

## ENGLISH PLOSIVE ALLOPHONES AND AMBISYLLABICITY

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Both American English (AmE) and British English (BrE) have a number of rules governing the pronunciation of the fortis plosive series /p,t,k/.<sup>1</sup> AmE has ASPIRATION, GLOTTALISATION and FLAPPING, BrE has ASPIRATION, PREGLOTTALISATION and WEAKENING. Taking Kahn (1976) as our starting-point, we will show that the BrE rules, like the AmE rules, are syllable-based. In particular, we will demonstrate that the BrE data unambiguously support Kahn's conception of ambisyllabicity and of the way phonological rules refer to ambisyllabic consonants. While Kahn's account of AmE showed some defects, it is argued that these can and should be remedied within a theory of the syllable that includes the possibility of consonants that are simultaneously in the coda of one syllable and in the onset of the next. Reanalyses of the AmE data that sought to improve on Kahn's account without employing both syllable-based rules and the notion 'ambisyllabic consonant' (e.g. Kiparsky 1979, Selkirk 1982) are rejected.

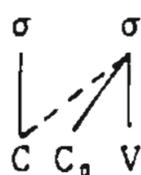
From our analysis it will appear that AmE and BrE largely employ the same set of syllabification rules, and that the distributional differences that are observed between AmE and BrE plosive allophones are accounted for by different structural descriptions of "cognate" rules:

In section 1, I repeat Kahn's analysis of AmE, but formulate it in terms of the framework presented in Clements & Keyser (1983). In section 2, I will present a sister-analysis of BrE. In that analysis we are forced to deviate from the syllabification rules Kahn proposed for AmE. In section 3 we will see how adoption of the BrE rules of syllabification makes for a more adequate description of AmE. In section 4 we will discuss a number of alternative proposals to derive the correct distribution of the plosive allophones of AmE.



consonant to their right. It also applies to /ŋ/ in *hangar*, which consonant was left untouched by clause 1 of SYLLABIFICATION, because it is not a possible word-initial consonant. LEFT CAPTURE is given in (4). In section 3 it will be argued that (4) is not in fact a rule of English.

(4) LEFT CAPTURE

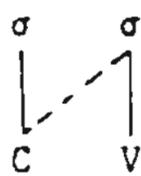


[-stress]

Condition: The resultant onset obeys universal constraints

Finally, Rule V, here given as LIAISON, is the only rule to operate across word boundaries. It captures the fact that in English, vowel-initial words pick up an onset from the preceding consonant-final word, causing e.g. *tick it* to be homophonous with *ticket* in 'fast speech'. The rule can be formulated without reference to word boundaries, because at this point there are no onset-less syllables left. Recall that, within the word, SYLLABIFICATION (clause 1) has created onsets in all cases except when the vowel is preceded by /ŋ/, and that this latter case has been taken care of by LEFT CAPTURE.

(5) LIAISON

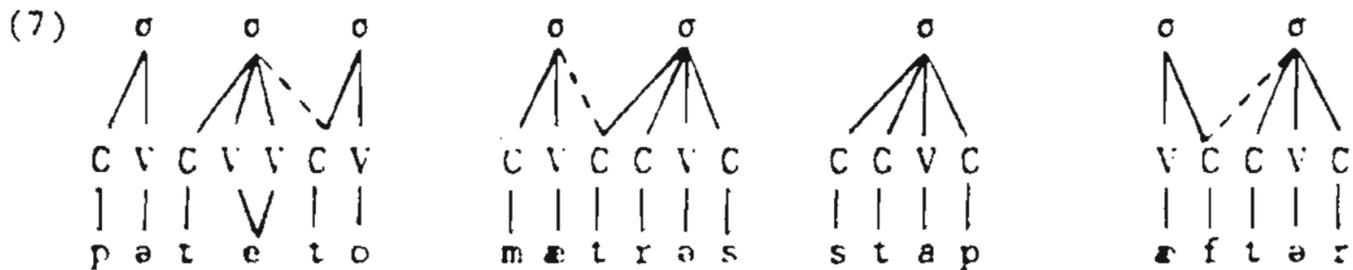


By thus first presenting a theory of syllabification, Kahn was able to characterise the structural descriptions of ASPIRATION, GLOTTALISATION and FLAPPING in an elegant way. Consider first the data in (6). ASPIRATION occurs in the words in column I, it may occur in those in column II, and does not occur in those in column III.

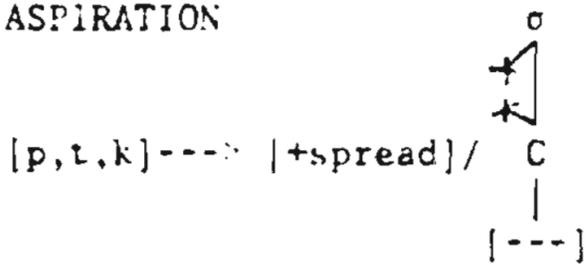
(6)	I	II	III
	<i>top</i>	<i>later</i>	<i>stop</i>
	<i>potato</i>	<i>potato</i>	<i>eat</i>
	<i>latex</i>	<i>after</i>	<i>strip</i>
	<i>Washington</i>	<i>mattress</i>	
	<i>trip</i>		

Kahn observed that the data are explained if we assume that ASPIRATION applies to /p,t,k/ in first position in the syllable, provided they are not ambisyllabic. In *potato* this of course applies to /p/, but also to the first /t/, which, like the /t/ in *latex*, has failed to undergo RIGHT CAPTURE because of the unreduced vowel following it. The second /t/ undergoes RIGHT CAPTURE in 'fast speech', and hence will be subject to ASPIRATION in 'slow speech', but not in 'fast speech'. RIGHT CAPTURE similarly bleeds ASPIRATION in *later* and *mattress*. In *stop*, ASPIRATION does not

apply because /t/ is not in first position in its syllable, a situation that also holds for /t/ in *after* in 'fast speech', after the application of LEFT CAPTURE. These syllabifications are illustrated in (7): here as elsewhere, the solid association lines are the result of SYLLABIFICATION, the dotted ones of one of the other syllabification rules. ASPIRATION is given in (8): the x's indicate that the particular association may not exist.<sup>2</sup>



(8) ASPIRATION



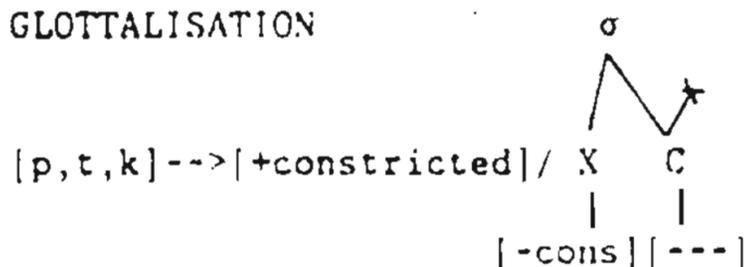
A /t/ in a word like *mat* is, in ordinary conversational style, both glottalised and unreleased. The glottal closure appears to be simultaneous with the oral closure: [mæt̚]. Such unreleased, glottalised allophones are common, though apparently less frequent, for /p,k/ as well. Leaving aside the question of why the plosives differ in their susceptibility to GLOTTALISATION, Kahn observes that the rule will apply in column I, that it may apply in column II, and will not apply in column III.

(9) I	II	III
mat	knelt:	mattress
heights	hit Ann	matriculate
can't		best
cart		apt
atlas		city

The fact that *can't* and *cart* are in column I, *knelt* is column II, and *best* in column III, shows that the nature of the segment preceding /t/ must be included in the structural description of GLOTTALISATION. As Kahn points out, a preceding nasal does not in fact have a consonantal articulation, *can't* being pronounced [kæt̚] because of (NASALISATION and) NASAL DELETION, and neither does /r/. The lefthand segmental context would thus appear to be [-cons], and this is precisely the reason why GLOTTALISATION applies variably to *knelt*: when /l/ has a consonantal articulation (involves an alveolar contact) it does not trigger GLOTTALISATION, but when that contact is lost (l-VOCALISATION), it does.<sup>3</sup> Further, /t/ is in absolute coda position in column I, but not in column III: in *mattress* and *city* it is ambisyllabic, while in *matriculate* it is in absolute onset position. In *hit Ann* (column II), it is in absolute coda position before LIAISON, and hence susceptible to

GLOTTALISATION only in 'slow speech'. The rule is given as in (10), where X may be C or V.

(10) GLOTTALISATION

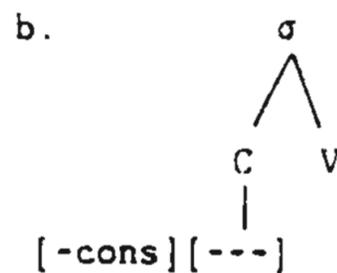
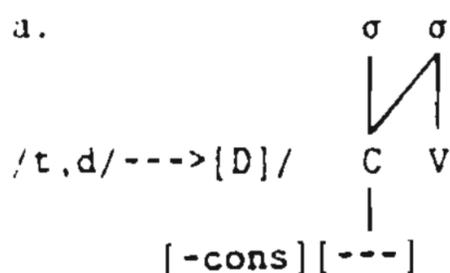


In words like *beta*, *metal*, *odor*, the medial consonants are voiced alveolar taps in ordinary conversational style. They arise from a /t,d/ weakening process known as FLAPPING. The rule does not occur in 'slow speech' at all, and is in this sense always variable. In 'fast speech' it always occurs in the words in column I, never in those in column III, while in column II it may apply.

(11)	I	II	III
	later	melting	latex
	shouting		late
	parting		tail
	winter		after
	symptomatic		symptomatic
	(my) late ex		mattress

First, Kahn observes that the lefthand context is [-cons] again. This accounts for flapped /t/ in *later*, *shouting*, *parting*, as well as for that in *winter*, which offers itself to FLAPPING after NASAL DELETION has applied. The fact that preceding /l/ sometimes does and sometimes does not undergo FLAPPING is again explained by the variability of l-VOCALISATION. Next, the structural position of /t,d/ in the syllable must evidently be that of an ambisyllabic consonant. Thus, retention of /t/ in *latex* shows that it must not be in absolute syllable-initial position, while retention of /t/ in *late* similarly demonstrates the exemption of absolute syllable-final /t/. All 'undergoers' in column I are ambisyllabic, the first five by virtue of RIGHT CAPTURE, while /t/ in *my late ex* is ambisyllabic after application of LIAISON. The inclusion of *mattress* in column III illustrates that the righthand segmental context must be V. We could formulate FLAPPING as in (12a), or, as Kahn prefers, as in (12b), in which case it must be ordered after ASPIRATION.

(12) FLAPPING a.



We will not dwell here on the central point of Kahn's thesis, viz. that these processes cannot be described if in our structural description we can only refer to segmental context and word boundaries. The reader is referred to Kahn for a discussion of the

difficulties besetting an attempt to capture the structural description of FLAPPING in such SPE terms.

## 2. A sister analysis of BrE

### 2.1. Allophones of /p,t,k/ in BrE

In BrE, comparable phonetic processes affect the fortis series /p,t,k/. Thus, there is ASPIRATION, as in *par, tar, car*, PREGLOTTALISATION, as in *lips, shouts, cooked*, and a lenition process affecting plosives in words like *better* which we will refer to as WEAKENING.

In BrE, ASPIRATION applies in the words in column I, but not in those in column II. Notice that there have been some changes relative to the data in (6). In particular, aspiration occurs in words such as *after, winter, mattress, later*, even in what Kahn calls 'fast speech'.

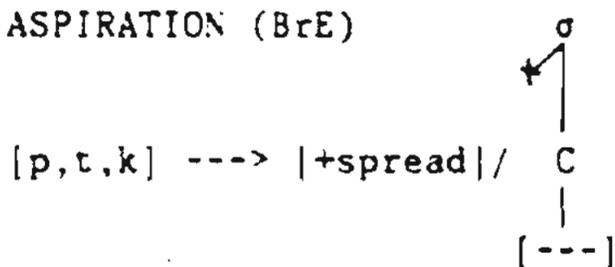
(13)	I	II
	potato	stop
	latex	eat
	after	distill
	winter	
	Washington	
	mattress	
	later	

It is clear that BrE differs from AmE where this feature is concerned. The question is: is this difference accounted for by a difference in syllabification, or by a difference in the structural description of ASPIRATION? Recall that /t/ in *after* could be exempt from ASPIRATION in Kahn's description by virtue of LEFT CAPTURE. As a result of the application of this rule, /t/ was no longer the first C in its syllable and ASPIRATION did not apply to it, just as it does not apply to the /t/ in *stop*. Thus, in order to include such words within the purview of ASPIRATION in BrE, we need simply assume that LEFT CAPTURE does not exist in this variety. Nothing in the phonology of BrE prevents us from taking this step. It will be clear that the main task of LEFT CAPTURE was to get the AmE facts of ASPIRATION to come out right in words of the *after* type. The rule's other task, that of taking /ŋ/ in words like *hangar* into the onset, should really be taken over by SYLLABIFICATION. As pointed out in Clements & Keyser (1983: 6), Kahn's working hypothesis that the set of permissible syllable-initial clusters coincided with the set of permissible word-initial clusters is incorrect.<sup>4</sup> Apparently, while /ŋ/ is an impermissible word-initial onset, it is not an impermissible syllable-initial onset. Similarly, /z/, which occurs syllable-initially in *measure, leisure*, is

excluded word-initially. The reverse situation apparently occurs in French: while /sp/ is a possible word-initial cluster (e.g. *psychologie*), word-internally /sp/ does not occur *syllable-initially* (e.g. *capsule*) (Selkirk 1982). We will assume that there is no constraint on the identity of the C in tautosyllabic CV in English and do not take over LEFT CAPTURE into the phonology of BrE. A different question is whether we should consider RIGHT CAPTURE optional, as Kahn does. Because short, unreduced vowels never appear in open syllables (i.e. they are never followed by a vowel), I assume that the rule is obligatory, except in the artificial mode of speech called 'slow speech' by Kahn.

While we can include words like *after* into the domain of ASPIRATION by disposing of LEFT CAPTURE, we cannot do away with RIGHT CAPTURE in order to get ASPIRATION to apply to words like *later*. RIGHT CAPTURE is needed in BrE as well. In particular, we would have no way of characterising the structural description of WEAKENING, which *only* affects ambisyllabic plosives, as we will see below. Thus, it would appear that the structural description of BrE ASPIRATION differs from that of AmE ASPIRATION to the extent that BrE no longer requires /p,t,k/ to be in *absolute* onset position. In this variety, ASPIRATION thus applies as in (14). We conclude that to account for the BrE data, we need to deviate both from Kahn's syllabification and from the structural description of AmE ASPIRATION.

(14) ASPIRATION (BrE)

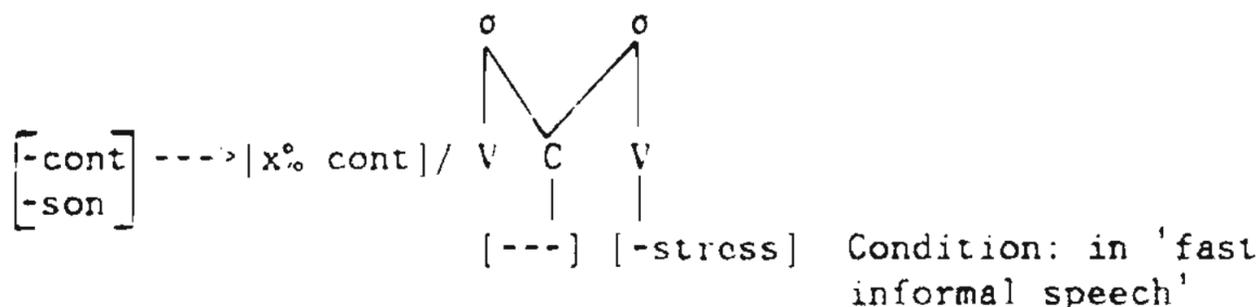


Rule (14) predicts that /t/ in *latex* or (*He said*) *the tie (was)* as well as /t/ in (*my*) *LATE ex* or (*He said*) *that I (was)* are aspirated in 'fast speech', which is correct. It does NOT predict that these sequences are homophonous, any more than *a name* and *an aim* are predicted to be homophonous. The two members of each pair differ in the status of the consonant at the word boundary, which is in absolute onset position in the first member, and ambisyllabic in the second. We may contrast these pairs with pairs like *a top - atop* (both /t/'s in absolute onset position, and both subject to (14)) or *drinker - drink a (pint of milk a day)* (both /k/'s ambisyllabic and subject to (14)), which ARE homophonous.

In informal, colloquial BrE (henceforth referred to as 'fast informal' BrE), a weakening of the oral closure of both fortis and lenis plosives may occur, so that the closure is no longer airtight. Gimson (1980) reports that this process is likely in 'weakly accented syllables' and gives words like *rubber*, *later* as examples. We will interpret this to mean that it applies to intervocalic plosives if the following vowel is reduced. Accordingly, we formulate WEAKENING as in (15), which formulation predicts this feature in *pity*, *get across*, but not in *winter* or *get*

out. The phonetic implementation affects the feature [continuant], which assumes some value of more than 0%.

(15) WEAKENING



How should we account for the fact that /t/ in a word like *pity* can undergo ASPIRATION, but also WEAKENING? Being characteristic of 'fast informal speech' (a style which is considerably less formal than 'fast speech'), we assume that WEAKENING belongs to a different register from ASPIRATION. While in Kahn's analysis, ASPIRATION applies before FLAPPING within the same register, and thus changes the structural description of a number of words to which FLAPPING could have applied (i.e. bleeds FLAPPING), in our analysis WEAKENING is applied after the rules belonging to the more formal register, to which ASPIRATION belongs, have applied. WEAKENING thus applies to the output of ASPIRATION, destroying its effect.<sup>5</sup> It would indeed seem to be intuitively satisfying that WEAKENING, clearly a colloquial rule, can be placed in a different stylistic stratum from any of the rules we have discussed so far. As it happens, this appears to be the only option open to us. A formulation of ASPIRATION whereby the rule bypasses words like *pity*, but includes words like *mattress*, *winter* and *after*, would not only be impossibly clumsy, but would actually make the incorrect prediction that words like *pity* are unaspirated in a style which is more formal than 'fast informal speech'. Likewise, if we order WEAKENING before ASPIRATION, the incorrect prediction is made that words like *pity* are never aspirated. To conclude our discussion of ASPIRATION and WEAKENING, it is stressed that both rules require that ambisyllabicity is available as a structural possibility for consonants in BrE.

In the course of this century, BrE has acquired PREGLOTTALISATION, as a result of which the transition from the voiced segment to voiceless /p,t,k/ in words like *mats*, *helps*, *linked* is marked by a glottal closure, occurring before the oral closure (Andrésen 1968). *Mats* could therefore be transcribed [mæʔts]. PREGLOTTALISATION is still very much a variable rule. Wells (1982:260) lists the contexts in which this process may occur (in standard or non-standard BrE) as in (16).

(16) a.	-----	Obstruent, Nasal	<i>quite good</i>	48.3
b.	-----	Liquid, Glide	<i>quite likely</i>	40.7
c.	-----	V	<i>quite easy</i>	3.3
d.	-----	Pause	<i>Quite!</i>	37.7
e.	-----	Obstruent, Nasal	<i>nights, curtsey, chutney</i>	51.0
f.	-----	Liquid, Glide	<i>mattress</i>	27.4
g.	-----	Syllabic nasal	<i>button</i>	16.0
h.	-----	V, Syllabic L	<i>butter, bottle</i>	0.3

In the standard accent, Wells says, PREGLOTTALISATION may occur in any of the contexts (a,b,d,e,f), but some speakers have it only in (a,b,e). Andr sen (1968) gives data based on the speech of 45 standard British speakers in the late fifties. His data do not contradict Wells' statement. Mean percentages for each context have been included in (16), third column. (based on Andr sen (1968:112-54); I have removed the data for /t/ from his figures). Clearly, the contexts in which Wells claims PREGLOTTALISATION is not applied in standard BrE score low, and the contexts singled out by him as being more general (a,b,e) score highest. What is interesting about the figures is the fact that PREGLOTTALISATION is about equally frequently applied in contexts (a) and (e), but that context (b) attracts far more applications than context (f). Notice that in context (e) the fortis plosive is always in absolute syllable-final position, as it necessarily is in (a) and (b), but that in context (f) the fortis plosive is (generally) in syllable-initial position (by SYLLABIFICATION), and may become ambisyllabic by RIGHT CAPTURE. The structural situation (generally) obtaining in (f) is thus different from that in (b), where /p,t,k/ are necessarily in absolute coda position. Context (f), as it stands, includes words like *butler* as well as words like *betray*, in addition to words like *mattress*. In our interpretation, context (f) only concerns words of the latter type: words like *butler* have the plosive in absolute syllable-final position, and words like *betray*, in which the /t/ is in absolute onset position, are never preglottalised.<sup>6</sup>

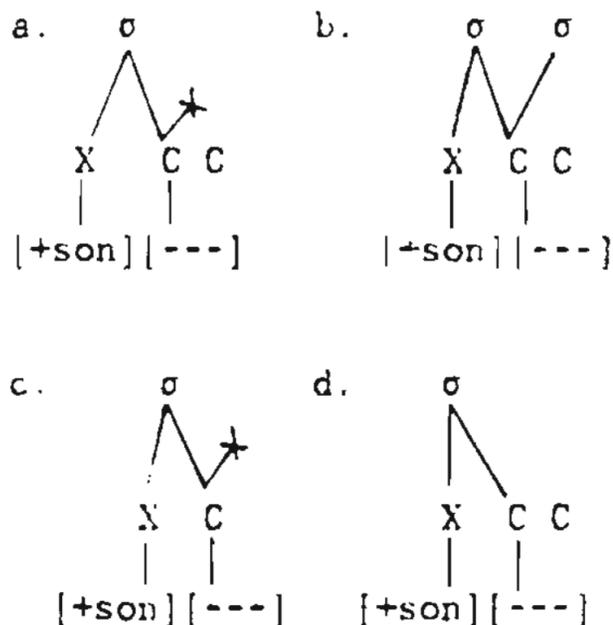
The data could be interpreted in at least two ways:

- (1) Speakers who preglottalise in contexts (a,b,e) and speakers who do so in context (f) form non-intersecting sets. This is the claim made by Roach (1973). Respectively, these speakers would have rules (17a) and (17b). Context (d) can be included in the structural description of rule (17a) by deleting the right-hand C, to give (17c).
- (2) Speakers who preglottalise in context (f) form a subset of those who do so in contexts (a,b,e). That is, some speakers have extended the structural description of rule (17a) so as to drop the requirement that /p,t,k/ should be in ABSOLUTE syllable-final position, which gives rule (17d).

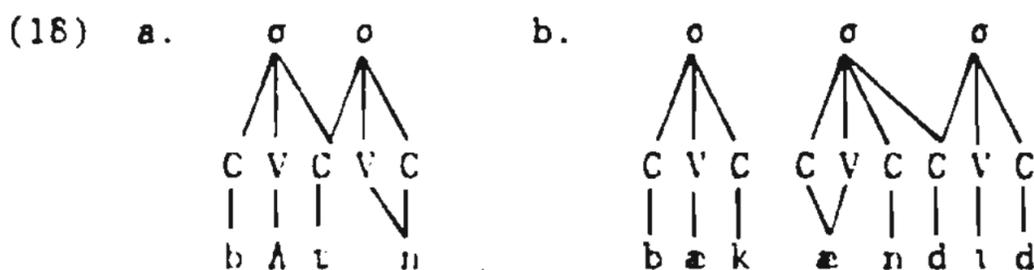
Regardless of which of these interpretations is correct (or of how much of either is), both require that reference to ambisyllabic consonants can be made, as we must either refer to ambisyllabic consonants alone (17b) or to ambisyllabic and syllable-final consonants (17d).<sup>7</sup>

(17) PREGLOTTALISATION

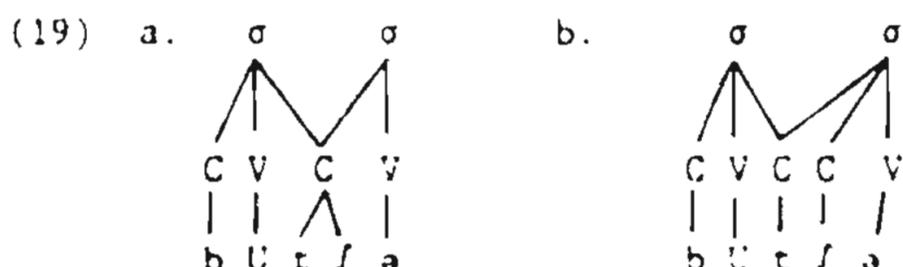
[p,t,k]--->[+constricted]/



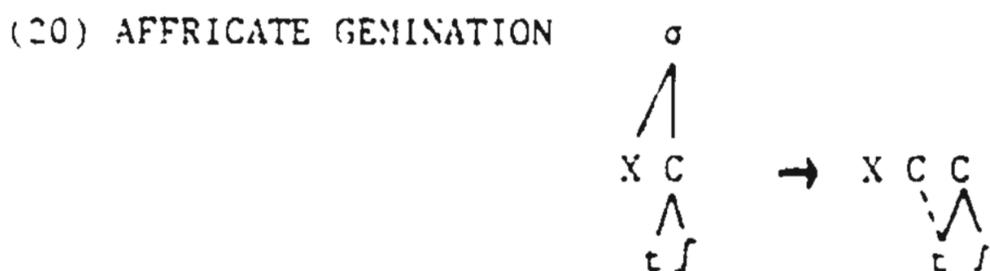
It should be noted that inclusion of context (d) in combination with context (f), either by itself or in combination with (a,b,e), is notationally less straightforward, since removal of the righthand C here would cause the rule to overgenerate in words like *butter*. In either case, the righthand C would have to be replaced with a disjunction 'either C or Pause'. Unfortunately, the elimination of this sort of disjunction was precisely one of Kahn's motivations for introducing syllable structure in the structural description of phonological rules. The question therefore arises if we can legitimately collapse contexts (f) and (d) in this way. There is no indication in the literature that context (d) and context (f) tend to be mutually exclusive in the same speaker. What does seem to be clear, though, is that the spread of PREGLOTTALISATION has not been altogether uniform, and that rival structural descriptions have been around. For example, Higginbottom (1964) finds, for six speakers, that context (g) (e.g. *button*) is mutually exclusive with context (f). An interesting rival rule would appear to be one in which reference is made to a following [+cons]-segment on the segmental tier, rather than a following C on the CV tier. Such a rule would predict a glottal stop in *button*, assuming words with syllabic nasals are represented as in (18a) at the point PREGLOTTALISATION applies, and would predict the absence of a glottal stop in *back-handed* in (18b), assuming /h/ has no independent segmental specification (Lass 1976, Clements 1980). Both Andréson (1968) and Higginbottom (1964) report less PREGLOTTALISATION before /h/ than before other fricatives,<sup>9</sup> and preglottalisation before syllabic nasals is not uncommon (cf (16)), though generally regarded as being nonstandard. Thus, mainstream BrE apparently stipulates the presence of C, rather than the presence of [+cons], to the right of /p,t,k/.



However, the assumption that PREGLOTTALISATION refers to the CV tier and not to the segmental tier, would appear to make problems for /tʃ/, which is commonly glottalised in words like *butcher*, *feature* and *furniture*. The ambiguous status of /tʃ, dz/ in English has been nicely captured by Clements & Keyser (1983:49), who analyse them as complex segments, occupying a single C-slot. But if *butcher* has the structure of (19a), it will be left untouched by any version of PREGLOTTALISATION.



As it happens, it is not difficult to motivate an extra C-slot for syllable-final affricates undergoing (17). One of the motivations for the CV tier is that it allows for a characterisation of segmental timing which is independent of the segments themselves. Roach (1973) is fairly explicit about the durational character of glottalised /tʃ/. He notes that there is a marked increase in the duration of the affricate in *butcher* relative to a pronunciation without preglottalisation, and observes that speakers who preglottalise /tʃ/ also have a 'long' pronunciation of /dz/, as in *badger*. This, he goes on, "could lead to the conclusion that some speakers take words such as 'butcher' and 'badger' to be phonemically /bʊttʃə/ and /bæddzə/". He finds there is "no longer a very marked duration difference" when the affricate is preceded by a long vowel. Note, though, that *teacher* is rhythmically more akin to *pizza* than to *Peter*. We therefore assume that mainstream BrE has AFFRICATE GEMINATION, a rule that provides syllable-final affricates with an extra C-slot. It is stated in (20). Note that after the restructuring, the appropriate syllable structure will be provided through the Resyllabification Convention of Clements & Keyser (1983), which says that the output of a phonological rule is resyllabified according to the syllable structure rules examined up to that point in the derivation.

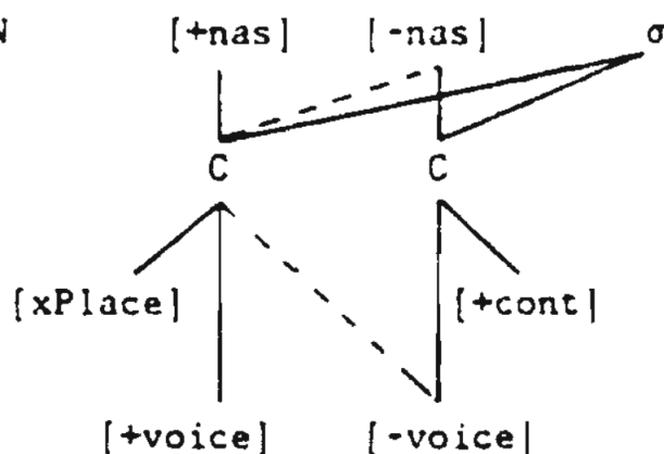


Thanks to the application of this rule, *butcher* has the structure of (19b), and satisfies the structural description of PREGLOTTALISATION. Observe that both operations crucially make use of ambisyllabicity: thanks to RIGHT CAPTURE on the single C-slot of affricates, AFFRICATE GEMINATION can apply to *orchard*, as it does to *arch*, to the exclusion of *kerchief*. And again thanks to RIGHT CAPTURE of the C-slot of /t/ after gemination, PREGLOTTALISATION can apply to *orchard*. The correctness of this



vowel appears in the second syllable, or because the fricative belongs to a different word (*sunshine*). Further, unlike Kahn's LEFT CAPTURE (Rule IV), EXTENDED RIGHT CAPTURE obeys the syllable structure rules of English. It thus does not apply to *Longford*, since /-ŋf/ is not a possible syllable-final cluster in BrE. STOP INSERTION can now be formulated as a rule that operates over tautosyllabic nasal+fricative sequences. It is given in (23). Since the segmental duration is not increased by a timing unit in columns I and II in (21), it is reasonable to assume that the rule creates a complex (nasal+stop) segment on the first C, in line with Wetzels (1986). Note that the inserted plosive is homorganic with the nasal (*amongst* /-ŋkst/, \*/ŋtst/) and receives its [voice] and [nasal] specifications from the fricative. We assume that there are separate laryngeal and velic tiers on which, respectively, voicing and nasality features are represented. The C-slot for the fricative then provides the righthand C for the purposes of (17).<sup>9</sup>

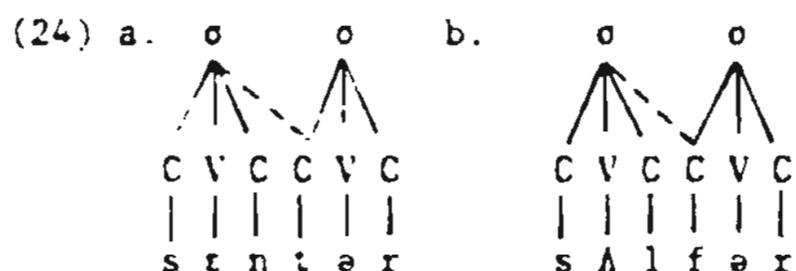
## (23) STOP INSERTION



It is of some interest that RIGHT CAPTURE correctly characterises the phonological, as opposed to the phonetic, nature of STOP INSERTION. The voiced segments (the vowel and the nasal) in a word like *concert* are pronounced short, as in a syllable closed by a fortis obstruent. Without application of RIGHT CAPTURE, or in Kahnian 'slow speech', these segments are pronounced long, as in a syllable closed by a lenis obstruent, or without an obstruent in the coda. In this respect, (23) differs from its AmE counterpart. In AmE, a word like *teamster* may be pronounced [tɪ:mpstər], with retention of the 'original' length of *team* (Ohala 1981). While AmE STOP INSERTION, like its BrE counterpart, can be characterised as being governed by tautosyllabicity, the stop does apparently not feed into the phonology of the language, and remains a low-level effect arising from the particular timing feature involved (i.e. velic closure preceding the release of the oral closure).

## 3. Kahn revisited

With the hindsight afforded by our inspection of the BrE data, let us now briefly return to Kahn's analysis of AmE. We have deviated from Kahn's theory of syllabification only where this was unavoidable. Specifically, we were forced to abandon LEFT CAPTURE, and to extend RIGHT CAPTURE. In this section I will argue that the same steps should be taken for AmE. There are two general considerations that make this move seem desirable. First, we can assume that the two varieties of the language have the same rules of syllabification; we thus express the fact that AmE and BrE have different distributions of aspirated plosives by having different formulations for ASPIRATION. Second, rules like LEFT CAPTURE are rare.<sup>10</sup> Rules for ambisyllabification are usually of the LIAISON-type (cf. liaison in French, Clements & Keyser (1983:36) for Welmers' (1973) labial flap in Efik) or of the RIGHT CAPTURE-type, in which a weak syllable is the 'captee' rather than the 'captor' (cf. Van der Hulst (1984:199) for Lozano's (1983) l-velarisation in Spanish, Clements & Keyser (1983:81) for the Danish stød, Berendsen & Zonneveld (1985) for Dutch svarabhakti). More importantly, however, there are empirical reasons for adopting EXTENDED RIGHT CAPTURE and dropping LEFT CAPTURE. First, we would have an explanation for the fact that /t/ in *center* is flapped, as well as for the fact that /ʌ/ in *sulphur* is shortened. The first process requires the /t/ to be ambisyllabic, the second that the /f/ is syllable-final. The required structures cannot be created by either RIGHT CAPTURE (the 'captor' syllable ends in C) or LEFT CAPTURE (assuming /nt-/ and /lf-/ are proscribed onsets), but are straightforwardly obtained by the application of EXTENDED RIGHT CAPTURE. In (24a), NASAL DELETION can apply to *center*, because /t/ is in syllable-final position. Subsequently, FLAPPING applies, because /t/ is ambisyllabic (cf. Kaisse 1985:28). In (24b), SHORTENING applies because /f/ is in syllable-final position.



The second empirical reason is the fact that EXTENDED RIGHT CAPTURE actually seems to do a better job at predicting the distribution of aspirated plosives than does LEFT CAPTURE. The second syllables in *Alka* (*Seltzer*), *Kolper*, *acting*, *opting*, *symptom*, *parka*, *hamper*, *hanker*, *after* have unaspirated plosives in 'fast speech'. Clearly, some, but not all of the clusters here are universally permitted onsets. In particular /lk-, mpt-, rp-/ look suspicious. All of them, however, are possible coda-clusters IN ENGLISH, the latter three being attested in *milk*, *unkempt* and *harp*. *Washington* is excluded from EXTENDED RIGHT CAPTURE, because /-ŋt/ is not a possible English coda, and so are *Nootka*, *Hodgkin* and *bodkin*. Further, assuming that final /o/ in -co formations is [-stress], we can account for the unaspirated /k/ in *Arco* (cf. *Rocco*) as well as

for aspirated /k/ in *Aamco*, *Gemco*. Admittedly, Kahn mentions *napkin* and *Atkins* as examples of words that contain unaspirated /k/'s. Our EXTENDED RIGHT CAPTURE does not account for these words. It would appear, however, that in 'fast speech' aspiration occurs quite naturally in the speech of some speakers I have consulted. On balance, it seems clear that EXTENDED RIGHT CAPTURE explains the facts of aspiration better than LEFT CAPTURE. Since the rule's other task, that of taking /ŋ/ into the onset of the second syllable of a word like *hangar*, has been taken over by SYLLABIFICATION, we reject LEFT CAPTURE as a rule of English.

There are two types of data, both given by Withgott (1982), that our analysis, or any other analysis, does not account for. First, the intervocalic /t/ in both *militarist* and *capitalist* are predicted to be flaps. Withgott points out that this is correct only for /t/ in *capitalist*, the /t/ in *militarist* being aspirated. Hammond (1982) proposes that RIGHT CAPTURE should be bled by the destressing rule taking /ɛ/ (cf *military*) to schwa, an account that would also produce the right results for *mono[t]ony* (cf *monotonic*). However, Don Churma (personal communication) points out that the right explanation is probably a purely phonological one, in view of the non-flapped /t/'s in *Mediterranean* and *gelatinous*, words in which the reduced vowel after /t/ is underlying. Second, the unstressed function-word *to* may have flapped /t/, even though /t/ here is predicted to be in absolute syllable-initial position, as in *two to one, by tonight*. Rather than assume that RIGHT CAPTURE may sometimes apply across word boundaries, as Hammond (1982) does, I will assume that we are here dealing with one of the many fairly specifically conditioned cliticisation rules of AmE. Neither type of data, then, would lead one to believe that English plosive allophones are governed by anything other than surface syllable structure.

#### 4. *Alternative proposals*

We have shown that Kahn's central point, viz. that the occurrence of the various plosive allophones in AmE is governed by a type of syllable structure in which ambisyllabicity is a possible configuration, is confirmed by the data from BrE. The evidence for ambisyllabicity is overwhelming. Inclusion of ambisyllabicity among the structural positions for consonants increases the possibilities for syllable-based structural descriptions to five. All five possibilities are represented by at least one of the rules discussed in sections 2 and 3.

1. Absolutely syllable-initial: ASPIRATION (AmE)
2. Syllable-initial: ASPIRATION (BrE)
3. Ambisyllabic: FLAPPING, WEAKENING
4. Syllable-final: PREGLOTTALISATION, AFFRICATE GEMINATION, STOP

## INSERTION, NASAL DELETION, SHORTENING

## 5. Absolutely syllable-final: GLOTTALISATION

Moreover, in this section we will refer to l-VELARISATION, which rule belongs to category 5 in BrE, and to category 4 in AmE. Crucially, for these rules to produce the correct output, the same consonant may have to be both 'syllable-final' and 'syllable-initial'. In BrE, words like *meeting*, *liking*, *viper* have shortened vowels in the first syllables, and - in other than fast informal speech - aspirated plosives intervocalically. The first feature is due to SHORTENING, typically produced by 'syllable-final' fortis obstruents, the second typically by 'syllable-initial' fortis plosives. Similarly, in the same variety, words like *mattress*, *cycling*, *Cyprus* have preglottalised, aspirated plosives (in addition to shortened vowels in the first syllables), again showing that consonants can be 'syllable-final' for the purposes of one rule (PREGLOTTALISATION) and 'syllable-initial' for the purposes of another (ASPIRATION). Further, if we may assume that a vowel like /ɒ/ may not occur in an open syllable (cf section 2), /l/ and /r/ are needed as codas in the first syllable of *Ollly* and *sorry*, but this structural demand is in conflict with the facts that /l/ in *Ollly* is clear, like any syllable-initial /l/, and that /r/, which occurs in *sorry*, is deleted in the coda in BrE. For cases like these, there is only one solution imaginable within a syllable-based account that does not make use of ambisyllabicity: one in which phonological rules and syllabification rules are ordered among each other. In *Ollly*, for example, we could first have a syllabification rule that produces *0-lly*, then a rule marking /l/ as clear, and then a resyllabification rule to produce *Oll-y*. Or, conversely, have the word start out as *Oll-y* to satisfy the structural demand, resyllabify, and apply the allophonic rule for /l/. There are two objections to such a solution. The first is that the solution would have to deny either the surface-true nature of the sort of rules that have been used as evidence for ambisyllabicity (e.g. in slow speech, /l/ in *Fill every cup* may be dark, but after LIAISON it is clear) or the surface-true nature of constraints like '/ɒ/ does not occur in an open syllable'. The second is that unless the ordering can be motivated on other grounds, the solution is no more than an unattractive notational variant of ambisyllabicity.

In this section we wish to address more directly a number of alternative proposals concerning the distribution of the plosive allophones of AmE. The main motivation behind these proposals is that ambisyllabic consonants would appear to go against the generalisation that the nodes in syntactic and phonological trees (and the syllable is a clear candidate for having tree-like structure) exhaustively dominate the elements at lower levels, and that therefore an element cannot be dominated by nodes belonging to different trees. We will try to show that the alternative proposals, ingenious as they may be, do not succeed in accounting for the facts. The alternative proposals are discussed in the order from 'relatively minor' to 'major' difference with the account defended here.

Selkirk (1982) agrees with Kahn that the distribution of plosive allophones in AmE is syllable-based, but rejects the claim that ambisyllabicity plays a role in the environment of the rules concerned. Selkirk thus restricts the possible ways in which a rule may refer to position in syllable structure to position in onset and position in coda.<sup>11</sup> In her reanalysis of the AmE data, Kahn's SYLLABIFICATION is assumed as it stands, while two resyllabification rules are proposed. The first, referred to as RS I, is obligatory. It shifts a consonant that is alone in the onset of a stressless syllable into the coda of a preceding syllable, provided that syllable ends in a vowel or /r/. Thus, the /p/ in *happy*, *harping*, *interpolate* changes from an onset into a coda C. The second rule, RS II, is identical to the first, except that it is optional and that the coda may end in a consonant. Both rules are subject to a syllable template that Selkirk proposes, which in effect restricts the operation of RS II to (i) obstruents and (ii) sonorants if the preceding syllable has a rhyme (actually a nucleus, according to Selkirk) that consists of a short vowel and a sonorant C. As a result, aspiration - a feature of syllable-initial /p,t,k/ for Selkirk - is correctly predicted to be variably present in words like *Atkins*, *Lefkowitz*, *napkin*, just as it is in *actor*, *nifty*, *helicopter*, as well as in words like *filter*, *lanky*, *wimpy*. In all these words, RS II may move the onset obstruent of the last syllable into the coda of the preceding one, bleeding aspiration. Note, however, that the relief afforded here by Selkirk's solution is cancelled out by cases like *Washington*, *bodkin*, *Nootka*, *Gemco*, which now are also predicted to be unaspirated. Moreover, there are three undesirable consequences of Selkirk's resyllabification rules, which stem from the demand that the consonant to be moved should be alone in the onset. First, aspiration is predicted in such words as *central*, *April*, *actress*, *acclamation*. Selkirk in fact claims that these plosives are aspirated, which effectively puts her description *hors de combat* vis-à-vis Kahn's, as the authors appear to be describing different dialects. My own observations suggest that Kahn's is the more representative here, and that most speakers of AmE differ from the BrE-type pattern described by Selkirk: typically, aspiration occurs in *acclaim*, as in BrE, but not in *acclamation*. Second, Selkirk's description predicts that NASAL DELETION before tautosyllabic plosives will occur in *center* ([sɛ̃Dr]), but not in *central*. Again, there are conflicting reports about the data. Kaisse (1985:29) gives *central* with NASAL DELETION and opposes it to *centrality*, where /n/ is preserved. My own observations suggest that /n/ in *central* is in fact treated like /n/ in *sent*, with 'vestigial /n/' (Malécot 1960) equally likely to occur in either, and that *central* is clearly unlike *centrality* in this respect. Therefore, Selkirk's description would appear to make the wrong predictions here for mainstream AmE. Thirdly, Selkirk's description predicts that STOP INSERTION (applying between a nasal and a tautosyllabic voiceless fricative, as in *since*, *amongst*) will apply in *concert*, but not in *instrument*, *minstrel*, where s(t)<sup>12</sup> cannot be moved into the coda of the preceding syllable because of the following tauto-onset /r/. However, *minstrel* and *instrument* may have inserted stops, just like *mincer* and *mince* and unlike *construct* (n). Selkirk does not discuss

such data, but it would certainly be in the spirit of her proposal to consider STOP INSERTION to be syllable-based. All three problems are created by the renunciation of ambisyllabicity: if - in Selkirk's description - consonants in onset-clusters (e.g. *lamprey*, *central*) were allowed to become codas, they would be subject to GLOTTALISATION, as in *lamp* and *sent*, which they clearly are not. We conclude that Selkirk's proposal cannot count as a reasonable alternative to the analysis defended here. Let us nevertheless have a brief look at Selkirk's solution for GLOTTALISATION and FLAPPING, which may be of interest in its own right. Selkirk arrives at a simple statement of these two processes affecting syllable-final plosives by creating complementary contexts on the basis of whether the plosive is released: [-release] triggers GLOTTALISATION (of /p,t,k/), [+release] triggers FLAPPING (of /t,d/). An additional condition for the latter process is that /t,d/ be preceded by [-cons]. For FLAPPING, the analysis makes the interesting claim (cf also Kiparsky 1979) that final /t,d/, if released, are flapped, differing from the 'usual' flapped /t,d/ in being voiceless or devoiced. I have not been able to find confirming evidence for this claim, although for some speakers there would appear to be a characteristic type of prepausal stop articulation which involves a short closure. What would be needed to support the analysis here is evidence that flapping and the 'short duration' articulation for final plosives are phonetically related. In any event, Selkirk's claim is that these statements are simpler than Kahn's, and that they should therefore be preferred. The simplicity may only be apparent, though. Note that it is mediated through the offices of a novel feature [release], and the distribution of its specifications is anything but simple. Selkirk motivates the feature on the grounds that languages differ in whether the first of two heterorganic plosives is released or not, with English typically not releasing such plosives in *actor* and French typically releasing them in e.g. *acteur*. Clearly, a phonological theory should be able to account for such non-mechanical, language-specific differences. But such facts as Selkirk cites for English and French are really instances of the general phonetic phenomenon of the timing of articulatory movements: in English the closure phases of /k/ and /t/ in *actor* overlap, while in the equivalent French case they do not. Such timing differences are, or can be, crucially important determiners of phonetic form. However, half of the times, the 'release' Selkirk refers to in her rules is not a matter of articulatory timing at all, but of whether or not an utterance-final closure is or is not audibly released. What is lacking in her account is a demonstration that, independently of the rules she is concerned with, these two aspects of plosive articulation are different phonetic manifestations of the same phonological thing.<sup>13</sup>

Earlier Kiparsky (1979) proposed an analysis of the distribution of AmE plosive allophones that avoided reference to ambisyllabicity. The analysis is based on the fact that, on Kahn's as well as the present analysis, rules creating ambisyllabic consonants within the word operate within the foot. Glottalised stops and flapped /t/'s are derived in two steps. First, a word-cycle LAXING rule laxes

all non-foot-initial /t/'s that are preceded by [-cons]. This causes such /t/'s in the coda (e.g. *right*) and in the onset (e.g. the second /t/ in *potato*) to be [+lax]. Post-cyclically, there is a rule (POSTCYCLE) that voices lax /t/ syllable-initially (producing a flap) and glottalises lax /t/ syllable-finally. In order to derive flapped /t/ in *get Ann*, syllabification is assumed to be cyclic. When it applies at the phrasal level, before POSTCYCLE and after LAXING, syllabification detaches a coda-consonant and makes it into an onset-consonant in the well-known LIAISON context. Since /t/ in *get Ann* is non-foot-initial at the time LAXING applies, and syllable-initial at the time POSTCYCLE applies, it will be a flap. As for aspirated plosives, any [-lax] syllable-initial plosive will now be aspirated. As Hammond (1982) points out, this will incorrectly aspirate /t/'s in *actor*, *after* etc., which have syllable-initial plosives in Kiparsky's analysis. If we rectify this situation by postulating a word-level rule that aspirates only foot-initial /p,t,k/ (cf also Vogel 1985), we find that such a solution does not produce better results than the syllable-based solution: while *napkin* and *Atkins* can be accommodated, the aspirated, non-foot-initial plosives in words of the *Nootka*-type become a problem. More generally, observe that the syllable structure assumed for FLAPPING (essentially Maximum Onset Principle, and no resyllabification within the word) implies that SHORTENING, l-VELARISATION (AmE ambisyllabic /l/ is dark), STOP INSERTION, NASAL DELETION are also foot-based. With regard to STOP INSERTION, Van der Hulst (1984: 198) observes that with the notion ambisyllabicity at one's disposal, it is unnecessary to assume that the nasal and the fricative are in the same foot for STOP INSERTION to be triggered in AmE, as proposed in Hayes (1982). Here we point out that at least for BrE a foot-based rule produces the wrong results. In that variety, words in which the nasal and the fricative occur in the same foot but in different syllables do not have STOP INSERTION or PREGLOTTALISATION, such as *Longford*, *damsel* and a possible *Hamsham*, clinching the case for a syllable-based rule. I am not sure whether the phonetic facts of AmE allow one to draw the same conclusion, but it would not be surprising if they did. With regard to l-VELARISATION, it can be observed that /l/ in *McKinley* resembles /l/ in *Lee* rather than that in *jelly*, which suggests that the foot-based solution makes the wrong predictions here. With regard to SHORTENING, we may compare *damsel* and *tinsel*, or *whimsical* and (a phonologically well-formed) *winceable*, where the former members of each pair are not subject to the rule, but the latter are, in line with a syllable-based approach (\*/-ms/). The evidence, then, clearly converges against a foot-based account.

Kiparsky raises two objections against Kahn's analysis. The first is that it conflicts with the facts: by assuming different syllabifications in V#CV and VC#V in order to account for the difference in pronunciation between *a tease* and *at ease*, Kahn wrongly predicts that also *a name* and *an aim* have different syllabifications, which, Kiparsky claims, is not true for rapid speech. However, it is doubtful if *a name* and *an aim* are in fact homophonous, even in 'fast informal speech'. Indeed, one of the arguments Kahn uses to defend his analysis is precisely the

prediction of the heterophony of *a name* (/n/ in absolute onset position), and *an aim* (/n/ ambisyllabic), and the homophony of *a name* and a hypothetical *annaim*. The heterophony of *an aim* and *a name* in fact provided one of the motivations for the juncture phoneme of the structuralists (cf *an ice(man)* - *a NICE (man)* etc. in Hockett 1958:55). Certainly, there seems to be no doubt that there is a style informal enough for LIAISON to have applied and formal enough for such pronunciations to remain distinct. Second, Kiparsky argues that there is no plausible syllabification of a hypothetical *Islip* which allows both SHORTENING before fortis obstruents (cf *ice*) and DEVOICING of /l/ after /s/ (cf *slip*) to have syllabic domains. As we have seen, if ambisyllabicity is a possible syllabic configuration, this situation is dealt with effortlessly in BrE words like *neutral*, where /t/ is both preglottalised and aspirated. (The first syllable of *neutral* has the duration of *newt*, not that of *new*, so that for preglottalised we could also read shortened.) Neither argument against a syllable-based solution, then, can be accepted. Since neither its predictive power nor its intuitive appeal (observe that e.g. (ə) *seeking (helicopter)* and (ə) *Sea King (helicopter)* have identical syllable structures) force one to prefer it to the syllable-based approach, we reject the foot-based approach.

Vogel (1985) assumes that FLAPPING is an Utterance-based rule: the process affects any intervocalic /t/ within the U(tterance). Clearly, there are cases where we do not get FLAPPING, even within the U. This may happen under emphasis, as in *Isn't that Awful!* Or when the righthand vowel belongs to a not-too-familiar name, as in *Count Arden is a great guy!* Or possibly in a sentence like *Set A is in fact smaller than set E*. If we say that FLAPPING is suspended under conditions X, we produce an unsatisfactory description inasmuch as the same conditions X will figure in the case of LIAISON, which must be suspended in exactly the same cases (cf *famous artists* and *Countess Arden*, etc.). Of course, if Vogel means to say that processes like LIAISON do not cross U-boundaries, there is no reason to take issue with her, but such a statement is not a full description of when FLAPPING occurs.

It would appear that ambisyllabicity is here to stay: none of the alternative analyses discussed above presents a viable alternative to the Kahnian description presented in sections 2 and 3.

#### NOTES

- [1] I should like to thank Don Churma for his discussion of Kahn's LEFT CAPTURE and his suggestion to try the rule backwards, and Meg Withgott for her discussion of the implications of her data reported in section 3. I thank Don Churma and Leo Wetzels for their useful comments on an earlier draft of this article. This research was supported by the Netherlands Organization for the Advancement of Pure Research.

- [2] Hayes (1986) proposes the following constraint on the formulation of autosegmental rules (I quote from a preprint):

LINKING CONVENTION: An autosegmental rule may apply to a given representation only if any association lines in its structural description match up precisely with the association lines in the representation.

Adoption of this convention would simplify many of the formulations in this article. However, it would forbid rules that refer to (i) both syllable-final and ambisyllabic consonants, and (ii) both syllable-initial and ambisyllabic consonants. Rules of both types exist in English, and are discussed in sections 3 and 4. Type (i) is exemplified by SHORTENING before fortis obstruents, as in *like*, *liking* (cf *lie*, *lied*), NASAL DELETION, as in *camp*, *camping* (cf *campaign*) and STOP INSERTION, as in *sense*, *sensitive* (cf *sensation*). Type (ii) is exemplified by BrE ASPIRATION, as in *try*, *citrus* (cf *footrest*). As Hayes' convention is motivated on the basis of rules referring to association lines between the CV-tier and the segmental tier(s), I will assume that it holds only for those association lines, and not for association lines between the CV-tier and the  $\sigma$ -tier.

- [3] Don Churma points out to me that this is not a necessary correlation for all speakers.
- [4] Examples of both initial and final clusters that are excluded at word boundaries are given in Booij (1983).
- [5] This organisation could harmlessly be assumed for AmE, too, if SYLLABIFICATION, ASPIRATION and GLOTTALISATION are assumed to belong to a more formal register than LEFT CAPTURE, RIGHT CAPTURE, LIAISON and FLAPPING.
- [6] Again, these data demonstrate the difficulties that would arise if we were to attempt to capture PREGLOTTALISATION in SPE terms. Roach's (1973) formulation of a rule that applies ONLY in context (f) overgenerates both by including *butler*-type words and *betray*-type words. Higginbottom (1964) and Andréen (1968:107) expressed the right intuition here. They say that PREGLOTTALISATION before consonants is common in the same word, if the plosive and that consonant form a possible word-initial cluster, adding the further condition that the preceding vowel should be stressed, as in *Patrick*, *fatuous*, *infatuation*, which contrast with *Patricia*, *fatuity*. This corresponds with a Kahnian description except that (1) it is not PREGLOTTALISATION that is dependent on stress, but RIGHT CAPTURE, and (2) it is not the prosodic status of the first vowel that is relevant, but that of the second, which should be [-stress]. Thus, RIGHT CAPTURE, and hence Rule (17b),

apply to *chronicler*, *military*, etc., contrary to what Higginbottom and Andrézen would predict.

- [7] None of the sources other than Roach contain any indication that situation 1. is in fact correct. His reference to a supporting statement by Higginbottom is in error. The issue does not, fortunately, affect our argument.
- [8] In Andrézen's data, the percentage for plosives before /h/ is 21.5, as against 38.4 for plosives before other fricatives.
- [9] We could, incidentally, introduce a C-slot at no cost, since a rule deleting a C-slot would be required anyway in order to account for the homophony of *cents* and *sense* after (23) (if indeed these are homophonous).
- [10] One just like it has been proposed for Pāli by Wetzels & Hermans (1985).
- [11] Since (non-syllabic) consonants can also appear in the nucleus of a syllable in Selkirk's description, this third possibility is also available.
- [12] Selkirk leaves open the question whether /st/ count as one or as two consonants for the purposes of RS II.
- [13] In Dutch, for example, utterance-final plosives are normally released, but the closure phases of heterorganic plosives overlap, provided they are in different syllables, as in *akteur*. The two phonetic aspects do not necessarily go hand in hand.

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