Syllabification and Lexical Phonology in German

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Introduction

This paper examines a number of phenomena in German phonology that bear on the theory of Lexical Phonology (Kiparsky 1982, 1985, Halle/Mohanan 1985, Halle/Vergnaud 1987a, b). It is argued that in order to account for these phenomena, it is not necessary to assume an interleaving between morphological and phonological processes, as in the version of Lexical Phonology of Kiparsky (1982, 1985) and Halle/Mohanan (1985), but rather allows for a complete separation of the phonological and the morphological component, as proposed in Halle Vergnaud (1987a ,b).

German, like English, displays a distinction between class 1 and class 2 suffixes. Class 1 and class 2 suffixes differ with respect to stress assignment. Crucially, they also differ with respect to rules of resyllabification that apply to the suffixed forms. In this paper, I examine certain phonological alternations which are sensitive to syllable structure with respect to these levels, namely the alternation between [x] and [c], g-deletion, and a phenomenon related to obstruent devoicing. I argue that these alternations which seem to be morphologically conditioned can in part be considered epiphenomenal with respect to the specific kind of resyllabification applying at level 1 and level 2, the levels that level 1 and level 2 suffixes are designated for. I argue from a number of phenomena that syllabification should apply cyclically at level 1, but not at level 2. This is in conformity with the fact that cyclic rules like stress assignment apply at level 1, but not at level 2 and thus establishes level 1 as the cyclic component and level 2 as the noncyclic component. I argue that beside level 1 and level 2 no further levels have to be assume for the lexical phonology of German.

In the first section, I outline the distinction between level 1 and level 2 in German phonology, present an algorithm for syllabification in German, and introduce some basic facts about resyllabification at two levels of German lexical phonology. In the second section, I discuss the x/c-alternation and in this context also the distribution of [ə]. The third section is about g-deletion, and the fourth section about another phenomenon which interacts with syllabification, certain apparent exceptions to the rule of obstruent devoicing. In the final section, I give a summary of all the rules and principles discussed and the required ordering relations between the rules.

1. Class 1 and class 2 suffixes in German and resyllabification

In the following, I assume the model of Lexical Phonology outlined in Halle / Vergnaud (1987a, b). In particular, I assume that morphological processes such as suffixation do not take place in the phonological component, but rather in the lexicon. Phonological rules are ordered into blocks or levels, in particular two levels, a cyclic level (= level 1) and a noncyclic level (= level 2). Suffixes are either marked for level 1 or level 2. A stem that is headed by a class 1 suffix undergoes the rules of level 1, a stem that is headed by a class 2 suffix the rules of level 2.

I assume the following syllable structure algorithm for German (following in part Rubach 1989). Furthermore, syllabified forms are subject to the general Sonority Sequencing Condition given in (2).

(1) Syllable Structure Algorithm
   a. Nucleus Placement

N
X ---> X
[-cons] [-cons]

b. Onset Formation

N O N
C V --> C V

c. Onset Rule

O O
C C* --> C C*

d. Coda Rule

N Coda N Coda
X (C*) C --> X (C*) C

e. Sonorant Nuclearization

N
C --> C
[+son] [+son], if C is not syllabified.

f. Resyllabification Rule for Syllables with Nuclear Sonorant

Coda N O N
C C C C
[+son] [+son]

(2) Sonority Sequencing Condition
The Sonority of segments must decrease at the edge of a syllable.

(3) Prohibition against Syllabification of Final C (level 1)
Do not syllabify a morpheme-final consonant.

The condition (3), which operates at level 1, ensures that the last consonant of a morpheme is not syllabified (in another terminology, the consonant is extrametrical, cf. Giegerich 1985 among others). We will see the significance of this condition later in the course of the paper. The last consonant of a morpheme is syllabified at a later stage in one of the following ways: if followed by another morpheme by cyclic syllabification or by special rules of resyllabification or if it is at the end of a word, by a postlexical rule of syllabification. Consition (3) does not hold at the postlexical level. Otherwise, the postlexical rules of syllabification are the same as the one given in (1). The rule of Sonorant Nuclearization applies to words like *Himmel, Keller,* and *Atem* to the final sonorant and turns it into a nucleus of a new syllable. This syllable needs an onset, and so the preceding consonants become onsets of this syllable by (1f). The rules (1b) and (1f) of onset formation is under certain conditions followed by a rule of gemination, which ensures that the consonant does not only become an onset but also the coda of the preceding syllable (cf. section 2). This gives for *Himmel* the syllabification him.ml with [l] being a nucleus.

German class 1 and class 2 suffixes are distinguished in two respects (cf. Giegerich 1985). First, class 1 suffixes are generally nonnative suffixes attaching to nonnative bases. Class 2 suffixes are generally native suffixes attaching to native bases. Second, class 1 suffixes, but not class 2 suffixes, may affect stress placement. A list of some of the class 1 suffixes is given in (4a), a list of class 2 suffixes in (4b).

(4) a. -abel, -(i)al, -ar, ell, -ei (-erei), -ianer, -esk, -ie, -ier- (en), -ist, ismus, -a, -atisch
b. -chen, -ig, -lich, -lein, -heit, -keit, -isch, -er, -sal -los 1

Notice that all class 1 suffixes start with a vowel. There do not seem to be class 1 suffixes in German that start with a consonant. This imposes some diagnostic difficulties with respect to certain phenomena, as we will see.

Furthermore, class 1 and class 2 suffixes differ with respect to resyllabification that applies to the suffixed forms. A good test for syllable boundaries in German is obstruent devoicing. Obstruent Devoicing is a rule sensitive to syllable structure under which obstruents in codas become voiceless, provided that the codas are free, i.e. do not end in a geminate that is part of the following syllable. This last condition follows from the Geminate Constraint (cf. Schein /Steriade 1986).[2] The effect of Obstruent Devoicing is seen in (5a) and (5b).

The rule itself is stated in (6).

(5) a. Rind [rint], halb [halp], Magda [mak.da], Abdel [ap.del]
b. Ebbe [eb.bə], Widder [wid.dər]

(6) Obstruent Devoicing (postlexical level)
Coda
[-son] --> [-voiced] / __

Class 2 suffixes that are consonant-initial apparently do not involve resyllabification. If these suffixes attach to a stem that ends in a voiced obstruent, the obstruent always becomes voiceless. This is illustrated in (7). It is crucial in these examples that [bl] and [gl] are possible onsets in German. Therefore, resyllabification of the obstruents in (7b) should in that respect be possible.

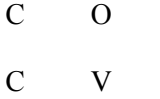
(7) a. Lab+sal [la:p.za:l], gruend+lich [grunt.lic]
b. lieb+lich [li:p.lic], reg+los [re:k.lo:s]

However, resyllabification apparently occurs if the suffix is vowel-initial, as seen in (8):

(8) belieb+ig [bə.li:.big], Reibung [rai.bu]

Thus, there seems to be the following conflict. Resyllabification takes place with vowel-intial suffixes, but not with consonant-initial suffixes. However, these two cases can be subsumed under a uniform rule, namely a rule of partial resyllabification. This rule only creates a minimal onset for the first syllable of a vowel-initial suffix of level 2 and is given in a preliminary version in (9).

(9) Partial Resyllabification (preliminary version) (level 2)



If a class 1 suffix attaches to a stem, then complete resyllabification applies, as in (10).

(10) moebl+ieren [mo:.bli:.rən]

Unfortunately, resyllabification with consonant-initial suffixes cannot be tested. However, we can draw the following conclusion. Syllabification applies cyclically at level 1, namely to the entire string headed by a class 1 suffix, but not al level 2. At level 2, only the rule of Partial Resyllabification applies before class 2 suffixes.

A special case arises with vowel-initial class 2 suffixes that attach to a stem ending on an obstruent followed by a sonorant. Apparently, here, the obstruent is syllabified as being in the onset of the following syllable, even if this does not result in a possible onset ([dm] and [dl] are impossible onsets word-initially in German). The obstruent is never devoiced, as seen in (11).

(11) Widm+ung [vidmu], Haendl+er [hendəlr]

However, as we will see in section 3, these cases arguably involve a more specific rule of resyllabification which differs from usual syllabification rules.

2. The x / c-alternation

German has an alternation between [x] and [c]. At first sight, this alternation seems to be morphologically conditioned. The examples in (12a) and (12b) differ in where the morpheme boundary lies: [c] appears morpheme-initially, [x] morpheme-internally or morpheme-finally.

(12) a. Kuhchen [Ku:][cə̃n] b. Kuchen [Ku:xə̃n]
Indochina [Indo:][ci:na:] bauchig [baox][ig]

Hall (1985), therefore, proposes a rule that that spreads the [+back] value of the preceding vowel to the segment underlying [x]/[c] (which is not specified for [+back]) under the condition that this segment and the vowel be tautomorphemic. However, within the present version of Lexical Phonology, an account of the alternation can be given in which the presence of [x] or [c] does not depend on a morpheme boundary, but rather on syllable structure. Then, the rule responsible for the x/c-alternation need not mention morpheme boundaries at all.

The crucial assumption in the new account is that different kinds of suffixes may be associated with different kinds of resyllabification. However, before going into the distribution of [x] and [c] in derived words, it is necessary to clarify the conditions under which [x] and [c] alternate in underived words.

Three kinds of environment have to be distinguished with respect to the [x]/[c]-alternation, positions within free onsets, positions within free codas and geminate positions. First, in free onsets always[c] occurs and never [x] - regardless of the quality or stress of the following vowel. This is illustrated in (13a) and (13b).

(13) a. Chile [ci:.lə̃], b. Hypo.chonder [hupo:.con.də̃r]
Charisma [ca:.ris.ma], Kolchos [kol.cos]
Choleresterol [co:.les.tə̃.ro:l]

Second, regarding codas, the following generalizations hold. [c] always appears after consonants, as in (14):

(14) Lurch [lurc], Kelch [k lc], manch [manc]

If preceded by a vowel, [x] appears if the vowel is [+back] and [c] if the vowel is [-back], as seen in (15):

(15) [c]: Licht, Recht, Locher, keucht, leicht
[x]: Schacht, Loch, Fluch, Lauch

The third environment, positions in which [x]/[c] is a geminate, requires some further comment. In certain positions in German, a consonant must be a geminate. There are two conditions that require a consonant to be a geminate in those positions. The first one is a condition that certain syllables have to have a consonant in the coda; the second one is a condition that certain syllables have to have an onset. The positions in question are intervocalic positions in which the consonant is immediately preceded by a short vowel and is followed by certain kinds of vowels (not [ə̃], [i], or [u]).

German has a general condition on the weight of a syllable. Syllables whose nucleus consists of a short vowel (except for [ə̃]) are necessarily closed (cf. Vennemann 1982).3 Open syllables with a short vowel (which is not [ə̃]) are impossible, whether the syllable is stressed ot not.

According to this condition, the forms in (16a) are impossible, whereas the forms in (16b) are actual words in German.

(16) a. *[ku], [lu], [a:.me:.ri:.ka]
b. Kuh [ku:], Lu [lu:], [a:.me:.ri:.ka:] (Amerika)

Thus, German syllables whose nucleus is a vowel have to be (at least) bi-moraic - assuming that short vowels contribute one mora and long vowels contribute two moras in German. The condition does not only excempt syllables with nuclear [ə̃], but also syllables with nuclear sonorants. This is seen in examples such as *Geruch* [gə̃.rux], where the first syllable is one-moraic, and *Himmel* [him.ml] where the last syllable is one-moraic.

Conversely, the maximal weight of a syllable in German is constrained. In underived words, word-finally, a syllable of the following form is permitted: tense vowel or diphtong - consonant, as in *kuehl, Rhein, Bauch*.

Also a syllable of the following form is possible: short vowel - consonant - consonant, as in *Rind, Schalk, Pult*. But in this context, a syllable of the form long vowel - consonant - consonant is impossible, for instance syllables such as [ri:nt], [ʒaolk], and [pu:lt]. Equally impossible is a syllable of the form short vowel - consonant - consonant - consonant, for instance [ʒrilkt], [falct].[4] Since, as we have said in section 1, word-final consonant are unsyllabified, the condition is that German allows for at most two-moraic syllable. These two conditions on the minimal and the maximal syllable weight can be combined in the following condition.

(17) Syllable Weight Condition (level 1)
A syllable must have exactly three moras, except when its nucleus is [ə] or a sonorant.

From this condition, it follows that, word-medially, a syllable with a short vowel as its nucleus must have a consonant in its coda. Generally, for underived words and derived words with class 1suffixes the following holds: intervocalic consonants that are preceded by a short vowel (= [ə]) are geminates, i.e., they are both coda of the first syllable and onset of the second one. Hence, we have the following rule of gemination as part of the syllabification algorithm operating at level 1.

(18) Gemination (level 1)

N	O		N	Coda	O	
X	C		X		X,	if X = [@] and not a sonorant.

The condition (17) only holds at level 1. In particular, it does not hold at the postlexical level, since at that level, wordfinal consonants are syllabified and thus lead to syllables with more than two moras. Generally, then, the postlexical level allows for richer syllable structures than level 1.

The second condition which leads to geminates in certain positions is that in general, syllables in German must have an onset. This at least holds for certain vowels such as [o], [a], and [e], though not for [@], [i], and [u]. This can be seen from the fact that [?] (or glottal narrowing [O] cf. Giegerich 1987) is inserted as an onset word-initially, as in (12a), or word-medially, as in (12b, c).

(19) a. Ende [?en.də], Ort [?ort]
b. beachten [bə.?ax.tən], Viehart [fi:.?art]
c. Aorta [a:? r.ta:], Oase [o:.?a:.zə], Manuela [ma:.nu:.?e:.la:], Raffa?el [raf.fa:.?e:l]

The condition of the requirement of an onset is formulated in (20).

(20) Onset Requirement

*	O	N	
0	V,	unless V	{[ə], [i], [u]}

The Onset Requirement need not be stated as a filter, as in (20). Rather it can be incorporated into the Onset Rule (1b). This rule then may also account the insertion of [?]. The modified rule is given in (21), where the insertion of [?] as an onset is taken as the elsewhere case in accordance with the Elsewhere Condition of Kiparsky (1982).

(21) Modified Onset Rule

for V {[ə], [i], [u]},		N		O	N
	C	V	-->	C	V

	N		O	N	
	V	-->	?	V,	elsewhere

These two conditions (17) and (21) as general conditions on syllabification require that consonants preceded and followed by appropriate vowels must be both in the coda of the first syllable and in the onset of the second one, since the first syllable needs an additional mora and the second one an onset.

Now concerning the distribution of [c] and [x] in these positions, the following generalization holds. If the segment underlying [x]/[c] is preceded by a [+back] vowel, [x] appears, and if it is preceded by a [-back] vowel, [c] appears. Thus, [x]/[c] in this position behaves as if it were in the coda, rather than in the onset. The distribution seems to be systematic and is illustrated in (23):

(23) a. [c]: Michael [mic.ca:.ʔe:l]
Manichaer [ma:.nIc.c .ɔr]

b. [x]: Rachel [rax.xe:l]
Bachus [bax.xus]
Tachometer [tax.xo:me:tɔr]
Zacharias [tsax.xa:.ri:.as]
Trochaeus [trox.xe:.us]

This imposes a general condition on how the rule for the x/c-alternation should be stated. I take [x]/[c] not to be specified for [+back] underlyingly. The rule cannot be an assimilation rule that assimilates the [+back] value from the preceding vowel under the condition that [x]/[c] is in the coda. Otherwise, the Geminate Constraint (cf. Schein/Steriade 1986) would be violated in the cases in (13b). Rather, the rule must be divided into two subrules. One subrule says that the segment underlying [x]/[c] becomes [-back] if it is in the onset. The other subrule says that the value [+back] is spread from a preceding vowel. These two rules are stated in (24):

(24) a.
O
C
[dorsal]

[-back]

b.
V C
[dorsal] [dorsal]

[+ back]

An environment that has yet to be considered is [x]/[c] before [ɔ]. Again, this environment requires some general comments, namely about the status and the distribution of [ɔ] in German.5

There is evidence that [ɔ] does not occur underlyingly in stems. First, [ɔ] never occurs stem- initally. The initial vowels in proper names such as *Erich* and *Ellen* are [e:] and [e], rather than [ɔ]. Second, [ɔ] does not seem to occur in underived forms, except when it is required by syllabification. As part of syllabification [ɔ] may optionally be inserted before a nuclear sonorant with subsequent denuclearization of the sonorant, for instance before [l], [r] , [n], or [m] in *Huegel, Weiher, Eden,* and *Atem*. This rule is given in (25):

(25) [ɔ]-Insertion in Syllabification
N N Coda
C --> ɔ C

In proper names (except for suffixes forming proper names such as the feminine suffix *-e*) and borrowings [ɔ] does not seem to occur. This can be shown by contrasting such words with words that contain [ɔ] as part of prefixes or suffixes, as in (26):

(26) Renate [re:.na:.tɔ] : renovieren [rɔ.no:.vi:.rɔn]
Gesine [ge:.zi:.nɔ] : Gesinde [gɔ.zin.dɔ]
Beate [Be:.ʔa:tɔ] : beachten [bɔ.ʔax.tɔn]
Knesset [knes.set] : esset [ʔes.sɔt]

[ɔ], however, occurs in affixes without being required by syllabification. This is the distinction between 'schwa mobile' and 'schwa constans' discussed in Issatchenko (1974). [ɔ] obligatorily occurs in prefixes such as *be, ge* , in derivational suffixes such as *-er* (for nomina agentis) or *-e* (feminine suffix), and in adjectival

inflectional suffixes, as in *neues, neue, neuer, neuen*. Instead of taking [∂] to be underlying in those cases, one may assume an empty rime or V-slot or an empty moras, which are filled by [∂] at a later stage in the derivation, depending on the prosodic theory that is assumed. In nominal and verbal endings the occurrence of [∂] depends either on syllabification or other prosodic or phonological requirements. For instance, [∂] is inserted before the nominal endings for dative plural *-n* if syllabification is not possible otherwise, as in (27b).

(27) a. Uebel+n --> Uebeln, Reiter+n --> Reitern
b. schirm+n --> Schirmen, Kamin+n --> Kaminen, Krawall+n --> Krawallen

For certain suffixes there is a requirement that [∂] be inserted in order to yield a bisyllabic form, for instance with the infinitival ending *-n* or the Genitive ending *-s* (cf. Giegerich 1985, 1987), as in (28):

(28) a. handel+n --> handeln, feier+n --> feiern, Kamin+s --> Kamins, Krawall+s -->. Krawalls
b. schall+n --> schallen, zier+n --> zieren, Mann+s --> Mannes

Furthermore, [∂] is inserted in order to avoid impossible sequences like [tt] and [dt], as in (29b) and (29c):

(29) a. sing+t --> singt, verlang+te --> verlangte
b. rett+t --> rettet, rett+te --> rettete
c. red+t --> redet, red+te --> redete

According to Wiese (1985), there are general conditions on the sequence of ∂-insertion and suffixation. It is important to notice that Wiese assumes the model of Lexical Phonology of Kiparsky (1982, 1985) and Halle / Mohanan (1985), where morphological affixation takes place in the phonological component requiring orderings between morphological rules and phonological rules. That is, the morphological component is not separated from the phonological component as in Halle / Vergnaud (1987a, b). Generally, with stems of nouns and verbs, [∂] is inserted (in the process of syllabification by rule (25)) before suffixation of inflectional morphemes takes place, as illustrated in (30):

(30) a. Uebel+n --> Uebeln, Feier+n --> Feiern
b. wackel+ig -->wackelig, wackel+n --> wackeln, wackel+t --> wackelt

By contrast, with adjectival stems, inflectional suffixation is supposed to take place before the syllabification rule of ∂-insertion. This is illustrated in (31):

(31) uebl+n --> ueblen, ungeheur+n --> ungeheuren

In order to capture the difference between ∂-insertion with verbs and nouns, and ∂-insertion with adjectives and derivational suffixes, Wiese suggests that the two types of suffixation belong to distinct phonological levels. At the level of suffixation of verbs and nouns, syllabification and ∂-insertion (conditioned by syllabification) applies to the stems before suffixation. At the level of suffixation of adjectives and derivation, suffixation precedes syllabification and syllable structure conditioned ∂-insertion. This way, the form *Uebels* (noun) and *uebles* (adjective) are derived as indicated in (32):

(32) a. [uebl]
[ue.b∂l] syllabification and ∂-insertion
[ue.b∂l] [n] suffixation
[ue.b∂ln] resyllabification

b. [uebl]
[uebl][n] suffixation
[ue.b∂ln] syllabification and ∂-insertion

However, as Wiese himself observes, ∂-insertion before the consonant constituting the adjectival inflectional ending applies obligatorily and independently of syllable structure, as seen in (33):

(33) blau+n --> blauen, geraum+n --> geraumen

The problem with Wiese's idea of exploiting level distinction of Lexical Phonology for ∂-insertion is that the difference does not lie just in different orderings of suffixation and syllabification + ∂-insertion. Rather, it is generally the case that if suffixation applies before ∂-insertion, then ∂- insertion is obligatory and independent of (i.e. not conditioned by) syllabification. Furthermore, certain suffixes consist themselves just of [∂]. Examples that we have seen are adjectival suffixes, derivational suffixes, and the (optional) suffix for the dative of masculine (monosyllabic) nouns. Wiese proposes for these cases that the suffix consist of an invisible consonant, which triggers obligatory ∂-insertion. But this is not a very convincing account. The data suggests rather that [∂] is, for certain suffixes, as well as prefixes, to be represented underlyingly, either as an empty V-slot, an empty nucleus, X-slot, or an empty mora (depending on the prosodic theory that is chosen). Then, blaues and *ueble* have the prosodic structures given in (34), where an empty V slot will later be filled in by [∂].

(34) a.

C	C	V	V	V	C
b	l	a	u		s

b.

V	V	C	C	V
ue:		b	l	

With [∂] being represented by an empty prosodic element, it is not necessary to specify the order of suffixation and syllabification (and ∂-insertion) for the two putative levels nor the order of affixation with adjectives and nouns themselves. Rather, if a suffix contains the element that represents [∂] underlyingly, then rules of resyllabification apply to the derived form and make a stem-final sonorant the onset of the syllable of the suffix. For instance, [l] becomes the onset of the syllable [∂] in *ueble.* These rule of resyllabification, of course, first have to denuclearize the sonorant (under the appropriate condition). The two rules of Sonorant Denuclearization and Onset Formation are given in (35). Of course, the latter rule is the same as the rule of the Syllable Structure Algorithm in (1).

(35) a. Sonorant Denuclearization (postlexical level)

N		N
C		V
[+son]		

b. Onset Formation (postlexical level)

O	N
C	V

Notice that in this account, syllabification of the sonorant as a nucleus is obligatory since otherwise a form such as *segeln* and *Uebeln* (from *uebel+n*, *n* being the inflectional ending for dative plural) could not be derived correctly.

(36)

[[Uebl] n]class 2	[[uebl] n]class 2	
	V	
VVCV C	VVCV V	
[ue b l][n]	[ue b l][n]	syllabification
VVCVC	VVCCV	
ue b l n	uebln	resyllabification (Sonorant Denuclearization, Onset Formation)
uebeln	ueblen	∂-insertion

The conclusions that we can draw at this point from the discussion of ∂-insertion are the following. First, [∂] (or the empty prosodic unit) does not occur underlyingly in lexical morphemes, but it does occur underlyingly in inflectional and derivational morphemes (suffixes as well as prefixes). The derivational morphemes containing underlying [∂], by the way, seem to belong generally to class 2, not class 1. Second, in order to correctly derive forms like *Uebeln* syllabification should apply to roots and suffixes individually. Third, certain resyllabification rules should apply to derived forms. Among them are a rule that denuclearizes

a nuclear sonorant and another rule turns an unattached sonorant into the onset of the following syllable. This rule also applies at another place, as we will see in Section 4. Finally, within this account, *ə*-insertion does not require another level distinction, for instance a distinction between level 2 (for adjectival inflection and derivation) and level 3 (for nominal and verbal inflection), as in Wiese (1985). This level distinction could only be motivated on the basis of the old view of Lexical Phonology according to which morphological processes interleave with phonological processes and thus could be ordered with respect to phonological rules at the relevant level. Beside the differences in the occurrence of [*ə*], there does not seem to be any other phonological distinction between these two classes of morphological processes. Therefore, I will assume that German has only two levels, level 1 for class 1 suffixes and level 2 for class 2 suffixes (derivation as well as inflection). This then allows morphological processes to take place in a component that is completely independent from the phonological component.

Now let us turn back to the [x]/[c]-alternation. It appears that before [*ə*], the [x]/[c] alternation behaves like in free codas or geminate positions. That is, it depends completely on the preceding vowel, whether [x] or [c] appears. The important point is that it does not matter whether the preceding vowel is long or short or if it is a diphtong. Thus, this environment cannot be subsumed under the position of geminates. The relevant data is given in (37). Notice that the occurrences of [*ə*] in (37) are arguably all due to syllabification (or specific metrical conditions imposed by the suffix, for instance the infinitival ending *-n*). Thus, [*ə*] in (37) is neither underlying nor conditioned morphologically:

(37) short vowels: [c]: kichern, zechen, Michel, Knoechel, Kuechen
[x]: Kachel, stochern, Rachen
long vowels: [c]: siechen, Fluechen
[x]: Kuchen, Aachen, suchen, fluchen
diphtongs: [c]: bereichern, keuchen
[x]: tauchen, Laucher

I propose the following account of this phenomenon. At the relevant stage of the derivation, the rule creating nuclear sonorants has not yet applied. Then also [*ə*] has not been inserted by (25) Hence, [x]/[c], if syllabified, could only be in the coda of the preceding syllable, and rule (24) applies as with [x]/[c] in free codas.

However, this approach poses two potential problems. First, it might require a different treatment for [x]/[c] before [*ə*] that is not conditioned by syllabification, but rather genuine part of a morpheme. But here, we may assume that even if [*ə*] is represented by an empty prosodic unit, then, before this unit is associated with [*ə*], no rules creating an onset for this syllable apply. The second problems emerges with the Syllable Weight Condition (17), namely with the syllable structure of, for instance, *Kuchen* ? The syllable structure may not be as in (38), because then the first syllable would have three moras, which is impossible word-internally in underived environments according to the Syllable Weight Condition (17).

(38)

```
CVVCVC
k u: x  n
```

But there is an unproblematic alternative. There is reason, to assume that [x] at this stage is not be syllabified at all. Since the following 'syllable' is invisible, it need not have an onset, and since the preceding syllable is already heavy, it may not have another element in its coda. Then, the syllabification at this point would be as in (39), where both [n] and [x] are unsyllabified by the algorithm.

(39)

```
CVV
k  u:  (x)  (n)
```

An alternative explanation would be that syllables with nuclear [*ə*] actually do not need an onset at all. Then, assuming that syllabification rules create onsets only when necessary, [x]/[c]before [*ə*] always would belong to the preceding syllable, but not to the onset of the following syllable. Thus, again, rule (24) would apply as

for free codas. There is independent evidence that syllables with [ə] as nucleus are not subject to the Onset Requirement. If -ə or -ən as plural suffixes or -ə or -əl as nominalizing suffixes are attached to a vowel-final stem, then no glottal stop or glottal narrowing need to be inserted - in fact, glottal stop is impossible in this position. Examples are given in (40):

(40) Reh - Rehe [re:.@]
Fee - Feen [fe:.@n]
Kuh - Kuehe [ku:.@]
Ruh - Ruhe [ru:.@]
Greuel [groi.@l]

Notice also that with other suffixes [h] may appear as an onset, as in (41):

(41) ehern [e:.hern]

Again this explanation raises the problem with the Syllable Weight Condition (17). If [x]/[c] is necessarily in the coda of the preceding syllable before [ə], then this syllable might become too heavy than permitted by (17). According to (17), syllables such as [si:c] and [reic] should be impossible word-medially. But crucially, this account, as opposed to the first account, does not allow for any reasonable solution to the problem of syllable weight, and therefore is inferior to the first account.

Now let us look at distribution of [x] and [c] in derived environments. First, let us consider the x/c-alternation with respect to class 1 suffixes. There are few nonnative roots ending in [x] or [c]. However, at least two examples give evidence about what is at stake. In *Masoch* and *Eunuch*, the final consonant is [x] and, for many speakers, the last vowel is long [o:] and [u:] respectively, rather than short [o] or [u]. Independently of the quality of the preceding vowel, [x] becomes [c] before a suffix of class 1, as seen in (42):

(42) a. Masochist [ma:.zo:.cist], Masochismus [ma:.zo:.cis.mus]
b. eunuchesk [oi.nu:.cesk], Eunuchismus [oi.nu:.cIs.mus]

Not all speakers agree with this data. But the general principle seems to be that it fails to hold for exactly those speakers who also accept the underived forms with short vowels, rather than long vowels, that is [masox] and [oinux]. The appearance of [c], rather than [x], in the examples in (42) can only be explained if [x]/[c] is taken to belong only to the onset of the first syllable of the suffix. That is, it may not belong to the coda of the stem-final syllable, not even if it is taken to be a geminate, which belongs both to the first and the second syllable. Thus, it appears that class 1 suffixed words undergo complete resyllabification, which makes the stem-final consonant the onset of the suffix-initial syllable.

[x]/[c] behaves differently, however, at the end of a root whose last syllable contains a short vowel. Here, suffixation of a class 1 suffix cannot turn [x] into [c]. This is shown in the examples in (43):

(43) Bloch [blox] - Blochianer [blox.xi.a:.nər], *[blo.ci.a:.nər]
VanGogh [fangox] - VanGoghesk [fan.gox.xesk], *[fan.go.cesk]
rach- [rax] - rachitisch [rax.xi:ti], *[ra.ci:ti]
bach- [bax] - Bachanal [bax.xan.na:l], *[ba.can.na:l]
Epoche [epox.xə] - epochal [ep.pox.xa:l], *[ep.po.ca:l]

This data, however, does not present a particular problem. It shows only that resyllabification of class 1 suffixed words must obey general conditions on syllable structure. In particular, it must observe the Syllable Weight Condition and satisfy the requirement that syllables whose nucleus is a short vowel must be closed. Thus, if the vowel is followed by [x], [x] must be the coda of the stem-final syllable. This presupposes that the Syllable Weight Condition (17) must be satisfied throughout level 1. Because of the Onset Requirement (in particular for the suffix-initial syllables starting with [a] in (43)), therefore, [x] must be a geminate having undergone the rule of Gemination (18) and thus constitute both coda and onset of the two syllables in question.

It is clear that resyllabification of class 1 suffixed works exactly the same way as syllabification of underived words. Recall that in those cases, we have exactly the same distribution of [c] and [x]. In underived environments, [x] becomes [c] if it is preceded by a long vowel or diphtong and followed by a vowel, i.e. when it is syllabified as being in the free onset of a syllable. Again, when [x] is preceded by a short vowel, it must remain [x]. This shows that the rules of resyllabification of level 1 are identical (in the relevant respects) to the rules of syllabification applying to underived forms. In particular, the rule of gemination (18) applies to forms derived with class 1 suffixes. But this means that that there are no particular resyllabification rules at level 1, but rather than syllabification of class 1 suffixed forms applies cyclically, namely to the entire string.

The situation is different with class 2 suffixes. With vowel-initial class 2 suffixes, stem-final [x] may never become [c]. Thus, the same roots as in (44) with class 2 suffixes keep [x], as seen in (44a). Examples with native roots are given in (44b). [c] in those contexts is for all speakers impossible:

(44) a. masochisch [maso:xI], *[maso:ci] ('like Masoch'}
eunuchisch [oinu::xI], *[oinu:ci] ('like an eunuch')
b. Bauch [baox] - bauchig [baoxIk], *[baocik]

There are two possible explanations. First, the occurrence of [x] may have to do with a difference between resyllabification before level 2 suffixes and before level 1 suffixes. As we have seen in section 1, there is reason to assume that resyllabification at level 2 is only 'partial'. Stem-final single obstruents are resyllabified as the onset of the first syllable of a vowel-initial suffix (*belie.big*). But stem-final consonants are not resyllabified if the suffix starts with a consonant. Thus, resyllabification only creates onsets. This suggests the following account for the data in (44). Stem-final [x] is resyllabified as the onset of the first syllable of a vowel-initial class 2 suffix. But this resyllabification is 'minimal': it only creates a geminate; it does not alter the coda of the preceding syllable. This mechanism could be generalized for *belie.big*. Also here, one might assume that intervocalic [b] is actually a geminate, rather than a free onset. This gives the following rule of resyllabification at level 2:

(45) Rule of Partial Resyllabification (level 2)

R	O	R			R	O
X			------->		X	X
C		V			C	

The only problem this account raises for the moment is the problem of syllable weight, i.e. the same problem that raises if ∂-initial syllables are allowed to lack an onset in order to account for the distribution of [x] and [c] before [∂]. The rule of Partial Resyllabification would create syllables of the form VVC, which should not be permitted word-medially. However, the Condition on Syllable Structures need not necessaily apply at all levels. Instead we may say that it only has to hold at level 1, but not at level 2, at least not before resyllabification at level 2. This account has the advantage that the resyllabification of stops and fricatives like [x] is achieved by one and the same rule.

The second possible explanation is in terms of the Onset Requirement. We have seen that [∂] does not require an onset. This also seems to hold for some other vowels in certain positions. [i] and [u], for instance, are not strictly subject to onset requirement. They requires an onset word-initially and after prefixes and morpheme-initially in compounds, as in (46):

(46) a. Irrsinn [?Ir.zin], beirren [b∂.?ir.r∂n], Seeigel [se:.?i:.g∂l]
b. beurteilen [b∂.?ur.tai.l∂n], Todesurteil [to:.d∂s.?ur.tail]

But they do not require an onset word-medially after a vowel, as in (47). Notice that this is independent of stress.

(47) a. Ruine [ru:.i:.ne], ruhig [ru:.ig]
b. Trauung [trau.u], Genugtuung [g@.nu:k.tu:.u]

Since the initial vowel in the class 2 suffixes in (47) is always [i] or [u] (and generally there do not seem to be any class 2 suffixes starting with a different vowel than [i] or [u]), this suggests that we have the same situation as with [x]/[c] followed by [*ə*], namely a syllable with a nucleus that does not require an onset. Then *bauchig* would be syllabified as *bauch.ig* , and the rule turning [x] into [c] in onsets does not apply.

This account has two disadvantages. First, it poses the same problem with respect to overweight syllables as the first account (which could be solved the same way). Second, more importantly, it requires that stops and fricatives (at least [x]) be resyllabified differently at level 2. [x] would not be resyllabified if the following syllable does not require an onset. It would then stay in the coda of final syllable of the stem. Stem-final stops, however, always have to be resyllabified as onsets if the suffix starts with a vowel (in order to avoid obstruent devoicing). Because of this problem, which could receive only a stipulative solution, I adopt the first explanation based on the assumption that resyllabification is partial before class 2 suffixes.

Before suffixes starting with [*ə*], the distribution of [x]/[c] is exactly as in the cases in which [*ə*] is due to syllabification. That is, [x]/[c] behaves as if it belonged to the coda of the preceding syllable. This is shown in (48).

(48) [c]: stech-e [stex*ə*]
reich-es [reic*ə*s]
Buech-er [buec*ə*r]
[x]: Buch-es [bu:x*ə*s]
Bach-e [Bax*ə*]

These cases can also be accounted for by the last solution that was sketched above for contexts in which [*ə*] is conditioned by syllabification.

In the next section, we will examine another phenomenon that may relate to cyclic syllabification and gives further, indirect evidence for the account of the alternation between [x] and [c].

3. G-Deletion

As has been argued frequently (e. g. Wurzel 1970, Kloeke 1982), the velar nasal [ŋ] in German (as in English) derives from [ng] with assimilation of [n] to [g]. One sort of evidence (mentioned in Kloeke 1982) is the treatment of the borrowing *balkon* in German phonology. The final consonant of *Balkon* is either [n] or [ŋ]. If it is [n], then the preceding vowel is long, i.e. [o:]. But if the final consonant is [ŋ], then the preceding vowel is short, i.e. [o]. The explanation is that if the vowel is long, the rime of the final syllable may at most contain one consonant. But if the vowel is short, it may contain two consonants, and, crucially, counts as two consonants ([g] being deleted after this constraint on syllable structures has to obtain). In certain contexts, [g] is deleted. As with the x/c-alternation, g-deletion seems to be in part phonologically, in part morphologically determined. Again, let us first consider g-deletion in underived environments and then with respect to suffixation of the two levels.

In underived environments, the following generalizations hold for g-deletion. First, [g] is always deleted in codas, as seen in (49a). This is also the case if the syllable contains appendices, as in (49b):

(49) a. Tang [taŋ], Ring [riŋ] b. Hengst [heŋst],
Angst [aŋst],
laengs [leŋs]

If [ng] occurs between vowels, [g] is not deleted. Rather, it is syllabified as the onset of the next syllable, since it does not undergo devoicing, as in the examples in (50). Notice that it is irrelevant whether the next syllable is stressed or not.

(50) Tango [taŋ.go:],

Linguistik [liŋ.gu.is.tik],
Lingune [liŋ.gu:.n@],
Ingolf [iŋ.golf],
Mangan [maŋ.ga:n]

The rule governing the appearance of [g] in these contexts obviously is the following. G-deletion applies after syllabification, and [g] is deleted in exactly those contexts in which it occurs in the coda. This rule is stated in (51).

(51) g-Deletion

Coda

g --> O / [+nasal] ___

The rule of G-Deletion must be preceded by a rule of n-Assimilation, which turns [n] into [ŋ] when preceded by [g]. This rule is independent of syllable structure and applies across syllable boundaries as in *Tango* in (52):

(52) n-Assimilation
[+nasal, -back] --> [+back] /__ [-son, +back]

A special case arises if [ng] occurs before [∂]. In this environment, [g] is always deleted. This is shown with the examples in (53). They all contain [∂] that results from syllabification, rather than from morphology.

(53) klingen [kliŋ .ŋ∂n],
Klingel [kliŋ.ŋ∂l],
rangeln [raŋ. ŋ∂ln],
Finger [fiŋ. ŋ∂r]

The same can be observed with environments in which the occurrence of [∂] is conditioned morphologically, as in (54):

(54) Ring-e [ri ŋ.ŋ∂]
Ge-sing-e [g∂.siŋ.ŋe]
Ring-er [riŋ.ŋ∂r]
lang-en [laŋ.ŋ∂n]

This data strongly resembles the distribution of [x] and [c] before [∂] and calls for a uniform account. Let us reconsider the possible explanations that we have discussed then. All of the accounts for the x/c-alternation turn out to be accounts of g-Deletion as well. In the first account, the [∂] is considered invisible at the relevant stage of the derivation. This is the solution that Hall (1989b) proposes for g-deletion before [∂]. G-Deletion would then apply to *Finger* when it is syllabified as in (55). Again, since the 'invisible' final syllable does not need an onset, [g] may be in the coda of the preceding syllable.

(55)

CVCC
f i n g r

In the second account the idea is that ∂-initial syllables generally do not require an onset. This, applied to the present case, means that [ng] remains in the coda of the first syllable. Then, [g] must delete. We see that whatever role [∂] plays at the stage of the application of syllable structure-sensitive rules, the x/c-alternation will behave exactly the same way as g-Deletion. Since the second solution, as we have seen with the x/c-alternation, poses the problem of overweight syllables in underived environments violating the Syllable Weight Condition (17), I adopt the first solution.

Like the x/c-alternation, g-Deletion displays a difference with respect to class 1 and class 2 suffixation. First, let us consider class 1 suffixes. Here, it seems that [g] after [n] in the coda of a stem never deletes. This was observed by Kloeke (1982) and further discussed by Hall (1989b). Again, this is independent of whether the following vowel is stressed or not, as the following examples show:

(56) Anglist [aŋ.glist],
Anglikaner [aŋ.glika:.nər],
Laryngal [la:.riŋ.ga:l],
Diphtongie [dif.toŋ.gi:],
Schellingianer [ʃel.liŋ.gia:.n@r],
moehringesk [mo:.riŋ.gesk]

The absence of g-Deletion in the examples in (56) follows straightforwardly from what was said earlier about resyllabification at level 1. Forms headed by class 1 suffixes are subject to complete resyllabification with the same syllabification rules that apply to underived forms. Applying these rules gives the right results for (56). For instance, *anglist* is syllabified as *an.glist* , since [gl] is a possible onset in German and normal syllabification rules create maximal onsets. *Laryngal* is syllabified as *lar.ryn.gal*, creating the maximal possible onset [g] (since [ng] is not a possible onset in German).

With class 2 suffixes, [g] must delete in the same environments. Consider the examples in (57).

(57) a. englisch [eŋ.li ʃ], b. Diphtonge [dif.to ŋ. ŋə]
Thueringisch [tu:.ri ŋ. ŋ i ʃ], Ringer [ri ŋ. ŋər]
Haengung [he ŋ. ŋu ŋ] Ringe [riŋ. ŋə]

The first case, g-Deletion in *englisch* follows directly from the rules of resyllabification that we have posed earlier. According to section 1, before vowel-initial class 2 suffix a stem-final consonant is resyllabified as the onset of the following syllable. This gives the syllabification eng.lisch. Notice that within this account we cannot assume that this rule of resyllabification creates a geminate, because the first syllable would be of the form [e l]. Such a syllable violates general conditions on syllable structure, because [l] is more sonorous than [n] (or at least not less sonorous than either [n] or [ŋ]). The problem now is the cases where the stem ends in [ng] and [g] is deleted before a vowel-initial suffix. If we assume the rules as usual, then [g] should be syllabified as the onset of the first syllable of the suffix and hence should not be deleted. Therefore, let us consider the possible solutions to this problem.

One explanation is as follows. The rules of n-Assimilation and g-Deletion are rules that apply at level 2 before resyllabification. An approach of this sort is taken in Hall (1989). The derivation of *Haengung* and *Laryngal* then is as in (58).

(58) level 1: [Laryng] al]class 1 [[haeng] ung]class 2
[La.ryn.gal] resyllabification

level 2: [la.ryŋ.gal] [haeŋ] u ŋ] n-Assimilation and g-Deletion
[hae ŋ.ŋu ŋ] resyllabification

This proposal does not require phoneme-specific resyllabification rules. But it poses a general question about the status of these rules. N-assimilation and g-Deletion at first sight appear to be rules at the postlexical level, because they apply to underived environments such as *Tang* . But here they are rules applying at level 2 and also applying to underived environments. N-Assimilation and g-Deletion must apply to derived forms which enter a process at level 2 as well as to any other underived forms that meet the conditions. N-Assimilation is not a structure-changing rule, but g-Deletion is. Therefore, g-Deletion should be subject to Strict Cycle Condition (cf. Kiparsky 1982) and generally not apply to underived forms. However, it turns out that this is not a problem at all. Level 2 is the noncyclic level, and so no rule of level 2, whatever its status, is subject to Strict Cyclicity. So, any underived form has to undergo the rules of level 2, when applicable. Also forms derived only with class 1 suffixes may undergo the rules of level 2. For instance, n-Assimilation can apply to the [n] in Anglist at level 2.

An alternative explanation of the difference between class 1 and class 2 derived words might be the following. No resyllabification applies to [ng] after at level 2. Then, the syllabification of *Haengung* would be *haeng*. *ung* with subsequent deletion of [g], which remains in the coda. This account explains the cases in (57), and it also can be carried over to the x/c-alternation with class 2 suffixes. But it also has disadvantages. In particular, it is not in conformity with other results about resyllabification at level 2 that we have obtained. It is not generally the case that class 2 suffixes do not trigger resyllabification. Recall that stops in the relevant environment are always resyllabified. Therefore, this account would require that resyllabification rules be specific to certain consonants. Single stops (and certain sonorants, because of cases like *englisch*) would be subject to resyllabification. But fricatives and stops like [g] after [n] would not undergo resyllabification. Such a rule, however, seems highly unmotivated. Therefore, the first explanation is clearly to be favored.

4. Problems with Obstruent Devoicing

I would like to briefly discuss a phenomenon that also involves the interaction between morphology and phonology, in particular with respect to syllabification. However, this phenomenon appears to be independent of the preceding two phenomena.

Obstruent Devoicing is a rule that is sensitive to syllable structure, not morpheme boundaries. However, in certain derived environments, the rule does not only take into account the usual syllabification of forms.6 Apparent exceptions of this sort to Obstruent Devoicing (as observed for instance by Kloeke (1982) and recently discussed by Rubach 1989) are given in (59).

(59) a. Eign+ung [aig.nu ŋ],
Verkabl+ung [fer.kab.lu ŋ],
Wagn+is, [vag.nis]
b. Handl+ung [hand.lu ŋ],
Fidl+er [fi:d.l∂r],
Widm+ung [vid.mu ŋ],
Adl+er [a:d.l∂r]

In these examples the obstruent that is the penultimate consonant in the root does not devoice, even though this would be required of the usual rules of syllabification. The examples in (59) all contain class 2 suffixes. We have said that class 2 derivations are subject to Partial Resyllabification. That is, in the examples in (59), only the last sonorant would be resyllabified and become the onset of the following syllable. Then, it is expected that the preceding consonant, being an obstruent in a free coda, should be devoiced. But instead, it remains voiced. Even if resyllabification in examples in (59) would be complete, the same problem remains. In the examples, both consonants of the stem could be syllabified as the onset of the following syllable, since [gn] and [bl] are possible onsets in German. Then, the obstruent would not have to be devoiced. But the examples in (59b) show that the account does not work. Here the stem-final consonant sequence cannot be resyllabified as the onset of the following syllable since [dl] and [dm] do not form possible onsets in German.

Two further observations show the scope of the problem. First, the phenomenon is not restricted to class 2 suffixes. It systematically occurs with class 1 suffixes, as we have seen. For instance, the obstruents preceding the sonorants in the following examples do not undergo devoicing. Notice that *-a* clearly is a nonnative class 1 suffix, even though it does not attract primary stress. *-atisch* is a class 1 suffix with primary stress being obligatorily on the first syllable.

(60) syntagm+a --> Syntagma [sun.tag.ma:]
paradigm+a --> Paradigma [pa.ra.di:g.ma:]
syntagm+atisch --> syntagmatisch [sun.tag.ma:.ti]
paradigm+atisch --> paradigmatisch [pa.ra.dig.ma:ti]
stagn+ieren --> stagnieren [tag.ni:.r@n]

Thus, either the phenomenon is independent of the two levels of lexical phonology, or the relevant rules apply both at level 1 and level 2.

Second, the lack of obstruent devoicing occurs only when the obstruent is followed by a sonorant. It does not show up when the obstruent is followed by another obstruent. In *Smaragde* in (61), [g] is devoiced in the derived form with the plural suffix *ə*, even though [g] and [d] both clearly belong to the root *smaragd*. (In *Jagd* on might argue that [d] actually constitutes a suffix, since *Jagd* is the nominalization of *jagen* . Also the [d] in *Magd* arguably is reanalysed as a suffix, since the [a] is *long* and *Magd* otherwise would constitute a too heavy syllable.)

(61) Jagd - Jagden [ia:k.dən]
Magd - Maegde [mek.də]
Smaragd - Smaragde [sma:.rak.də], smaragdisch [sma:.rak.di]

Two proposals have been made in the literature to account for this phenomenon, one by Hall (1989b) and the other one by Rubach (1989). Hall proposes that lack of devoicing in (59) is a consequence of a language-specific rule of resyllabification, which applies at level 2 and all further levels of lexical phonology. This rule makes a consonant C in a coda an onset of the next syllable under the condition that C is followed by a sonorant in the onset of that syllable and this sonorant is followed by a morphological boundary. This rule is stated in (62), where ']' represents a morpheme boundary.

(62)

V C [+son]] V

This rule is quite stipulative and in the given formulation creates impossible syllables, namely open syllables whose nucleus is a short vowel (though the later can be easily prevented if the rule is stated as a rule of gemination). Most importantly, this rule creates syllables with onsets which may never occur word-initially.

Rubach takes a different approach, which makes it less stipulative. His account crucially relies on the fact that sonorants in German may be syllabic (namely before they undergo the optional rule of *ə*-insertion (25)). Furthermore, he assumes that syllabification is cyclic, in the sense that syllabification applies to each cycle before affixation. This assumption, however, blurs the distinction between level 1 and level 2, which, as we have said, differ in whether syllabification applies cyclically or not, and it presupposes the old model of Lexical Phonology, where morphological rules interleave with rules of morphological affixation.

However, one can simply say the following, which is equivalent for the purpose of the argument. Syllabification applies to both stems to which level 1 and level 2 suffixes and respects morpheme boundaries. With this modification, Rubach's proposal then is that roots like *widm* are syllabified as wi.dm with nuclear [m]. I will say that the same time, the suffix *-ung* is syllabified but without subsequent resyllabification. The result, as Rubach suggests, is the tri-syllabic form *wi.dm.ung*. At this stage, Obstruent Devoicing would apply. But it does not apply to [d], because [d] is in the onset of the syllable with nuclear sonorant and not in a coda.

This form does not show up like this in German. Rather, it must undergo a rule of Sonorant Denuclearization which makes nuclear [m] the onset of *-ung*. This rule takes place at the postlexical level and is ordered there after Obstruent Devoicing. Furthermore, this rule is specific to certain suffixes (see Rubach 1989 for discussion). Formally, the rule is the same as the one given in (35a). After this rule has applied, the rule of Onset Formation as given in (35b) applies. Earlier, the two rules of Sonorant Denuclearization and Onset Formation took place at level 2 for the derivation of forms like *ueble,* namely as specific resyllabification rules at level 2. Thus, these two rules apply at two places, at level 2 and at the postlexical level after Obstruent Devoicing. The derivation of *Widmung* then is as given in (63):

(63) [[widm] ung]class 2

CVCV VC
[[wi.dm] ung] syllabification

CVC CVC
[w i d m u n g] resyllabification: Sonorant Denuclearization and Onset Formation

What is crucial is that Obstruent Devoicing applies before this rule of Sonorant Denuclearization.

Some suffixes do not trigger the rule of sonorant denuclearization, for instance not *-ei* (*Reiterei,* not *Reitrei*) or *-ig* with verbal stems (*wackelig,* not *wacklig, knitterig*, not *knitterig*). With certain suffixes, it depends completely on particular lexical items whether the rule applies. Thus, it applies in *adlig* (from *adel + ig*), but not in *huegelig* (from *huegel+ig*). This dependence on particular suffixes or lexical items constitutes an argument for this approach to the lack of obstruent devoicing. The failure of this rule to apply in forms like *huegelig* or *wackelig* also shows that an account such as Hall's cannot be correct - at least not without further modification. With Hall's language-specific rule of resyllabification root-final sonorants always have to be in the onset of a following vowel-initial suffix. By contrast, Rubach's postcyclic rule of the rule of denuclearizing nuclear sonorants may apply only to specific forms and therefore allows both forms with nuclear sonorant and with onset sonorant. Furthermore, in this account no morphological information needs to be specified in the formulation of the rule, in particular no morphological boundaries need to be specified.

Notice that in this account also forms like *Radler* (from *rad+l+er*) can be derived. Here the crucial syllabification happens not on the first cycle, but on the second. On the second cycle, *radl* must be syllabified, and the syllabification that results from the application of the usual rules is *ra.dl.*

Rubach's proposal for failure of obstruent devoicing poses potential problems with respect to a coherent account of g-deletion and the failure of obstruent devoicing. In particular, it may pose a problem for the derivation of *englisch*. Applying Rubach's rules of syllabification, *englisch* would have the following derivation:

(64) [[engl] isch]class 2

VC CV V C
[[e n.g l] isch] syllabification: Sonorant Nuclearization and Onset Formation

VC CV VC
[e n. g l. i sch] g-Deletion (does not apply)

VCC CVC VC CCVC
a) [e n g. l i sch] or b) [e n .g l i sch] Sonorant Denuclearization, resyllabification

G-Deletion, like Obstruent Devoicing, certainly should apply before Sonorant Denuclearization. But then [g] remains, at least if the syllabification in b), not in a) is assumed. The only solution would be to assume the syllabification in a) and let g-Deletion apply again after Sonorant Denuclearization and resyllabification. In fact, the syllabification in a) is the only one coherent with Rubach's analysis (since then no impossible onsets are created).

Another potential problem of Rubach's proposal to g-Deletion contexts is the derivation of forms like *Engel* (root *engl*) or *Angel* (as in the compound *angel-saechsisch* with root *angl*). Application of Rubach's rules to the root *engl* might yield the derivation in (65).

(66) [engl]

VC CV
[e n g l] syllabification (sonorant nuclearization and onset creation)
[engə̆l] ə̆-insertion

This obviously gives the wrong result, since [g] may at no stage of the derivation delete. But the generality of Rubach's analysis can be rescued if stem-final consonants are taken to be extrametrical. Then, at the initial stage of the derivation we would have *eng(l),* where [g] may belong to the coda of the first syllable. At this stage, g-Deletion would apply. Only later would the sonorant [l] become nuclear. Then, only [ ] could become the onset of this new syllable. This then also gives a new account of *englisch*. G deletes at the first cycle with the syllabification [[eng(l)] isch], before even [l] has become nuclear. This analysis does not require g-Deletion to apply again after Sonorant Denuclearization. In fact, for these cases again it is sufficient to assume that g-Deletion takes place only at the beginning of level 2 and nowhere else.

Rubach does not assume that morpheme-final consonants are unsyllabified for the derivation of forms like Widmung. But it is easy to show that his analysis is compatible with the Prohibition against Syllabification of Final C (2) being operative in the syllabification of each morpheme. The derivation is given in (67):

(67) [[widm] ung]class 2

CVC VCC	
[[w i d (m)] ung]	syllabification
CVC CV VCC	
[w i d. d m. u ng]	syllabification incl. Sonorant Nuclearization
CVC CVC	
[w i d . m u ng]	resyllabification (Sonorant Denuclearization and Onset Formation)

5. Summary

Let me summarize the rules and the level-ordering of rules that have been established in this paper.

Level 1, the cyclic level is the level containing all the rules that suffixes of class 1, i.e. suffixes marked for this level, undergo. The two cyclic rules of prosodic structure, stress-assignment and syllabification apply at this level. Furthermore, all underived words undergo the rules of this level that are not subject to Strict Cyclicity, in particular, the rules of stress assignment and syllabification and conditions of prosodic structure.

Level 2 is the noncyclic level. Cyclic rules such as stress assignment and syllabification do not apply at this level. In particular, the usual rules of syllabification, i.e. the syllabification rules of level 1 do not apply here at all. Only a rule of partial resyllabification operates at this level, a rule that takes into account the syllable structure that has been assigned at level 1 and creates minimal onsets for vowel-initial morphemes word-medially. Also underived words undergo rules of level 2. Moreover, at level 2, they do not only undergo structure-changing rules, but any rules, since all rules of level 2 are non-cyclic rules and hence not subject to Strict Cyclicity. In particular, underived words may undergo the rule of n-Assimilation (not a structure-changing rule) and the rule of g-Deletion (a structure-changing rule). The rules and conditions of level 1 and level 2 are listed below.

<u>Level 1 (the cyclic level)</u>

1. syllabification algorithm including Prohibition against Syllabification of Final C, Gemination, Sonorant Nuclearization, Resyllabification for Nuclear Sonorants
2. stress assignment
4. Syllable Weight Condition (3., 4. not ordered at level 1)
   A syllable has exactly two moras, except when its nucleus is [ə] or a sonorant.

<u>Level 2 (the noncyclic level)</u>

1. n-Assimililation
   [-back, +nasal] --> [+back] / __ [+back, -sonorant]
2. g-Deletion

Coda
g --> 0 / ___

3. Syllabification of Unsyllabified C

R R
-->
X C X C

4. Partial Resyllabification

Coda O --> Coda O

C V C V

5. Sonorant Denuclearization

N

C V
[+son]

6. Onset Formation

O N

C X
[+son], where the sonority of C is greater than the sonority of X

postlexical level:

1. Obstruent Devoicing

[-son] Coda
--> [-voiced] / ___
[+voiced]

2. Sonorant Denuclearization (see level 2)
3. Onset Formation (see level 2)
4. x/c-Rule (not ordered at the postlexical level)

a. R b. O
N Coda [dorsal]
V C
[dorsal] [dorsal] [-back]

[+ back]

Notes

[1] The suffix *-isch* actually may act both as a class 1 suffix and a class 2 suffix. This can be seen from the fact that it shifts stress with some roots (in particular, roots of Greek origin), but not with others.

(1) a. Platon - platonisch, Kanon - kanonisch
b. Thueringen - Thueringisch, Rheinland - rheinlaendisch

Certain roots may take *-isch* both as a class 1 suffix and a class 2 suffix. The difference may not only show up in stress shift, but also in whether [g], following [ŋ], is deleted, a rule sensitive to the distinction between class 1 and class 2 discussed in section 3. An example is given in (2).

(2) karolingisch [ka:ro:li ŋ gi ŋ] (class 1), [ka:ro:li ŋi ç] (class 2)

[2] Geminates consists of one melodic unit associated with two timing slots (two C-slots). For German, this does not have consequences in terms of phonetic length, i.e. the number of prosodic units need not have a phonetic correlate. Geminates such as [d] in *Widder* are not longer than other consonants. Phonetically longer consonants arise only if a compound boundary intervenes between the two units, for instance the [n] in *Kinnarbe* (from *Kinn+narbe*) or in *unnuetz* (from *un+nuetz*) with a prefix boundary, which behaves in

all phonological respects like a compound boundary.

[3] I assume that the distinction between lax and tense vowels in German is underlyingly a distinction in length, since lax vowels apparently contribute one mora to the weight of a syllable and tense vowels two for the purpose of the Syllable Weight Condition (17). A late rule then turns short vowels into lax vowels and long vowels into tense vowels.

[4] Apparent exceptions to the condition on the maximal syllable weight are words like *Obst,* and *Larynx* as noticed by Moulton (1956). But here, the final consonants ([st] in Obst and [s] in *Larynx*) are appendices and thus do not count for syllable weight.

[5] There is an extensive literature on the occurrence of [ə] inGerman, in particular Issatchenko (1974), Kloeke (1982), Strauss (1985), Giegerich (1985), Wiese (1985).

[6] This phenomenon is restricted to southern dialects of German.

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