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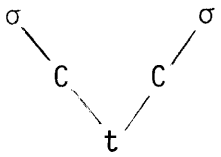
The distinction between melody tier and CV-skeleton has made possible a revealing representation of geminate consonants as we see in (1).

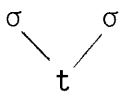
(1)



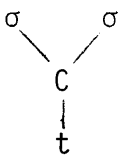
In this paper we propose that the formal representation of ambisyllabicity is identical to that of gemination. In both cases we are dealing with one unit which is part of two syllables; the consonant is initiated in the first syllable and released in the second syllable. Before we look at the relevant facts of Danish which support the analysis, let us briefly discuss the general conceptual considerations behind our approach to ambisyllabicity.

There are phonetic differences between geminate consonants and ambisyllabic consonants which could be taken to argue against our proposal; geminates in languages like Italian or Finnish are demonstrably longer than simple consonants, whereas ambisyllabic consonants of English, at least flaps, are noticeably shorter. If the units of the skeleton tier are taken as having a timing value which can be cashed in real time, then our identical representation for ambisyllabicity and gemination would be in trouble. But we

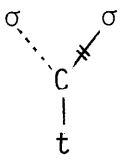
know independently that this picture is somewhat naive. Not all skeleton elements are temporally equal. Onset consonants, even complex onset clusters, do not add to the weight of syllables. This shows that subsyllabic aspects of timing are not adequately represented on the skeleton tier. It seems that only higher prosodic constituents (moras, syllables and feet) play a crucial role in timing. The representation which we propose for both ambisyllabicity and gemination brings out what they have in common: their syncopated nature with respect to two syllables. But now that we have made ambisyllabic segments and geminates so similar, one might ask how we account for their differences. We propose that this is to be done by phonetic rules, which interpret the representation with reference to the phonology of the particular language. Whether a language allows long consonants underlyingly (e.g. Italian fatto vs. fato) or not (e.g. English) will in part determine the final phonetic realization of the structure.

(2) a. 

Kahn (1976)

b. 

Clements & Keyser (1983)

c. 

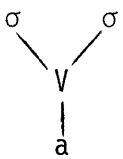
Selkirk (1982)

Previous proposals for the representation of ambisyllabicity which are shown in (2) pose several drawbacks:

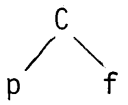
(i) As has been noted in the literature, both Kahn's (2a) and Clements and Keyser's (2b) representation result in improper bracketing in prosodic structure.

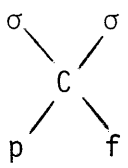
(3) [C V [C] V]
1 2 1 2

(ii) Questions with respect to descriptive power may arise. Consider (4). Can the V-slot be shared by different syllables in a way analogous to the ambisyllabic C-slot in (2b)?

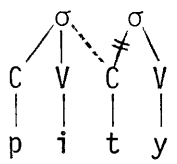
(4) 

(iii) Autosegmental phonology allows the representation of complex segments as in (5a) (cf. Keyser & Kiparsky 1982, Steriade 1982, Clements & Keyser 1983). Compounding this with the representation in (2b) results in (5b), where the C shared by two syllables is also shared by two melodic segments. This raises an interesting empirical question: Do such structures exist?

(5) a. 

b. 

(iv) Denying the existence of "phonological" ambisyllabicity, Selkirk (1982) proposes a rule of resyllabification from onset to coda, which we translate as in (6).

(6) 

Pointing out that so-called "ambisyllabic" segments never need be syllable-initial and syllable-final at the same time, she argues that all phonetic properties characteristic of "ambisyllabic" segments are derived from their coda status. The resyllabified structure (6), however, runs counter to the universally observed preference for onsets: Syllables do like onsets, after all.

The notion of ambisyllabicity which captures the shared nature of the consonant has real intuitive appeal. This is completely lost in a resyllabification analysis. Over and beyond this syllabification intuition, we will show that there is other more substantive evidence for the phonological reality of ambisyllabicity.

2. Ambisyllabicity in Danish

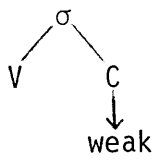
In Danish, there is evidence that certain consonants function simultaneously as the onset of one syllable and the coda of the preceding syllable. Their phonological behavior provides empirical support for our hypothesis that such consonants are indeed "phonological geminate". In 2.1, we will discuss the phonological rules which are necessary background for our analysis. In 2.2, we present the analysis of these Danish facts followed by a brief comparison of other possible analyses in 2.3.

2.1 There are three rules involved:

i) Consonant Gradation (CG) - (7)
ii) Grave Assimilation (GA) - (9)
iii) Stød Association (SA) - (12)

In syllable final position, underlying obstruents (excluding b) undergo consonant gradation (CG).

(7) Consonant Gradation (CG)

a. 

b.

Underlying		Surface
voiceless	⟶	voiced
voiced	⟶	spirant

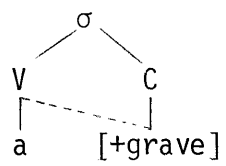
As shown in (7b), underlying voiceless obstruents /p/, /t/, /k/ become voiced, and underlying voiced obstruents /d/ and /g/ become fricatives /ð/ and /ɣ/. In (8) we see examples showing consonant gradation at work.

(8)

/p/	galopērə "to gallop"	galop "gallop" (N) ↓ b	optimal ↓ b
/t/	vatērə "to pad"	vat "cotton wool" ↓ d	atlas ↓ d
/k/	lakērə "to lacquer"	lak "paint" ↓ g	faktom "fact" ↓ g
/d/	abedisə "abbess"	abed "abbot" ↓ ð	admiral ↓ ð
/g/	pædagogik "education"	pædagōg "educator" ↓ ɣ	sygdom "sickness" ↓ ɣ

The low vowel a becomes [+grave] when followed by a tautosyllabic grave consonant. We express this rule by autosegmental assimilation of the grave feature as in (9).

(9) Grave Assimilation (GA): (a → α)



In the examples in (10a) we see that the grave vowel appears when the syllable is closed by a grave consonant. This is in contrast to the examples in (10b) where the grave consonant is the onset of the following syllable.

(10) a. vɑksinerə
ɑmfiteater
ɑbsalon
gɑmlə "old"
uðgɑŋ "exit"

b. akusatīv
amerika
napoleon
familiə

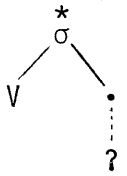
In (11), we see that the vowel quality does not change if the closing consonant is a coronal.

(11) a. atlas
fantasərə

b. latīn
fanatikər

On an accented syllable, a stød (i.e. glottal stop) is realized on the sonorous coda immediately following the nucleus vowel, as in (12).

(12) Stød Association (SA)[1]

a. 

If the vowel is long, it bears the stød; if the vowel is short, the stød falls on the sonorant consonant ((13a) vs. (13b)). No stød appears in (13c) because the postnucleus position is filled by a non-sonorous segment. (The stød is represented by /'/.)

(13) a. mī'l "mile"
pǣ'n "pretty"

b. mil' "mild"
pæn' "pen"

c. hest "horse"
skrift "writing"

Phonetic variation may occur due to an optional rule of vowel shortening which displaces the stød from the vowel to the consonant. Examples are given in (14).

(14) hū'ð huð' "skin"
brē'w brew' "letter"

Notice that each of these rules (CG, GA, SA) has crucially something to do with the coda position in the syllable: CG and SA apply to some segment when it is in the coda, GA is conditioned by a syllable final consonant. Thus the application of these rules should give information about the position a consonant occupies in a syllable.

2.2 Consider the consonants in the environment V́_V̆ in (15) and (16).

(15)

a. lɑ́bə̆ "to patch" b. brǽn'ə̆r "burns (pres.)" c. bǣɣə̆ "to bake"

tɑ́gə̆ "to thank" hún'ə̆n "the dog" dȫðə̆nə "dying"

(16) a. kɑ́pə̆ "kappa" b. kɑ́n'ə̆da "Canada"

jɑ́kŏb "Jakob" ɑ́n'ŭom "annual grant"

fɑ̀kŭltɛ́t "faculty" kím'ŏno "kimono"

Although normally intervocalic consonants show onset properties, before a schwa the consonants act as if they were closing the syllable. They show all above-mentioned coda properties. The underlined C in (15a) triggers GA; receives a stød by SA in (15b); and undergoes CG in (15c). These are the cases which are traditionally considered to be ambisyllabic by Jespersen (1934), Martinet (1937) and Basbøll (1974).

Compare the cases in (16) in which intervocalic consonants show a mixture of onset and coda properties (from Hansen (1979)). Before a full vowel, the underlined consonant conditions GA in (16a) and bears stød (16b), suggesting that these consonants are codas. However notice that the Cs in (16a) do not, as we might expect, show the third characteristic of codas --CG (e.g. √jɑkob, but not *jɑgob).

If the consonants in (15) are ambisyllabic, what is the status of examples in (16)?

We claim that the distinction between the two sets is morphological. The cases in (16) are monomorphemic, whereas those in (15) are morphologically complex. That they are all followed by schwa is coincidental since most of the vowel-initial suffixes at this level are schwa-initial. Thus the distinction between the examples in (15a) (e.g. lɑbə) and (16a) (e.g. kɑpa) is not merely one of vowel quality. The crucial factor is the different morphological bracketing.

(17) a. [[lap] ə]

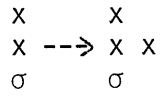
b [kapa]

This interplay of phonological and morphological facts suggests an approach in terms of lexical phonology. Following in the spirit of Kiparsky (1983),we assume a single ordered set of rules which, in the unmarked case, applies at all levels -- lexical and post-lexical -- and whose differential behavior at each level follows from independent general principles. Therefore the morphologically

complex [[lap]ə] would have a derivation in which CG takes place on the earlier cycle [lap] before the infinitive suffix -ə is attached. In contrast CG does not apply to [kapa] because there is no internal cycle on which its structural description is met.[2]

To account for the complex of mixed properties shown by the consonants in (15) and (16), we introduce a Gemination rule which creates the "geminate" structure we suggest in (1).[3] This rule applies on the word cycle after stress.

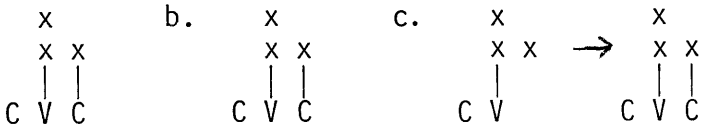
(18) Gemination:



(i.e. Add a second grid position to syllables under stress.)

In addition, we assume that the segmental material is aligned with the grid. Long vowels and closed syllables already fulfill the bipositional grid alignment - see (19a) and (b). Short open syllables will add a position as shown in (19c).

(19)



Let us now consider the derivations in (20):

(20)

	a. kanada	b. kapa	c. lap	d. lapə
CG	—	—	lab	—
(Affix)	—	—	lab+ə	—
Gemin.	C C \ / kanada	C C \ / kapa	C C \ / labə	C C \ / lapə
GA	—	C C \ / kαpa	C C \ / lαbə	C C \ / lαpə
SA	? | C C \ / kanada	—	—	—
CG	—	—	—	—
Output	kan'ada	kαpa	lαbə	*lαpə

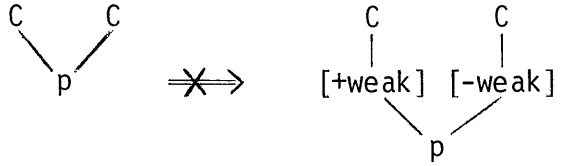
Application of the gemination rule (18) closes the stressed syllable, thus feeding SA and GA in the cases (20a &b) above. On the other hand, notice that CG does not take place in (20b). Gemination crucially does not feed this rule because, in general, such rules may not apply to only part of a geminate structure. To be precise, we propose that the application of CG in this case is blocked by the principle of the "integrity of geminates". This constraint has been proposed in various forms by Kenstowicz & Pyle (1973), Guerssel (1978), Schein (1981), Steriade (1982) and many others. We state our version of this constraint in (21).

(21) Geminate Constraint

No rule can apply to the melody element of a geminate structure unless both skeleton positions fulfill the structural description of the rule.

This constraint[4] blocks the application of CG in a geminate structure such as in (22) because it would only be applying to half of a geminate.

(22)



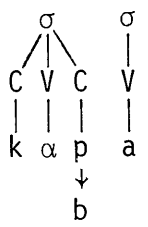
To return to the derivations in (20): if lαbə had gone through the rules in the same way as kαpa did, we would expect the geminate constraint to block CG, resulting in the ill-formed *lαpə. Recall however our earlier remark about the morphological complexity of this form. This ensures that CG may take place on an earlier cycle as shown by the derivation in (20c). Thus the constraint in (22) is irrelevant here. We correctly derive the case in (20b) without CG, using the geminate constraint, and the case in (20c) with CG because of an earlier cycle in which the consonant is purely a coda.[5] Making this assumption we also, correctly, do not derive the form in (20d).

Now that we have shown how our analysis works, let us compare it to the other analyses. The cyclic solution for the schwa cases does not bear on the representation of ambisyllabicity, and it is available to all analyses. What is however crucially different is that with our geminate representation we can invoke the independently motivated universal geminate constraint to block the application of CG.

2.3

Consider the structure in (23).

(23)



This is the structure which would be created in a resyllabification-to-coda analysis. In this structure, both CG and GA can apply, deriving the ungrammatical */kαba/. The desired output is /kαpa/, without CG.

To overcome this problem, proponents of the resyllabification-to-coda analysis might argue that the rule of CG is simply no longer available at this level. However, this can be shown to be false.

CG must be applicable in the postlexical phonology, as illustrated by the behavior of the enclitic definite article. Postlexically, in (24a) and (b) the enclitic article -əd is added, which undergoes CG.

(24)

Word Level	a.	b.	c.
	kapa	fakultet	god
	C C	C C	
Gemination	kapa	fakultet	—
	C C	C C	
GA	kαpa	fαkultet	—
		C C	
CG	—	fαkulted	goð
Affix	—	—	goð + hed
CG	—	—	goðheð
Postlexical Level			
Enclitic	kαpa + əd	fαkulted + əd	—
CG	kαpaəð	fαkultedəð	—
Output	kαpaəð	fαkultedəð	goðheð

This shows that CG cannot have been turned off earlier.

One might reject this evidence by arguing that the enclitic postarticle is not introduced postlexically. Either it could be treated as a full word in itself, or it could be regarded as a word-level suffix (parallel to -hed "-hood") (see 24c). In both cases, the postarticle would undergo the word level rules, in particular CG, and there would be no argument to the effect that CG has to apply postlexically. Then, if resyllabification is postlexical and CG does not apply after the word level, the nonapplication of CG in forms like /kɑpa/ is explained. Independent evidence shows that these enclitics are indeed postlexically introduced. In (25a), preceding the genitive ending -s, the underlying d of the enclitic article does not show gradation to ð, which would be expected if the post-article is introduced at the word level. Compare (25b) and (c).

(25) a. /hūs + əd/ + /s/ → /hūsəds/, */hūsəðs/ "of the house"

b. /gud/ + /s/ → /guðs/, */guds/ "god's"

c. /god + hed/ + /s/ → /goðheðs/, */goðheds/ "of goodness"

We explain the form in (25a) as follows. Consider the derivations in (26).

(26)

Word Level	a.	b.	c.	d.
	gud	gud	hūs	hūs
VA	-	-	-	-
CG	guð	guð	-	-
Postlexical Level				
	guð	guð + s	hūs + əd	hūs + əd + s
VA	-	-	-	hūsəts
CG	-	-	hūsəð	hūsəds
Output	guð	guðs	hūsəð	hūsəds

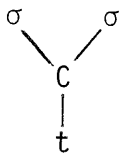
Danish has an independently motivated rule of voicing assimilation (VA) which assimilates the voiced stop d, but not the voiced fricative ð, to a following s. This rule is ordered before CG.

In (26b), the genitive ending -s is added postlexically, deriving guðs because VA does not affect ð. Compare (26d), where the form husəds is derived. At the postlexical level, rules apply across-the-board. VA changes the d of the postarticle to t, which subsequently is gradated back to d.

To recapitulate, we have shown that CG must continue to apply postlexically - a fact which cannot be reconciled with the resyllabification-to-coda proposal.

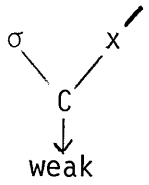
How does the C-sharing ambisyllabic representation in (2), repeated below, fare?

(27)



Since the ambisyllabic consonant functions as both coda and onset, the overapplication of CG cannot be ruled out by the geminate constraint. Rather, information blocking its application to the mixed structure in (27) must be encoded into the rule of CG as in (28).

(28)



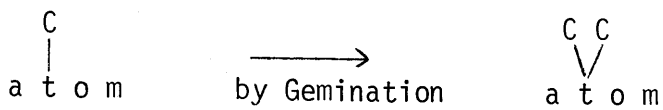
3. Concluding Remarks

To sum up so far, we have shown that, assuming a version of lexical phonology and the independently necessary geminate constraint, all the Danish facts can be straightforwardly explained if ambisyllabic consonants are represented as geminates.

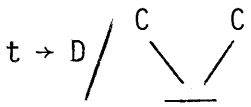
The Danish facts show the mixture of onset and coda properties characteristic of ambisyllabics with particular clarity. One might, however, wonder how our hypothesis will extend to other cases of ambisyllabicity. As a case in point, let us consider some problems which surface in discussions of English flapping.

Flaps typically occur in the environment $\acute{V}\_\breve{V}$ (cf. á[D]ŏm vs. ătómic.[6] However, the restriction of flapping to the environment "preceding unstressed syllable" does not hold across word-boundaries, as cases like a[D]éase, hi[D]Ánny show. Although this has led to complications in earlier analyses, it can be accounted for unproblematically under our assumptions. In line with our general proposal, flaps are created by a stress-conditioned gemination rule.

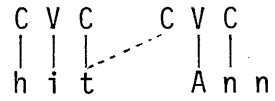
(29)



This structure is interpreted as a flap by the phonetic rule in (30).[7]

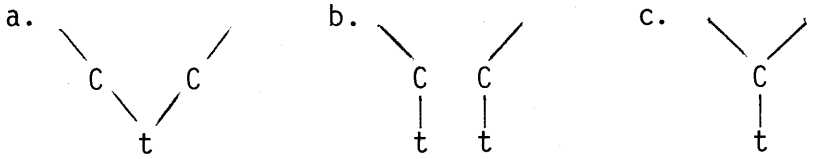
(30) 

Assuming that the initial syllable of Ann contains an empty C which is then filled by spreading of the preceding melody element /t/, we derive a geminate. The structure of hit Ann is shown in (31).

(31) 

This geminate is then realized as a flap by rule (30), which blindly interprets any such structure as [D]. Thus the conflict of environments mentioned above is resolved. This flap, unlike the general case, is not derived by the gemination rule at all - the C-slot is already present in the underlying phonological representation. This assumption is supported by the insertion of glottal stops in other environments (cf. see Ann, [siy ?æn]).

Finally, we note that our theory predicts that ambisyllabicity and true gemination are properties which are in complementary distribution. This does not mean that a language which shows ambisyllabicity effects cannot at the same time have phonetically "long" consonants. Rather, the ambisyllabic consonants will be represented as in (32a) and the long consonants as truly double consonants in (32b). A further prediction would be that the geminate constraint, although applying to the ambisyllabic consonants (32a), would not apply to the long consonants (32b).

(32) 

The structure in (32b) has independent motivation in the phonology of gemination as shown in work by Kenstowicz, Schein, and Steriade. This in fact forces a C-sharing approach to ambisyllabicity as that of Clements & Keyser to allow for a three-way distinction: ambisyllabic consonants (32c), geminate consonants (32a), and identical adjacent consonants (32b). Nothing then rules out the simultaneous occurrence of all three in one language. Since we do not have the C-sharing representation, our theory is in effect a subtheory of Clements & Keyser's in terms of generative capacity. A theory allowing a three way distinction is perhaps too powerful, if our observation regarding the complementary distribution of ambisyllabicity and true gemination among languages is true. This of course is an empirical question.

* We would like to thank Alan Prince and Lisa Selkirk for discussion.

FOOTNOTES

1. Whether a particular syllable in a word is accented * depends on lexical specification and on the derivational and inflectional affixes, which may themselves be accented, deaccenting or pre-accenting. The full treatment of these "Accent Assignment" rules is beyond the scope of this paper. See Ito (1983) for discussion.

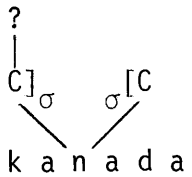
2.

	"philologist"	"philology"	"messenger"	"messengers"
Level 1	filolōg	filolog + ī	bud	bud
Level 2 (Word Level)	filolōɣ	filologī	buð	buð buð + ə
Output	filolōɣ	filologī	buð	buðə

The above paradigm shows that there are alternations with respect to CG with level 1 suffixes. Notice that level 2 suffixation does not show any alternation because CG has applied on the initial cycle. We assume for the purposes of this paper that level 2 is in fact the word level in Danish.

3. Note that the gemination rule proposed in (18) is not restricted to Danish. It is in effect a condition which holds in many other languages, like Yupik Eskimo, Italian, and Biblical Hebrew, requiring that stressed syllables have a branching rime. In such cases either a long vowel or a geminate results, depending on language particular parameters.

4. The geminate constraint holds for rules which apply to the melody element of a geminate if their structural description is met by only one of the skeleton positions of the geminate. This does not mean that phonological rules can never apply to geminate consonants. Rules, such as Stød Association, which associate an autosegment with the skeleton position are not blocked by the constraint. For this reason SA can apply in (20a) where CG is blocked. The geminate status of the n in this example is irrelevant.



5. In support of our morphological solution to the so-called schwa cases note that there are a few other non schwa-initial suffixes, e.g. -en and -isk, in which the preceding consonant undergoes CG in

exactly the same way. Observe, too, the compound form in c.

a. [[mæð]en] "bait"
b. [[jöð]isk] "jewish"
c. [mæð][os] "smell of food"

Cyclic application of CG derives all cases without necessitating the derivation of these suffixes from schwa.

6. The environment given is only the general case. In certain cases, rather than applying after a stressed syllable, it also applies between two unstressed syllables (cf. kapi[D]ol).

7. Since rule (30) itself contains the geminate structure in its structural description, it is not blocked by the geminate constraint.

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