioning factor in the rules.

## 6 Ambisyllabicity as gemination

Borowsky *et al.* (1984) discuss three rules of Danish that they claim are conditioned by ambisyllabicity. As we have noted, they represent ambisyllabic segments as geminates. In fact, they propose a stress-conditioned rule of gemination that adds a grid position to a stressed syllable. Their analysis is couched within the framework of Lexical Phonology, and we follow this aspect of their analysis. But we do not require ambisyllabicity or gemination. Because their gemination rule is conditioned by stress, it is more natural to regard the phenomena in question as being conditioned by foot structure, resulting in a considerable simplification.

The first process they consider is Consonant Gradation. This has the effect of weakening a consonant in coda position: underlying voiceless consonants are voiced and underlying voiced consonants are spirantised. This is illustrated by the examples in (69).

(69)

| | | | | | |
|---|---|---|---|---|---|
| galopeːrə [p] | 'to gallop' | galop [b] | 'gallop (N)' | optimal [b] | 'optimal' |
| vateːrə [t] | 'to pad' | vat [d] | 'cotton wool' | atlas [d] | 'atlas' |
| lakeːrə [k] | 'to lacquer' | lak [g] | 'paint' | faktom [g] | 'fact' |
| abedisə [d] | 'abbess' | abed [ð] | 'abbot' | admiral [ð] | 'admiral' |
| pædagogik [g] | 'education' | pædagoːg [ɣ] | 'educator' | sygdom [ɣ] | 'sickness' |

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In some cases an onset consonant undergoes Gradation. This happens only when the consonant appears before a schwa-initial suffix, as in (70).

(70) bæːɣə 'to bake' døðənə 'dying'

In their Lexical Phonology account, Borowsky *et al.* assume that the suffixes [-ə] and [-ənə] are added at a stratum following the operation of the rule of Consonant Gradation. Thus the intervocalic voiced obstruents are syllable-final at the time that Consonant Gradation applies. Even on their account, no ambisyllabicity is needed to account for Consonant Gradation.

The second process they discuss is Grave Assimilation, by which a low vowel is made back before a non-coronal consonant in the same syllable, shown in (71a), but not if the following non-coronal is the onset of the following syllable (71b) or if followed by a coronal (71c).

(71) a. vɑ̀ksinéːrə 'to vaccinate'
ɑ́mfiteàter 'amphitheatre'
ɑ́bsalon 'Absalom'
gɑ́mlə 'old'
úðgɑŋ 'exit'

b. akúsatiːv 'accusative'
amérika 'America'
napóleon 'Napoleon'
famíliə 'family'

c. átlas 'atlas'
fantasé:rə 'to be delirious'
latíːn 'Latin'
fanátikər 'fanatic'

As with Consonant Gradation, there are cases where Grave Assimilation appears to be conditioned by a following onset, as in (72).

(72) a. lábə̆ 'to patch'
tágə̆ 'to thank'

b. kápă 'kappa'
jákŏb 'Jacob'
fɑ̀kŭltét 'faculty'

Although in (72a) we could take the same tack as with Consonant Gradation and claim that the rule occurred before the addition of the suffix, we cannot do that in (72b), since these words are monomorphemic. Borowsky *et al.* assume that the non-coronal consonants after the first vowel in (72) are ambisyllabic, so that, by virtue of their coda position, they condition Grave Assimilation just as in (71). The specific mechanism they propose involves a Gemination rule, which adds a grid position to a stressed syllable, with subsequent association of a C or V slot to the grid and alignment of segmental material to these slots. I give their rule in (73).

(73)
$$\begin{array}{ccc} x & & x \\ x & \rightarrow & x\ x \\ \sigma & & \sigma \end{array}$$

This rule produces a structure like (4) when the first syllable is stressed, except that they use a CV tier instead of the moras in (4). For example, the

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[b] of [lábə̆] in (72a) will be associated with two C slots, one attached to each syllable of the word. This conforms to their general approach of considering ambisyllabicity to have a representation identical to geminates. The resulting 'geminate' includes a coda position which conditions Grave Assimilation (and the next rule to be considered, Stød Association). As we have noted before, this analysis requires a phonetic interpretation mechanism to interpret the phonologically geminate consonants as simple onsets, since they are not geminate phonetically.

The stress sensitivity of Borowsky *et al.*'s Gemination rule once again suggests that the foot is an appropriate unit for conditioning Grave Assimilation. I propose that Grave Assimilation makes a low vowel back if followed by a non-coronal consonant within the same minimal foot, as in (74).

(74) *Grave Assimilation*

$$\begin{bmatrix} V \\ +low \end{bmatrix} \rightarrow [+back] \,/\, {}_{F}[ \ldots __ \begin{bmatrix} +cons \\ -cor \end{bmatrix} \ldots ] \qquad \textit{Condition:}\ \text{F is minimal}$$

Rule (74) applies in (71a) and (72) but is inapplicable in (71b), where the non-coronal consonant following the low vowel is foot-initial.

If Gemination creates a geminate in (72), why does Consonant Gradation not apply to these forms as well? Gemination creates a coda position for the [b] in [lábə̆], for example, and Consonant Gradation applies to consonants in coda position. Borowsky *et al.* invoke the Geminate Constraint, which disallows the application of a rule to a melody element of a geminate structure unless both skeleton positions fulfil the structural description of the rule (essentially, Hayes' Linking Constraint (22)). This device is not needed to account for (72) if Consonant Gradation is restricted to coda position only and there is no ambisyllabification in these cases (or anywhere else in Danish). The non-coronal stops in (71b) do not undergo Consonant Gradation because they are never in coda position.

The final process for which Borowsky *et al.* invoke ambisyllabicity is Stød Association, by which an accented syllable is associated with a glottal stop, realised on its second mora (either a long vowel or a sonorant coda). An accented syllable is one which is stressed and also fulfils certain lexical and morphological conditions beyond our present scope. A stød is associated with the long vowel in (75a), with the sonorant following the short vowel in (75b), but not with the obstruent following a short vowel in (75c).

| (75) | a. | | b. | | c. | |
|---|---|---|---|---|---|---|
| | mi:'l | 'mile' | mil' | 'mild' | hest | 'horse' |
| | pæ:'n | 'pretty' | pæn' | 'pen' | skrift | 'writing' |

As with Grave Assimilation, Stød Association affects certain onset consonants, either stem-final sonorants before a suffix beginning with schwa (76a) or sonorants in monomorphemic words between a stressed and an unstressed syllable (76b).

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(76) a. bræn'ər 'burns'
hún'ən 'the dog'

b. kán'ăda 'Canada'
án'ŭom 'annual grant'
kím'ŏno 'kimono'

Again, Borowsky *et al.* attribute Stød Association to the sonorants in question having undergone Gemination, which places them in syllable-final position. And, once again, we can attribute it to an effect on stressed long vowels, or stressed short vowels followed by a sonorant within the same foot, with no appeal to ambisyllabicity.

The Danish material discussed by Borowsky *et al.* does not justify ambisyllabicity. Their rules are quite easily reanalysed as having foot conditioning, and the result is a much simpler analysis, since there is no longer any need for a spurious Gemination rule nor for a phonetic interpretation process that realises 'geminates' as simple onsets.

I have not attempted a reanalysis of the Danish material in OT terms, since my primary purpose here is to argue against the device of ambisyllabicity.

## 7 Conclusion

I have examined a number of cases where a consonant has been regarded as ambisyllabic, that is, belonging both to a preceding syllable as a coda and to a following syllable as an onset, without being a geminate. I have also examined experimental and anecdotal evidence that has been taken as supporting the concept of ambisyllabicity. The experimental and anecdotal evidence does not support ambisyllabic analyses. Each ambisyllabic analysis we examined was subject to a reanalysis in terms of prosodic categories, primarily the foot. This is not surprising, in view of the fact that the rules proposed for ambisyllabicity generally refer to stress, and the foot is a prosodic unit that contains exactly one stressed syllable. Since feet are required independently to account for stress, the prosodic account is superior to one employing ambisyllabicity, an additional construct, not otherwise needed. So the prosodic account is superior in terms of restrictiveness.

In some cases the prosodic analysis gives a more accurate description. Most strikingly, English shows aspiration in a context first observed by Withgott (1982) but never satisfactorily explained: at the beginning of the third syllable of words like *militaristic* and *Mediterranean*. These are wrongly predicted to be flapped in the analyses of Kahn (1976), Gussenhoven (1986) and Rubach (1996), because they would be ambisyllabic by their rules. By appealing to adjunction of the syllable in question to the following foot, we predict that the *t* in this position is foot-initial, hence aspirated by our rules. Because the adjunction structures are relevant for (at least) two other rules of English, they are well motivated. Adjoined foot structures allow for a distinction between minimal and maximal feet which accounts for certain dialect variants that cannot be

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accounted for using ambisyllabicity, for example the possibility of compensatory syllabification affecting the *r* of *Jerome*. So the prosodic account is also superior to ambisyllabicity in empirical terms.

Finally, the prosodic account eliminates the ambiguity of ambisyllabic structures, which have often been identified with geminate structures, leaving the phonetic component to sort out the distinction. This is an unfortunate ambiguity in view of the opposing nature of the two outcomes: geminates are long articulations, while segments considered ambisyllabic are typically very short, especially the flap. While this ambiguity can be avoided by various notational tricks, the proliferation of representations wrongly predicts that both gemination and ambisyllabicity could coexist in a single language. Rejecting ambisyllabicity both eliminates this ambiguity and provides for a more restrictive theory.

REFERENCES

Alcántara, Jonathan B. (1998). *The architecture of the English lexicon*. PhD dissertation, Cornell University.

Blevins, Juliette (1995). The syllable in phonological theory. In John A. Goldsmith (ed.) *The handbook of phonological theory*. Cambridge, Mass. & Oxford: Blackwell. 206–244.

Bloomfield, Leonard (1930). German ç and x. *Le Maître Phonétique* (3rd series) **20**. 27–28.

Booij, Geert (1996). Cliticization as prosodic integration: the case of Dutch. *The Linguistic Review* **13**. 219–242.

Borowsky, Toni (1986). *Topics in the lexical phonology of English*. PhD dissertation, University of Massachusetts, Amherst.

Borowsky, Toni (1993). On the Word level. In S. Hargus & E. M. Kaisse (eds.) *Studies in Lexical Phonology*. San Diego: Academic Press. 199–234.

Borowsky, Toni, Junko Itô & Ralf-Armin Mester (1984). The formal representation of ambisyllabicity: evidence from Danish. *NELS* **14**. 34–48.

Chomsky, Noam & Morris Halle (1968). *The sound pattern of English*. New York: Harper & Row.

Clements, G. N. & Samuel Jay Keyser (1983). *CV phonology : a generative theory of the syllable*. Cambridge, Mass.: MIT Press.

Davis, Stuart & Michael Hammond (1993). On the status of onglides in American English. *Phonology* **12**. 159–182.

Fallows, Deborah (1981). Experimental evidence for English syllabification and syllable structure. *JL* **17**. 309–317.

Féry, Caroline (1997). The mora as a measure of weight and a syllabic constituent. In P. M. Bertinetto, L. Gaeta, G. Jetchev & D. Michaels (eds.) *Certamen phonologicum III : papers from the 3rd Cortona Phonology Meeting*. Turin: Rosenberg & Sellier. 91–110.

Gimson, A. C. (1980). *An introduction to the pronunciation of English*. 3rd edn. London: Arnold.

Gussenhoven, Carlos (1986). English plosive allophones and ambisyllabicity. *Gramma* **10**. 119–141.

Hall, Tracy Alan (1989). Lexical Phonology and the distribution of German [ç] and [x]. *Phonology* **6**. 1–17.

Halle, Morris & William J. Idsardi (1997). *r*, hypercorrection, and the Elsewhere Condition. In Iggy Roca (ed.) *Derivations and constraints in phonology*. Oxford: Clarendon Press. 331–348.

https://doi.org/10.1017/S0952675700003912 Published online by Cambridge University Press

Halle, Morris & K. P. Mohanan (1985). Segmental phonology of Modern English. *LI* **16**. 57–116.
Halle, Morris & Jean-Roger Vergnaud (1987). *An essay on stress*. Cambridge, Mass.: MIT Press.
Hayes, Bruce (1982). *Extrametricality and English stress*. *LI* **13**. 227–276.
Hayes, Bruce (1986). Inalterability in CV phonology. *Lg* **62**. 321–351.
Hayes, Bruce (1995). *Metrical stress theory: principles and case studies*. Chicago: University of Chicago Press.
Hyman, Larry (1985). *A theory of phonological weight*. Dordrecht: Foris.
Inkelas, Sharon (1989). *Prosodic constituency in the lexicon*. PhD dissertation, Stanford University.
Itô, Junko (1986). *Syllable theory in prosodic phonology*. PhD dissertation, University of Massachusetts, Amherst.
Itô, Junko & Armin Mester (1994). Reflections on CodaCond and Alignment. In Merchant *et al.* (1994). 27–46.
Jensen, John T. (1993). *English phonology*. Amsterdam: Benjamins.
Jones, Daniel (1966). *The pronunciation of English*. 4th edn, reprinted with corrections. Cambridge: Cambridge University Press.
Kahn, Daniel (1976). *Syllable-based generalizations in English phonology*. PhD dissertation, MIT.
Kiparsky, Paul (1968). How abstract is phonology? In Paul Kiparsky (1982). *Explanation in phonology*. Dordrecht: Foris. 119–163.
Kiparsky, Paul (1979). Metrical structure assignment is cyclic. *LI* **10**. 421–441.
Klavans, Judith L. (1985). The independence of syntax and phonology in cliticization. *Lg* **61**. 95–120.
Liberman, Mark & Alan S. Prince (1977). On stress and linguistic rhythm. *LI* **8**. 249–336.
McCarthy, John J. (1981). A prosodic theory of nonconcatenative morphology. *LI* **12**. 373–418.
McCarthy, John J. (1993). A case of surface constraint violation. *Canadian Journal of Linguistics* **38**. 169–195.
McCarthy, John J. (1995). Faithfulness in prosodic morphology and phonology: Rotuman revisited. Ms, University of Massachusetts, Amherst.
McCarthy, John J. & Alan S. Prince (1993a). Generalized alignment. *Yearbook of Morphology 1993*. 79–153.
McCarthy, John J. & Alan S. Prince (1993). *Prosodic morphology I: constraint interaction and satisfaction*. Ms, University of Massachusetts, Amherst & Rutgers University. To appear, Cambridge, Mass: MIT Press.
McCarthy, John J. & Alan S. Prince (1995). Faithfulness and reduplicative identity. In J. N. Beckman, L. Walsh Dickey & S. Urbanczyk (eds.) *Papers in Optimality Theory*. Amherst: GLSA. 249–384.
Merchant, Jason (1994). German fricative assimilation, ambisyllabicity, and noncrisp alignment. In Merchant *et al.* (1994). 65–77.
Merchant, Jason (1996). Alignment and fricative assimilation in German. *LI* **27**. 709–719.
Merchant, Jason, Jaye Padgett & Rachel Walker (eds.) (1994). *Phonology at Santa Cruz 3*. Santa Cruz: Linguistics Research Center.
Mohanan, K. P. (1985). Syllable structure and lexical strata in English. *Phonology Yearbook* **2**. 139–155.
Myers, Scott (1987). Vowel shortening in English. *NLLT* **5**. 485–518.
Nespor, Marina & Irene Vogel (1986). *Prosodic phonology*. Dordrecht: Foris.
Noske, Manuela (1996). Feature spreading as dealignment. Ms, University of California, Davis.

https://doi.org/10.1017/S0952675700003912 Published online by Cambridge University Press

Orgun, Cemil Orhan (1996). Correspondence and identity constraints in two-level Optimality Theory. *WCCFL* **14**. 399–413.
Picard, Marc (1984). English flapping and aspiration revisited. *Canadian Journal of Linguistics* **29**. 42–57.
Prince, Alan S. (1983). Relating to the grid. *LI* **14**. 19–100.
Prince, Alan S. & Paul Smolensky (1993). *Optimality Theory : constraint interaction in generative grammar*. Ms, Rutgers University & University of Colorado, Boulder.
Ramers, Karl Heinz (1992). Ambisilbische Konsonanten im Deutschen. In Peter Eisenberg, Karl Heinz Ramers & Heinz Vater (eds.) *Silbenphonologie des Deutschen*. Tübingen: Gunter Narr. 246–283.
Rubach, Jerzy (1996). Shortening and ambisyllabicity in English. *Phonology* **13**. 197–237.
Selkirk, Elisabeth O. (1982). The syllable. In Harry van der Hulst & Norval Smith (eds.) *The structure of phonological representations*. Part 2. Dordrecht: Foris. 337–383.
Selkirk, Elisabeth O. (1984). *Phonology and syntax : the relation between sound and structure*. Cambridge, Mass.: MIT Press.
Selkirk, Elisabeth O. (1986). A two-root theory of length. *University of Masschusetts Occasional Papers* **14**. 123–171.
Stanley, Richard (1967). Redundancy rules in phonology. *Lg* **43**. 393–436.
Treiman, Rebecca & Catalina Danis (1988). Syllabification of intervocalic consonants. *Journal of Memory and Language* **27**. 87–104.
Turk, Alice (1994). Articulatory phonetic clues to syllable affiliation: gestural characteristics of bilabial stops. In Patricia A. Keating (ed.) *Phonological structure and phonetic form : papers in laboratory phonology III*. Cambridge: Cambridge University Press. 107–135.
Wells, J. C. (1982). *Accents of English*. Vol. 1 : *An introduction*. Cambridge: Cambridge University Press.
Wiese, Richard (1988). *Silbische und lexikalische Phonologie : Studien zum Chinesischen und Deutschen*. Tübingen: Niemeyer.
Wiese, Richard (1996). *The phonology of German*. Oxford: Clarendon Press.
Withgott, Mary Margaret (1982). *Segmental evidence for phonological constituents*. PhD dissertation, University of Texas, Austin.
Yip, Moira (1987). English vowel epenthesis. *NLLT* **5**. 463–484.
Zec, Draga (1988). *Sonority constraints on prosodic structure*. PhD dissertation, Stanford University.

https://doi.org/10.1017/S0952675700003912 Published online by Cambridge University Press