On the (in)fissibility of intervocalic consonants in Norwegian and German: Evidence from a word game

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Abstract

The syllabification of word- or morpheme-internal consonants, especially those preceded by short vowels, in Germanic languages has been subject to various analyses and there is generally not much consensus on the analysis of single string-internal consonants in these languages. This paper presents the results of a study based on a word game, carried out with German and Norwegian subjects, that provides evidence for a differential analysis of string-internal syllable junctures and consonants in these two languages. We conclude that in German a consonant preceded by a short/lax stressed vowel is best analysed as short and ambisyllabic while in Norwegian a consonant in the same environment is a geminate that contributes weight to the preceding syllable via its mora even though it is parsed in the following syllable. The analysis highlights the need for orthogonal syllable and moraic representations.

1. Introduction

In German, a matter of ongoing discussion is the affiliation of consonants following a stressed lax vowel to either the first or the second syllable or both, i.e., ambisyllabicity (Vennemann 1972, 1982, 1991a,b, Benware 1986, Ramers 1992, Wiese 1996/2000, Barry, Klein & Köser 1999, van Oostendorp 2003, Caratini 2007). The majority of scholars analyse German as not displaying a length contrast in consonants, that is, the potentially ambisyllabic consonants are phonologically short, as they are phonetically. Norwegian is commonly analysed as not differentiating between short and geminate consonants either (e.g., Lorentz 1996, Kristoffersen 2007) even though, for many speakers, there is a phonetic length difference between orthographic single and double consonants. However, Lunden (2006) and Rice (2006) disagree with this position and postulate contrastive geminate consonants for Norwegian. With this study we intend to contribute supporting evidence for one of the possible syllabification options for German and Norwegian postvocalic internal consonants (i.e., the medial C in (C)ˈv̆CV)[1] and in this way, shed light on the question of whether the two languages have phonological geminate consonants or not. Our data support the analysis of German consonants as short and ambisyllabic and of the Norwegian consonants as geminates in syllable onset position.

The data on which we base our investigation come from a word game we taught two groups of subjects (native speakers of Norwegian and German, respectively). The game forces participants to make a decision on syllabification of such medial consonants and yields different results for the two languages. We will show that German medial consonants preceded by a stressed short vowel are ambisyllabic in the base words, since they can be split in the word game while the Norwegian data produced in the word game support an analysis of such consonants as genuinely monolithic, i.e., not fissile.

[1] C = consonant; V = vowel, ˈv̆ = short stressed vowel.

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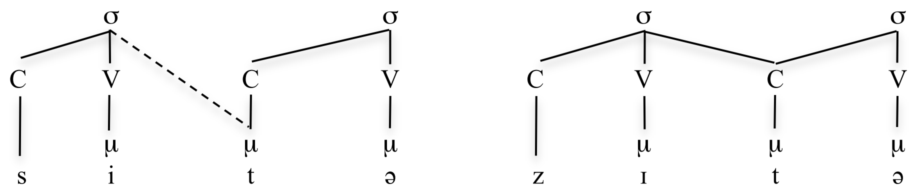
With regard to German, the word game pattern to be reported here apparently supports an analysis of such consonants as two C positions on a timing or skeletal tier. However, this account has to be rejected, since this analysis implies a difference in phonetic length, which is not found in German consonants. Concerning Norwegian, we regard the data as evidence for an analysis in which geminates contribute to the weight of the preceding syllable but are not parsed in that syllable. This constellation is difficult to reconcile with standard assumptions about weight-contributing or geminate consonants in the light of the common assumption that Norwegian stressed syllables are heavy and that this consonant contributes the additional weight needed for a stressed syllable with a short vowel. The Norwegian pattern is not straightforwardly explained either by approaches that regard geminates as two timing slots, or a moraic analysis that accounts for geminates as ambisyllabic segments, with the mora being associated to the first syllable. We will propose a representation for Norwegian geminates that separates syllabic affiliation of segments and their moraic association, such that a segment can provide weight to a syllable it is not part of.

(1) *Geminates, weight and ambisyllabicity*

a. Norwegian [sitə] *sitte* 'to sit' b. German [zɪtə] *Sitte* 'custom'



The paper is structured as follows. In section 2 we give some background on the use of word games as evidence in theory formation in the literature. Section 3 details the methodology applied in our study and section 4 presents the raw results, first separately for each of the two languages, and then a comparison of the two. These results will be subjected to analysis and discussion in section 5.

Section 5.1 briefly presents the issue of the representation of intervocalic consonants and geminates in moraic theory. In 5.2 we develop an analysis of the Norwegian data that builds on Rice's (2006) OT account of Norwegian syllabification and stress. We provide an analysis of degemination under stress migration, a pattern that turns out to be a good candidate to explain our data, but, as we will show, ultimately fails. Integrating the discussed theoretical assumptions into an analysis of our Norwegian data, the need for independent dimensions of representation of moraic affiliation and syllable structure emerges. A further analytical result concerns the status of retroflexes as underlying consonant clusters or geminates, in the variety of Norwegian investigated here.

Section 5.3 is dedicated to analysis and discussion of the German data. First we discuss the options for analysis of German intervocalic consonants following a short vowel. We then discuss a productive process in German, i-formations (nicknames formed by truncation) that could provide a potential explanation for the observed patterns. We will show that our word game patterns cannot be regarded as analogous to i-formations and we provide a formal analysis. Both analyses, the Norwegian and the German one, rely on moraic theory (e.g., Hayes 1989) and Optimality Theory (Prince & Smolensky 1993/2004, McCarthy & Prince 1995). Finally, section 6 summarizes the empirical and theoretical results of this study.

2. Word games as linguistic evidence

Word games, besides other sources of external evidence such as speech errors, poetic rhyme or writing systems, can provide psycholinguistic evidence for the organization of segments within bigger units such as words or syllables and can tell us something about the abstract representations speakers are endowed with (Fallows 1981, Berg & Abd-El-Jawad 1996, Berg 1992, Jensen 2004). It is assumed that the representational system responsible for the production of spoken language influences the performance of speakers in word games: linguistic units (such as syllables or feet) should be easy to manipulate, whereas a task involving an arbitrarily chosen sequence of segments should result in a bad performance (cf. Berg & Abd-El-Jawad 1996).

With the help of this type of psycholinguistic evidence it is also possible to test the organization of segments in specific contexts (e. g., the syllabification of certain segments within a word). The idea behind this procedure is that, in word games, speakers can be forced to reveal what their abstract organization concerning certain structures looks like (for experiments of this type cf. Berg & Niemi 2000, Schiller, Meyer & Levelt 1997, Pierrehumbert & Nair 1995, Derwing 1992, Bertinetto 1988). For example, when the speakers are asked to split a word (or a nonce-word) into two units in order to perform a word game, one can expect that they do this along prosodic or morphological constituent boundaries. Thus, in bisyllabic words containing only one foot and no morphological boundaries, they rely on syllable boundaries and reveal to which syllable they affiliate the word-medial consonant(s). This article presents a pilot study of this type: 8 German and 9 Norwegian speakers were asked to learn and apply a word game based essentially on the splitting of a bisyllabic word with initial stress, containing one or more intervocalic consonants.

It turns out that the German and Norwegian test persons split a source word containing a single, intervocalic consonant after a stressed, short vowel into different base units, respectively: As a general tendency, the Norwegian speakers syllabify the intervocalic consonants (only) as an onset of the second syllable, and they do this more often than the German speakers.

(2) German: *Sitte* [ɪ] 'custom' → split in *Sit-te*
Norwegian: *sitte* [i][2] 'to sit' → split in *si – te*

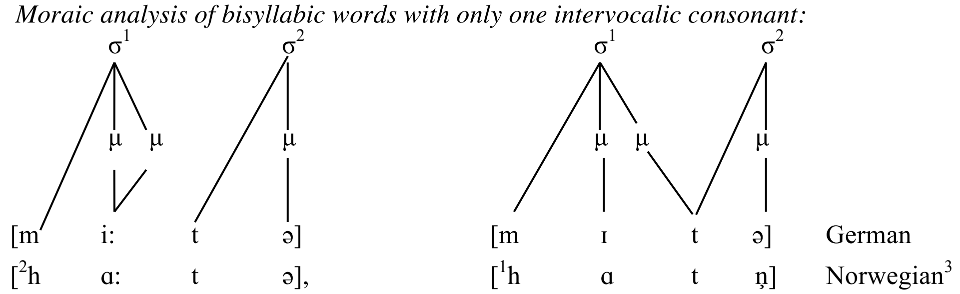
Words containing a single intervocalic consonant after a long vowel are very consistently attributed to the onset of the second syllable in both languages.

(3) German: *Schule* [u:] 'school' → split in *Schu-le*
Norwegian: *skole* [u:] 'to sit' → split in *sko-le*

The result regarding the short vowels supports those analyses which assume that, in German, the intervocalic consonant after a short, stressed vowel is (also) affiliated with the first syllable, while the Norwegian consonant is not. Further, the Norwegian data suggests that a long consonant (represented with a double consonant in the orthography) cannot be split, since it is a geminate, i.e., one segment bearing a lexical mora or some other length mark.

This is surprising, as superficially, the moraic representation for bisyllabic words with only one intervocalic consonant is the same in German and Norwegian.

(4) *Moraic analysis of bisyllabic words with only one intervocalic consonant:*



(*Miete* 'lease' vs. *Mitte* 'middle', German, cf. e. g. Ramers 1992)
(*hate*, 'to hate' vs. *hatten*, 'the hat', Norwegian, cf., e.g., Kristoffersen 2007)

2 Kristoffersen (2007: 14) does not consider tenseness an underlying feature in Norwegian.

3 The superscripts 1 and 2 in the phonetic transcription represent the two different tonal accents (or lexical pitch accents) in Norwegian.

Despite this surface similarity concerning the structure of stressed syllables, differences between the two languages in the analysis of these contexts arise under several aspects. One difference regards the phonological representation of the intervocalic consonants on the right in (4). In Norwegian, they are regarded as geminates, that is, they are considered as underlyingly moraic (Lunden 2006, Rice 2006; though cf. Kristoffersen 2007) and they surface also phonetically as long. This is mostly not claimed for the standard German counterparts which are usually analyzed as ambisyllabic, that is, belonging to both syllables (but see, e. g., Caratini 2007, Ramers 1992 who argue for underlying geminates also in standard German).[4] These differences in the phonological status of the intervocalic consonants must be related to the whole prosody of the items and will play a crucial role in the analysis in section 5.

3. The word game

3.1 Method and subjects

The word game was carried out with 9 Norwegian and 8 German test persons. The (2 male and 6 female) German participants were Erasmus exchange students or employees at the University of Tromsø (aged between 23 and 46 years) who came from different regions in Germany and declared that German was their (only) mother tongue. All but two of the German test persons had lived in Norway for a short time before participating in the experiment. One of the German test persons was a "speaker" of a language game which is slightly different from the one under investigation, four others claimed that they are aware of the existence of similar language games, but that they weren't "speakers" of any.

The nine Norwegian test persons were also students or employees at the University of Tromsø. One Norwegian participant was excluded from analysis because his answers were too unreliable and often didn't correspond to the assigned task. Among the evaluated 8 female Norwegian test persons (aged between 20 and 40) there was one "fluent speaker" of the so called *røverspråk* or *kråkespråk*;[5] the other participants declared that they had heard of such language games, but didn't speak any.

The mechanism the test persons were asked to perform was borrowed from an existing language game common in the German speaking countries. It was decided to use an existing game, because it is likely to be built on "natural" linguistic structures and to yield "natural data" whereas an artificially designed word game bears the risk of being a meta-linguistic task. Language games based on the repetition of syllables containing a fixed onset are found in German (among many other languages), and a more complicated version of this type of syllable manipulation is known in Norwegian as *dobbel månsing*. Therefore it is unlikely that differences in the performance of the two speaker groups are due to different degrees of acquaintance with the game mechanism.

We consider the manipulation to be similar to a word-formation process, more specifically, to a reduplication process, as indicated in the diagram in (6) below (cf. also Vogt 2009).[6] We expected that test persons would identify the involved specific linguistic structures (e.g. phonological constituents) and that they would apply the process after a training phase in an unconscious, fast and automatic manner, as is characteristic for the processing of data in "normal" oral speech.[7] We decided not to use nonce-words,

[4] Cf. for instance, Ramers (1992: 248), Restle (1998: 51-56). However, for Bavarian German, for instance, it is claimed that the intervocalic consonants have a longer duration (Maas 2006). The same holds for geminates in Swiss German (Kraehenmann 2003).

[5] In this language game each consonant is changed into consonant+o+consonant:
røverspråk -> rorøvoverorsospoproråkok

[6] But see, among others, Dressler (2000) and Zwicky & Pullum (1987), who exclude those word games from the realm of regular, linguistic grammar.

[7] Some teenagers document their fluency in *Räubersprache* ('bandit language'), *Löfflisch* ('Spoonian') and the like also on YouTube. The following links show communications where language games are used in a fast and automatic manner.

since this would have reduced the "naturalness" of the data (although it would have allowed for more control of other factors besides syllabification, such as phonotactics). Another point against nonce-words was that the participants could not be expected to perform the task without difficulties. Asking them to memorize unknown sequences of segments in addition to performing the mechanism of manipulation would have increased the difficulty level of the whole test unnecessarily.

The word game under investigation is normally used by teenagers, with the intention of being unintelligible to "outsiders". The mechanism is based on the division of an existing word (the source word) into base units the size of a syllable, e.g., *fünfte* 'fifth' is divided into <fünf> and <te>. Out of each base unit a new, derived game word is created: In this type of word game each base unit (syllable) is repeated twice. Additionally, the onset in the first repeated syllable is replaced by the segment *-h-* and the onset in the second repeated syllable is replaced by the segment *-f-*. Between the repeated units a prespecified syllable (*-le-*) has to be inserted. Each resulting derived game word is provided with new main stress, which was assigned by all speakers (Norwegian and German) always on the antepenultimate syllable.

(5) *Word game schema*: *fünfte* 'fifth' → <fünf> and <te>

fünf	fünf.ˈ***h**ünf*.***le***.***f**ünf*[8]
$C_1V_2C_3C_4$	$C_1V_2C_3C_4\mathbf{h}\underline{V_2C_3C_4}\mathbf{lef}\underline{V_2C_3C_4}$
te	te.ˈ***h**e*.***le***.***f**e*
C_1V_2	C_1V_2 $\mathbf{h}\underline{V_2}\mathbf{lef}\underline{V_2}$

In the psycholinguistic and linguistic literature (e.g., Pierrehumbert & Nair 1995, Treiman 1985) it is mostly assumed that fluent "speakers" of such language games learn some sort of word formation process, which they apply automatically and subconsciously after a while. The word game presented in (5) can then be analysed as a process where a base form (each syllable of the source word) is transformed by means of reduplication in a derived word, as shown in (6).[9]

(6) *The word game as a word formation process*
source-word (*fünfte*)
⇓

B base unit	⇒	manipulation (reduplication of the rime and insertion of invariant material)	DW derived word
fünf		*fünf*+***hünf.le.fünf***	*fünfhünflefünf*

Each participant was individually trained with the help of a powerpoint slideshow. The participant was first confronted with monosyllabic words (e.g., German: *Tisch* 'table' or *Buch* 'book'[10]) and their

http://www.youtube.com/watch?v=LcOIIqwIWqc, 24.02.2011
http://www.youtube.com/watch?v=wql8L2rhzgI, 24.02.2011
http://www.youtube.com/watch?v=Vq7P8dgNQTo&feature, 24.02.2011

8 In the example, inserted material is in italics, reduplicated segments are underlined while fixed, invariant segments are in bold.

9 Cf. a similar diagram in Pierrehumbert & Nair (1995). For retriplication (two repetitions of the base rather than the usual single repetition found in reduplication — hence, the term) as a regular grammatical process see Rose (2003) on Tigre.

10 See the list used during the training in (7) and in the appendix. In the appendix, the complete list of test items is also given.

manipulated form. The inserted and reduplicated material was presented in a different colour with respect to the base form but no syllable boundaries were given (cf. e. g. *Tisch**hischlefisch*** and *Buch**huchlefuch***). The participants received no explicit instruction whatsoever concerning the game's mechanism. Thus, pointing to the syllable as a unit involved was avoided. Furthermore, they did not hear a manipulated form so they had to assign a prosodic structure to the manipulated forms by themselves. In order to get a feeling for the game, the participants were told to read the examples, first silently and then aloud. In a second step, only the monosyllabic source word of the example was shown. After the item had disappeared from the computer screen, the test person had to produce (from memory) the manipulated form of the previously shown item without the help of any written representation, that is, neither the written representation of the source word nor of the manipulated word. In the final training stage, new monosyllabic items were given, which the participants had to transform according to the mechanism illustrated before.

In the training phase, the participants always had the possibility to go back in the powerpoint slideshow in order to re-examine the mechanism. It was important to give the participants enough time to get familiar with the manipulation. Often it was necessary to repeat the same item several times.

Later, the subjects were trained on bisyllabic items. These items all had a long vowel or a diphthong in the first syllable, or a medial consonant cluster with a clear sonority difference between the members. We expected that in those words speakers will unanimously parse the two medial consonants in different syllables. No example containing a single, intervocalic consonant after a short, stressed vowel was given during the training. The bisyllables were presented to the participants in the same way as the monosyllabic set: The inserted material was signalled in another colour but without syllable boundaries (e.g. *Kunde* → *Kun**hunlefun**de**helefe***). The procedure was the same as for the monosyllables.

(7) *Items used during training*

	Monosyllabic words	Bisyllabic words
German	*Tisch, Buch, Kraft, Dorn, Stuhl, Geld, Schnee*	*Kunde, Flügel, Leute, Karten, Name, Lampe, Frauen, Sprache, Leiter, Konto, Martin*
Norwegian	*bok, nett*	*kunde, vinter, klima, lampe, pause*

After the training the participants were subjected to the actual test, which provided only auditory stimuli. This corpus of test items consisted of recorded renditions by a German and a Norwegian native speaker, respectively. The subjects' renditions were recorded with a digital recorder and transferred to a computer for analysis.

3.2 The corpus

The corpus of items used during the test contained words with written double consonants, which corresponded to segments of different quality (alveolar stops, fricatives, liquids and nasals).

(8) *Items with written double consonants*:

German	gloss	Norwegian	gloss
Sitte	*'custom'*	*sitte*	*'to sit'*
Hessen	*'Hesse' (a German state)*	*klasser*	*'classes'*
Kralle	*'claw'*	*kjenne*	*'to know'* (inf.)

Furthermore, in both languages, items had been included that contained a short, stressed vowel followed by a segment which cannot be graphically signalled as a double consonant (e. g. in German <ch> and <ng> ; in Norwegian <sj>, <ng>, <kj> and <v>. In *støvel* (transcribed by Kristoffersen (2007: 39) as [stæʋ.ʋɭ̩] the labiodental approximant [ʋ] is orthographically not doubled but in fact realized as a long consonant. In *bikkje* the graph-combination <kkj>, representing the palatal fricative [ç], has only one doubled graph.

(9) *Items with a short stressed vowel followed by a segment that is not an orthographic geminate*:

German	gloss	Norwegian	gloss
Woche	*'week'*	*brosje*	*'brooch'*
Küche	*'kitchen'*	*støvel*	*'boot'*
Finger	*'finger'*	*bikkje*	*'tyke'*

Finally, other controversial (complex) segments following a short stressed vowel were tested. In German, three items containing a sequence of a plosive (/t/ or /k/) and a fricative (/s/ or /ʃ/), which can be analysed as an affricate, were submitted to the participants. These can be represented graphically with one graph <x> ([ks], as in *Hexe* 'witch') or with a combination of graphs (*Mütze*, [ts] 'cap' and *Klatsche*, [tʃ] 'swatter').[11] These cases are interesting because, on the one hand, affricates are represented on the CV-tier with only one C-position. On the other hand, affricates are segmentally complex. In these words the orthographic conventions require the following hyphenations: *Müt-ze*, *Klat-sche*. In the case of only one graph, the written hyphenation rules assign it to the second syllable (*He-xe* 'witch').

In the Norwegian corpus, retroflex sounds were also included. The retroflexion process turns coronal segments into their retroflex counterparts if they are preceded by an /r/. Simultaneously the /r/ is deleted, that is, sequences of /r + coronal/ are realized as just one segment, the retroflex.[12]

Items with a retroflex are comparable to the aforementioned items with one intervocalic consonant after a short, stressed vowel (*vorte*, [²vuʈə] 'wart', *karse* [²kaʃə] 'cress', *hørsel* [¹høʃl̩] 'hearing'): a short stressed vowel followed by a single segment. Orthographically, the two graphs representing the retroflex are assigned to different units according to hyphenation rules (e.g., *karse→kar-se*).

(10) *Items with short stressed vowel + controversial (complex) sound:*

German	gloss	Norwegian	gloss
Hexe	*'witch'*	*vorte*	*'wart'*
Mütze	*'cap'*	*karse*	*'cress'*
Klatsche	*'swatter'*	*hørsel*	*'hearing'*
		hjerte	*'heart'*

The following table gives an overview of the three contexts and the number of items included for each.

(11) *Tested contexts*:

	German	Number of tokens	Norwegian	Number of tokens
	Orthographic geminates (tt, ss, ll, nn)	8	Orthographic geminates (tt, ss, ll, nn)	9
I	Phonemes represented by a combination of graphs which are not graphically doubled ([ç] [x] [ŋ] → <ch>, <ng>)	3	Phonemes represented by a grapheme <v> or a combination of graphs which are not graphically doubled ([ç] [ʃ] → <kkj> <sj>)	5
II	Other items without 1:1 grapheme-phoneme correlation ([tʃ] [ks] [ts] → <tsch> <x> <tz>)	3	Other items without 1:1 grapheme–phoneme correlation ([ʃ], [ʈ] → <rs>, <rt>)	4
	Total	14		18

[11] The analysis of these sounds as mono- or biphonemic is controversial (see e. g. Ramers & Vater 1992: 85-91). Wiese (2000: 13f. and 261ff.) regards /ts/, /ks/ und /tʃ/ as complex segments (affricates).

[12] As minimal pairs such as Kurt [kʉʈ] 'man's name' and kutt [kʉt] 'cut' exist in UEN (Urban East Norwegian; Kristoffersen 2000), it is generally assumed that retroflexes in lexical words are not derived but underlying phonemes. See, e.g., Vogt (1939/1981), Theil Endresen (1974/1981), Hamann (2003), but also Solhaug (2010) and here section 5.

As fillers, items containing a long vowel or a diphthong in the first syllable, or a combination of consonants with falling sonority, were presented to the participants.

(12) *Items with a long vowel, a diphthong or a combination of consonants*:

	German	Number of items	Norwegian	Number of items
V	Items with long vowel, diphthong or consonant sequence	16	Items with long vowel, diphthong or consonant sequence	17

3.3 Influence of the writing system

One difficulty in analysing the results of this type of experiment lies in the influence of the writing conventions: Literate people are most probably influenced by the orthography which on the one hand prescribes certain hyphenation rules and on the other hand is also a representational system based on abstract units like graphemes and written syllables (Primus 2003). In other words, it is not always clear whether the participants in the word game access the orthographic lexicon or the phonological system (Laudanna 2006).

In most experiments of this type the stimuli are presented only auditorily. Nevertheless, it is reasonable to think that the participants do not disregard orthography completely. In the first place, the need to divide a word into units happens often in written language, whereas people normally do not encounter tasks that require the division of words into spoken syllables (except for psycholinguistic experiments). In both German and Norwegian only few structural properties clearly signal a syllable boundary. Whereas in German syllable-final devoicing or g-spirantization can count as a cue that signals the syllable boundary (e.g., Hall 1992), in Norwegian, syllable boundaries are based mainly on phonotactics (cf. Kristoffersen 2000). Further, the task to split a word into syllables should be easier to perform on written than on spoken language because the phonetic substance of spoken language is not equipped with exclusively discrete units (as opposed to written language). This property of the spoken medium can cause blurred boundaries also in phonological description (e. g., ambisyllabic consonants), which can hinder or impede the proper division of the word into two or more parts.

In psycholinguistics, a so-called graphemic buffer is assumed for the writing of words, in which the intended words are stored during the process of writing. In this buffer, the level of activation of the sequence of graphemes is kept sufficiently high in order to perform the writing (an activity which takes a relatively long time) and in order to serialise the graphemes (cf. Laudanna 2006). In experiments using word games, the implementation and the execution of the word game also require a relatively long time compared to the processing of "normal" spoken language. It is therefore plausible that in this kind of tasks the participants activate a kind of storage room (i.e., the graphemic buffer) to keep the information for a sufficiently long time in order to perform the game, and one could thus suspect that they activate the orthographic rather than the phonological representation of the item.

Nevertheless, although the influence of the orthography has to be taken into account, this type of experiment may indeed yield linguistically significant results. The comparison between two languages that have the same hyphenation rules regarding certain structures, as for, e.g., the written double consonants, reveals that there are significant differences in the execution of the word game. These differences can tell us something about the abstract phonological organization speakers are endowed with. Furthermore, aspects of the writing system can also be interpreted as evidence regarding phonological structure. And, last but not least, it has to be considered that the output of the word game is, however, spoken language and the speakers definitely have to produce an output in conformity with the phonological system of their language.

4. Results

The analysis of the items containing a long vowel or a diphthong in the first syllable, or a combination of intervocalic consonants, shows that the native speakers normally have a consistent intuition regarding syllabification. The German speakers respect the expected boundary nearly without exception (altogether 128 answers). Only one speaker split the word after a long vowel in 4 cases in an unexpected way. The same intuition concerning the syllable structure of these items was displayed by the Norwegian subjects. Only in one case (out of 136 answers), did a Norwegian participant syllabify an intervocalic single consonant in the coda of the first unit. Thus, as predicted by phonology and prescribed by orthography, in words containing a long vowel or a diphthong in the first syllable, or a combination of intervocalic consonants, speakers unanimously parse the consonants into the expected syllable. However, a different picture emerges regarding single intervocalic consonants after short, stressed vowels, as the following data show.

4.1 The Norwegian data

Altogether, the Norwegian speakers show a strong preference for open syllables, even in contexts in which the Norwegian hyphenation rules would prescribe the distribution of the graphs to both syllables. The most frequent pattern is the syllabification of the intervocalic consonant as the onset of the second syllable, and the second-most frequent was the syllabification of the consonant as both, the coda of the first and the onset of the second syllable. The least frequent pattern is the syllabification of the consonant only as a coda. This pattern was strong for words containing a lax vowel followed by a single (orthographic double) consonant. 63.2 % of the speakers realize an open syllable in the first unit (*Sitte→si.ˈhi.le.fi te.ˈhe.le.fe*; 43 examples out of 68 evaluable answers, cf. 13a), although this is not in line with the hyphenation rules, against a first closed syllable in 25 cases (*Sitte→sit.ˈhit.le.fit te.ˈhe.le.fe* or: *sit.ˈhit.le.fit e.ˈhe.le.fe* 36.8%, cf. 13d).

(13) *Context I: Syllabification pattern in items with short, stressed vowels followed by written double consonants (8 Norwegian speakers, 9 items)*

Sitte → si.ˈhi.le.fi te.'he.le.fe > sit.ˈhit.le.fit te.ˈhe.le.fe > sit.ˈhit.le.fit e.ˈhe.le.fe

	Category	%	*Number of tokens*
a.	Only in the onset (si-te)	63.2	43
b.	In the coda and in the onset (*sit-te)*	30.9	21
c.	Only in the coda (*sit-e)*	5.9	4
	Total:	100	68
d.	First syllable closed	36.8	25
e.	First syllable open	63.2	43

The tendency to realize the first syllable as open is also evident in context II (items containing a grapheme or a combination of graphs which cannot be doubled (*nisje, brosje, høvel, støvel, bikkje*).

(14) *Context II: Syllabification patterns in items with short stressed vowels followed by consonants which are not graphically doubled (8 Norwegian speakers, 5 items)*

brosje → *bro.ˈho.le.fo [ʃ]e.ˈhe.le.fe > bro[ʃ].ˈho[ʃ].le.fo[ʃ] [ʃ]e.ˈhe.le.fe >*
bro[ʃ].ˈho[ʃ].le.fo[ʃ] e.ˈhe.le.fe[13]

	Category	%	*Number of tokens*
a.	Only in the onset (*ni*-[ʃ]e)	75	30
b.	In the coda and in the onset *(bro*[ʃ-ʃ]*e*)	2.5	1
c.	Only in the coda (*ni*[ʃ]-*e*)	22.5	9
	Total:	100	40
d.	First syllable closed	25	10
f.	First syllable open	75	30

75% of the speakers (30 answers out of 40) realized an open syllable (cf. 14a). Only 25% (10 answers out of 40) preferred a closed syllable (cf. 14d): We find three instances of *bikkje* with a first closed syllable (*bi[ç]-e*), two instances of *støv-el* and *høv-el*, respectively, one answer with *ni[ʃ]-e* and *bro[ʃ]-e*, respectively (cf. 14c). One speaker doubled the post-alveolar fricative: *bro[ʃ]-[ʃ]e* (cf.14b). All the other answers show an open syllable. There is no significant difference in the data between the items with single <v> and the grapheme combination <sj> or <kkj>.

By contrast, in items with retroflex sounds following a short, stressed vowel (context III) a closed first syllable is the preferred option. However, there is high variability and the speakers showed a strong uncertainty on how to split the items with a retroflex and were often unable to perform the game in this context (only 31 answers could be evaluated out of 40). Although a first closed syllable is chosen in 61.3 % (cf. categories 15b-d collapsed into one group), category 15a (an open syllable) is the category which is most frequently applied (e. g. *vo*[ʈ]*e*→*vo.ˈho.le.fo* [ʈ]*e.ˈhe.le.fe;* 38.7%).

(15) *Context III: Syllabification of a retroflex consonant after a short, stressed vowel (8 Norwegian speakers, 4 items)*

vo[ʈ]*e* → *vo.ˈho.le.fo* [ʈ]*e.ˈhe.le.fe* > *vo*[ʈ].ˈ*ho*[ʈ].*le.fo*[ʈ] *e.ˈhe.le.fe* > *vor.ˈhor.le.for te.ˈhe.le.fe* > *vo*[ʈ].ˈ*ho*[ʈ].*le.fo*[ʈ] [ʈ]*e.ˈhe.le.fe*

	Category	%	*Number of tokens*
a.	Only in the onset (*vo*-[ʈ]*e*)	38.7	12
b.	In the coda (*vo*[ʈ]-*e*)	32.25	10
c.	Realization of two segments (*vor-te*)	22.6	7
d.	Doubling of the retroflex (*ka*[ʃ-ʃ]*e*)	6.45	2
	Total:	100	31
e.	First syllable closed	61.3	19
f.	First syllable open	38.7	12

The results show, in the first place, that the Norwegian writing conventions do not interfere significantly with the division of an item into syllables in speech tasks. In the written form the first syllable mostly contains one consonant (compare, e.g., *sitte→sit-te*; *bikkje→bik-kje* or *bikk-je*; *brosje→bros-je*, *vorte→vor-te*). Nevertheless, in nearly all contexts the first syllable is realized predominantly as open. The only context in which a first closed syllable is preferred is the context with the retroflex sounds

13 In the following tables the "ranking" of the answers follows (where possible) the ranking in context I (and not decreasing percentage): The first line reports the number of answers where the consonant was put only in the onset, in the second line the number of responses where the consonant is assigned to both syllables and so on.

(61.3% closed syllables in the retroflex context (cf. 15e) against 36.8% (cf. 13d) closed syllables in the context with orthographic geminates).

4.2 The German data

The German subjects, in contrast to the Norwegians, preferred a closed syllable as the syllabification of a graphic double consonant after a short stressed vowel:[14] Altogether, in context I, presented in the table in (17), 48 items out of 62 evaluable answers[15] are realized with a closed syllable. This corresponds to 77.4 % (cf. 17f). An open syllable is found in 14 cases only (cf. 17g).

Two German participants employed a strategy which in some way altered the pattern of the word game: instead of splitting the items into two base-units, each of the size of a syllable, and then building two new prosodic game words out of these two base-units (each composed of four syllables and with new main stress on the antepenultimate, cf. 16a-b), these speakers preserved the whole source word as a (prosodic) unit (together with main stress on the penultimate). They replaced only the original onset with a prespecified onset. At the left edge of this preserved prosodic unit, they added the initial string of the source word (an open or a closed syllable) twice. In the second rendition of this syllable they replaced the onset of the source unit with the other prespecified onset. Between the reduplicated syllables at the left edge and the preserved prosodic unit, the fixed syllable *-le-* was inserted. Finally, another new trisyllabic prosodic word was created containing only prespecified onsets (cf. 16c-d). That is, in these renditions of the game a new prosodic word composed of five syllables was created (maintaining the consonants under investigation in intervocalic position) and a new trisyllabic unit (without a "trace" of the intervocalic consonant in the source word) were built. Therefore, it is not possible to tell from these renditions of the game if speakers attribute the intervocalic consonant in the source word only to the coda of the first syllable (cf. 16c), only to the onset of the second syllable (cf. 16d) or to both syllables (16c-d), as we cannot tell if the original onset is only replaced or not present in the second prosodic word. However, it is possible to tell if, in these speakers' representations, the first syllable in the source word is closed or open. In our interpretation, the unit that is manipulated by the participants is what they consider to be the first syllable, repeating it initially twice (and replacing the onset of the second). Thus, these answers are evaluated only with regard to the realization of the first syllable (in the following tables, it is specified that they show a first open or closed syllable, but no clear onset in the second syllable, see, e.g., table 17c and d).

This alternative solution to the word game was able to emerge as no instruction was given to the participants, and training examples had been given in written form only.

(16)	a.	[ˈSonne]$_F$ → Sonn.ˈhonn.le.fon	ne.ˈhe.le.fe *or*:	
	b.	[ˈSonne]$_F$ → So.ˈho.le.fo	ne.ˈhe.le.fe	
	c.	[ˈSonne]$_F$ → Sonn.honn.le[ˈ**fon.ne**]$_F$	heˈlefe/ˈhelefe,	*or*:
	d.	[ˈSonne]$_F$ → So.ho.le[ˈ**fon.ne**]$_F$	heˈlefe/ˈhelefe	

The data shows further that, in 29 cases (46.8%, cf. 17a), the answers correspond to the written hyphenation rules, that is, the written geminates are distributed to both syllables.[16]

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14 Some of the German data are also discussed in Vogt (2012).

15 Two answers had to be excluded.

16 The speakers who preserved the prosodic structure of the source word in the first new prosodic word replacing only the original onset with the fixed onset were not excluded from the total number (=62), because we interpret their behaviour as not respecting the written hyphenation rules.

(17) Context I: Syllabification patterns in items with short, stressed vowels followed by written double consonants (8 German speakers, 8 items)

Sitte → sit.ˈhit.le.fit te.ˈhe.le.fe > sitt.hitt.le.[ˈfitte] ˈhe(ˈ).le.fe > si.ˈhi.le.fi tte.ˈhe.le.fe[17]

	Category	%	*Number of tokens*
a.	In the coda and in the onset (*Son-ne*)	46.8	29
b.	Only in the coda (*Sonn-e*)	4.8	3
c.	Closed first syllable; no clear onset in the second syllable (*Son*-[ˈ*fonne*]$_F$)	25.8	16
d.	Open first syllable; no clear onset in the second syllable (*So*-[ˈ*fonne*]$_F$)	6.5	4
e.	In the onset (*So-nne*)	16.1	10
	Total	100	62
f.	First syllable closed	77.4	48
g.	First syllable open	22.6	14

As the following table (18) shows, the tendency to close the first syllable conflicts with the writing conventions when a combination of written consonants representing one phoneme is used, as in the case of <ch> representing [ç] or [x]. According to the hyphenation rules in German the whole digraph has to go to the next line: *Woche→Wo-che*. The data shows that this influences the decision of the speakers: In 12 cases the speakers realize a first open syllable in this context, against 4 realizations of a closed syllable (i.e., 75% versus 25%, cf. 18a-e).

In the case of the test item *Finger* ([fɪŋɐ] ‘finger’) the velar nasal was always affiliated to the first syllable; 5 test-persons started the second syllable without the velar stop (g) (fi[ŋ]-er) and three realized it (fi[ŋ]-[g]er, cf. 18c-e). The answers show again that the test persons do not rely on the orthography because the hyphenation rules would prescribe *Fin-ger*. Additionally they are aware of the phonology of their language and know that it is not possible to employ the velar nasal syllable-initially.

[17] We show only the three most frequent patterns.

(18) *Context II: Syllabification patterns in items with short stressed vowels followed by consonants which are not graphically doubled (8 German speakers, 3 items)*

Finger → Fing.ˈhing.le.fing.er.ˈher.le.fer > Fing.ˈhing.le.fing.ger.ˈher.le.fer > Fing.hing.leˈfinger her.le.fer

	Category	%	*Number of tokens*
a.	In the onset (5x*Kü-che,* 4x*Wo-che*)	37.5	9
b.	Open first syllable; no clear onset in the second syllable (2x*Kü*-[ˈ*füche*]$_F$) (1x*Wo*-[ˈ*foche*]$_F$)	12.5	3
c.	In the coda (1x *Woch-e, 3xFing-er*)	16.66	4
d.	Closed first syllable; no clear onset in the second syllable (1x*Woch*-[ˈ*foche*]$_F$; 1x*Küch*-[ˈ*füche*]$_F$ 2x*Fing*-[ˈ*finger*]	16.67	4
e.	In the coda and in the onset (1x*Woch-che, 3xFing-ger)*	16.67	4
	Total	100	24
f.	First syllable open (7x*Kü-,* 5x*Wo-*)	50	12
g.	First syllable closed (3x*Woch*-, 1x*Küch*-, 8x*Fing*-)	50	12

We turn to the realisations of the affricates now. In 14 cases (out of 22 answers)[18] an open first syllable is realized (60.9 %, cf. 19f). In most cases it was the item *Hexe* that was separated this way. We attribute this to the fact that this sound combination is represented with a single grapheme. The interesting fact is that the two sounds of the affricate were never simply distributed across the two syllables. That is, renditions such as *Kla[t-ʃ]e* or *Mü[t-s]e*, with a stop in the coda of the first and a fricative in the onset are unattested in our data, even though this separation corresponds to the hyphenation rules of German orthography. Thus, we can conclude that our subjects don't consider these affricates a combination of consonants. In fact, they seem to be aware that an affricate – although segmentally complex – is represented as a single segment.

(19) *Context III: Syllabification patterns in items with short stressed vowels followed by sounds without 1:1 grapheme-phoneme correlation (8 German speakers, 3 items)*

He[ks]e → He[ks].ˈhe[ks].le.fe[ks] se.ˈhe.le.fe > He.ˈhe.le.fe [ks]e.ˈhe.le.fe

	Category	%	*Number of tokens*
a.	In the onset (*He-xe*)	39.13	9
b.	Open first syllable and no clear onset in the second syllable (*He*-[ˈ*fexe*]$_F$)	21.74	5
c.	Closed first syllable and no clear onset in the second syllable (*Müt*-[ˈ*fütze*]$_F$)	17.4	4
d.	In the coda (e. g. *He*[ks]-*e*)	13	3
e.	Doubling of one sound (e. g. *Klatsch-tsche*; *Müt*-[ts]*e*)	8.7	2
	Total	100	23
f.	First syllable open	60.9	14
g.	First syllable closed	39.1	9

18 Two answers could not be evaluated.

4.3 Comparison of Norwegian and German

A comparison of the Norwegian and German data in context I (syllabification patterns in items with short, stressed vowels followed by written double consonants) and context II (syllabification patterns in items with short stressed vowels followed by consonants which are not graphically doubled),[19] reveals the following picture: With regard to orthographic geminates and phonemes represented by a grapheme (<v>) or combination of graphs (<kkj>, <sj>) following a short, stressed vowel, 108 Norwegian and 86 German answers could be evaluated. 73 answers (=67.6%, cf. 20a) given by the Norwegian participants display an open syllable while the German participants prefer a closed first syllable (69.8%, cf. 21b).

(20) *Syllabification in context I and II (8 Norwegian speakers, 14 items)*

	Category	%	*Number of tokens*
a.	First syllable open	67.6	73
b.	First syllable closed	32.25	35
	Total:	100	108

(21) *Syllabification in context I and II (8 German speakers, 11 items)*

	Category	%	*Number of tokens*
a.	First syllable open	30.2	26
b.	First syllable closed	69.8	60
	Total:	100	86

The direct comparison of the Norwegian with the German data is problematic as the number of tokens is different in the two groups and the segments in context II (short V followed by bigraph for single C) are not the same. Furthermore, the number of items and participants is not high enough to allow for a thorough statistical analysis. On the other hand, a relatively low number of participants makes it possible to consider each speaker individually and to interpret her/his behaviour as a whole.[20] However, in our view it is undeniable that there is a strong tendency for the Norwegian speakers to realise an open first syllable and for the German speakers to realise a closed first syllable. In the following we present a representation of prosodic structure associated with intervocalic consonants in both languages, that is compatible with these data.

5. Analysis and discussion

In this section we will first give an OT analysis of the Norwegian data and then of the German pattern. Finally we will compare the two analyses. Before comparing the Norwegian with the German data on a geminate vs. non-geminate basis, it is necessary to consider possible representations of geminates.

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[19] Context III (syllabification patterns in items with short stressed vowels followed by sounds without 1:1 grapheme-phoneme correlation) was excluded here, as the Norwegian data concerning the retroflex showed so high variability.

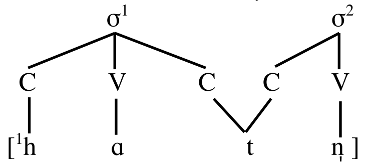
[20] A $\chi 2$-test considering the distribution of the variable open/closed depending on the speaker-groups Norwegian (68% open; 32% closed) vs. German (30% open; 70% closed) results in a $\chi 2$-value of 26.74. This is significant, as the critical value for $p = 0.05$. is 3.84 (df=1).

5.1. The representation of geminates

It is still a controversial issue how geminates are best represented, cf. Davis (2011), Spaelti (1994). The different approaches will be evaluated here against the background of our experimental data, which show that Norwegian speakers in these contexts prefer open syllables whereas German speakers mostly realise a closed first syllable.

Following Davis (2011), one possibility is to interpret geminates as double consonants consisting of two "halves" (two root nodes or two positions on the segmental tier), which can be manipulated independently. In this view, geminates – as opposed to single segments – are linked to two slots on a timing or prosodic tier and one would predict that geminates in the aforementioned word game could be easily split (*hatten* 'the hat' → *hat-ten*). But this is not confirmed by the experimental data regarding Norwegian.

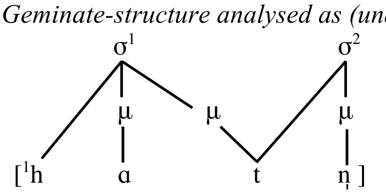
(22) *Geminate-structure analyzed as timing slots*:



(Norwegian, *hatten* 'the hat')

On the other hand, in moraic analysis the splitting of the geminate is not necessarily expected since consonantal length is not encoded on the segment tier, as illustrated below.

(23) *Geminate-structure analysed as (underlying) moraicity*



(Norwegian, *hatten* 'the hat')

At least the Norwegian data therefore seems to confirm the moraic account of geminate structure, which will be applied to the analysis of the experimental data shortly.

German, on the other hand, does not show phonetic length of intervocalic consonants. Thus, the representation in (22) is inappropriate for German, too, since it provides two segment slots for the consonant in question, which have to be interpreted phonetically as length. The assumption that single consonants preceded by a stressed, short vowel provide weight to the preceding syllable is a valid option, since short lax vowels generally don't occur in open syllables (see the arguments in Vennemann 1972, 1982, Ramers 1992, Wiese 1996/2000).

Hence, since German speakers prefer closed syllables in the word game, their pattern supports an analysis that assigns the intervocalic consonant to the preceding syllable (either exclusively or ambisyllabically). Moraic theory offers only the representation in (23) for this state of affairs and, thus, apparently can't distinguish the phonetic difference in pairs such as German *hatten* 'have.-2.pl.past' and Norwegian *hatten* 'hat.def'. We will discuss this in more detail after the analysis of Norwegian.

5.2 Analysis of Norwegian intervocalic consonants, based on the word game patterns

5.2.1 Basic analysis

In this section we will first consider an analysis of syllabification and stress as provided by Rice (2006) and extend it to capture the process of degemination which has to be regarded as a potential source of the Norwegian word game results. In degemination, under stress retraction, long consonants are shortened when stress moves from the syllable preceding (and potentially including the first half of) the geminate.

Since the stressed syllable in a word such as *sitte*, i.e., *.sit.* or *.si.*, ends up in unstressed position, or with reduced stress in the first and last syllable of the word game rendition (*sihílefi.../sithítlefit...*), these syllables with reduced or removed stress might be subject to constraints active in Norwegian that cause removal of weight from unstressed syllables, and these might exert a weight-adjusting influence on the stressed syllable in the word game as well.

As consonants in Norwegian are assumed to be contrastively long or short a faithfulness constraint protecting the underlying moraicity of consonants (Faith-Cμ) has to dominate a markedness constraint against moraic consonants (*Cμ). Rice (2006) invokes the constraint MaxLinkμ, which is violated whenever the link between an underlying mora and the segment it is associated with is broken, either by not mapping the mora to the surface representation or by dislocating the mora and realising it on a different segment. In his analysis of Norwegian stress Rice assumes both underlying long vowels as well as long consonants. For the sake of parsimony one should avoid underlying long vowels, because one set of segments distinguishing length fully suffices since the other set of long segments can be derived. However, as we will see below, this cannot be achieved if one also wants to avoid lexically marked stress. Before we analyse our data it is instructive to derive the alternation between long and short consonants discussed earlier, since we assume as the null hypothesis that the trend for open syllables in our language game is an effect of the grammar that produces this alternation.

Vowel length, as well as long consonants, is found in stressed syllables only. The lengthening of vowels in stressed syllables is captured by Stress-To-Weight (SW), a constraint requiring stressed syllables to be bimoraic, and which is never violated in Norwegian. Moreover, since vowels and consonants are always short in unstressed syllables, the constraint Weight-To-Stress (WS), demanding heavy, or bimoraic, syllables to be stressed, has to play an important role in Norwegian too. Furthermore, Norwegian has trochaic feet, which have to be binary. SW and FOOTBIN are top-ranked. In tableau (24) we reproduce one of Rice's example analyses, slightly simplified. As you can see from comparing candidates (g) and (h), low ranking *CODA prefers a form with a long vowel if there is a long vowel and a geminate consonant in the input.

(24) *Basic stress assignment in Norwegian, after Rice 2006 (hake 'chin')*

/ha$^{\mu\mu}$k$^{\mu}$ə$^{\mu}$/	SW	FOOTBIN	MAXLINK$^{\mu}$	WS	*CODA
a. (ˈha$^{\mu}$.)kə$^{\mu}$	*!	*	**		
b. (ha$^{\mu}$.ˈkə$^{\mu}$)	*!		**		
c. (ˈha$^{\mu}$.kə$^{\mu}$)	*!		**		
d. (ˈha$^{\mu}$k$^{\mu}$.)ke$^{\mu\mu}$			*	*!	*
e. ha$^{\mu}$k$^{\mu}$.(ˈkə$^{\mu\mu}$)			*	*!	*
f. (ˈha$^{\mu\mu}$k$^{\mu}$).kə$^{\mu}$		*!			*
g. (ˈha$^{\mu}$k$^{\mu}$).kə$^{\mu}$			*		*!
☞ h. (ˈha$^{\mu\mu}$).kə$^{\mu}$			*		

For the same reason, vowel lengthening is preferred if there is no long segment in the input, as is shown in the next tableau. Thus, one might be led to conclude that contrastive vowel length is dispensable. Nevertheless, we will see that it is not.

(25) *Automatic vowel lengthening (hake 'chin')*

	/ha$^{\mu}$kə$^{\mu}$/	SW	FOOTBIN	MAXLINK$^{\mu}$	WS	*CODA
	a. (ˈha$^{\mu}$.)kə$^{\mu}$	*!	*			
	b. (ha$^{\mu}$.ˈkə$^{\mu}$)	*!				
	c. (ˈha$^{\mu}$.kə$^{\mu}$)	*!				
	d. (ˈha$^{\mu}$k$^{\mu}$.)ke$^{\mu\mu}$				*!	*
	e. ha$^{\mu}$k$^{\mu}$.(ˈkə$^{\mu\mu}$)				*!	*
	f. (ˈha$^{\mu\mu}$k$^{\mu}$).kə$^{\mu}$		*!			*
	g. (ˈha$^{\mu}$k$^{\mu}$).kə$^{\mu}$					*!
☞	h. (ˈha$^{\mu\mu}$).kə$^{\mu}$					

Since vowel lengthening is automatic in stressed syllables, long consonants have to be lexically marked. The next tableau shows this for intervocalic geminates.

(26) *Underlying intervocalic geminate C (hakke* 'pick')

	/ha$^{\mu}$k$^{\mu}$ə$^{\mu}$/	SW	FOOTBIN	MAXLINK$^{\mu}$	WS	*CODA
	a. (ˈha$^{\mu}$.)kə$^{\mu}$	*!	*	*		
	b. (ha$^{\mu}$.ˈkə$^{\mu}$)	*!		*		
	c. (ˈha$^{\mu}$.kə$^{\mu}$)	*!		*		
	d. (ˈha$^{\mu}$k$^{\mu}$.)ke$^{\mu\mu}$				*!	*
	e. ha$^{\mu}$k$^{\mu}$.(ˈkə$^{\mu\mu}$)				*!	*
	f. (ˈha$^{\mu\mu}$k$^{\mu}$).kə$^{\mu}$		*!			*
☞	g. (ˈha$^{\mu}$k$^{\mu}$).kə$^{\mu}$					*
	h. (ˈha$^{\mu\mu}$).kə$^{\mu}$			*!		

The next tableau illustrates final geminate Cs and prepares the argument for our analysis of degemination under stress shift (which Rice doesn't discuss). In this tableau we added one more of Rice's constraints, NONFINAL (NF), which prefers a final unparsed syllable or segment. In this tableau it explains the length of the final consonant, since moraicity alone is not enough for a coda consonant to display length. The constraint shows its effect in the vowel length of monosyllabic forms such as *hat* 'hate' and the length of the final consonant in contrasting *hatt* 'hat'. A further constraint that is added is the bottom-ranked ALIGNRight (AR), which draws the stress foot to the right. To show the effect of this constraint better we assume that the *m* of *grammatikk* 'grammar' is moraic too, as is indicated by the word's orthographic form.

(27) *Final geminates*[21]

	/gra$^{\mu}$m$^{\mu}$a$^{\mu}$ti$^{\mu}$k$^{\mu}$/	SW	FTBIN	WS	MAXL$^{\mu}$	NF	*CODA	AR
	a. (ˈgra$^{\mu}$.ma$^{\mu}$).ti$^{\mu}$k	*!			**		*	*
	b. (ˈgra$^{\mu\mu}$.ma$^{\mu}$).ti$^{\mu}$k		*!		**		*	*
	c. (ˈgra$^{\mu}$m$^{\mu}$.ma$^{\mu}$).ti$^{\mu}$k		*!		*		**	*
	d. (ˈgra$^{\mu}$m$^{\mu}$.)ma$^{\mu}$.ti$^{\mu}$k				*		**!	**
	e. (ˈgra$^{\mu}$m$^{\mu}$.)ma$^{\mu}$.ti$^{\mu}$k$^{\mu}$			*!			**	**
	f. gra$^{\mu}$m$^{\mu}$.ma$^{\mu}$.(ˈti$^{\mu}$k$^{\mu}$)			*!		*	**	
	g. gra$^{\mu}$.ma$^{\mu}$.(ˈti$^{\mu}$k$^{\mu}$)				*	*!	*	
☞	h. gra$^{\mu}$.ma$^{\mu}$.(ˈti$^{\mu}$k$^{\mu}$)k				*		*	

The competition of the two geminates (one of them hypothetical) above already provides the solution to the stress shift issue. If there is a second geminate or a long vowel further to the right in the word, either as above or added by affixation, stress moves to the rightmost geminate or long vowel and preceding geminates/long vowels shorten. *Grammatikalitet* 'grammaticality', derived from *grammatikk*, displays stress on the ultima and a short(ened) *k*. Degemination doesn't only affect words used by strange people concerned with arcane knowledge (aka linguists), it is completely regular, as in *terrasere* [teraˈse:rə] 'build a porch', derived from *terrasse* [teˈrassə] 'porch'.

These two examples already show the dilemma with lexical economy. Either the following vowel is lexically long i.e., /-e:re/ or we have to assume that these vowels are lexically stressed, i.e., /-ˈere/. One of the major traits of elegance in Rice's analysis is that he does not have to use any lexical stress marking. Thus, we don't have to decide between contrastive vocalic or consonantal length but between contrastive segmental length or contrastive stress. We follow Rice here and prefer to avoid lexical stress. Assuming underlying /-alite:t/ and /-e:re/, respectively, *CODA settles the issue and causes stress shift and degemination.

[21] We altered Rice's analysis in one minor detail, switching the ranking of MAXLinkμ and WS. This doesn't have any repercussions for the analysis of his data, but it is crucial for our purposes, as this tableau and the next one on stress shift show.

(28) *Stress shift*

	/gra$^{\mu}$m$^{\mu}$a$^{\mu}$ti$^{\mu}$k$^{\mu}$-a$^{\mu}$li$^{\mu}$te$^{\mu\mu}$t/	SW	FTBIN	WS	MAXL$^{\mu}$	NF	*CODA	AR
a.	...(ˈti$^{\mu}$k$^{\mu}$).ka$^{\mu}$.li$^{\mu}$.te$^{\mu\mu}$t			*!			**	***
b.	...(ˈti$^{\mu}$k$^{\mu}$).ka$^{\mu}$.li$^{\mu}$.te$^{\mu}$t				*		**!	***
c.	...ti$^{\mu}$k$^{\mu}$.(ˈka$^{\mu}$).li$^{\mu}$.te$^{\mu\mu}$t	*!	*	**			**	**
d.	...ti$^{\mu}$k$^{\mu}$.(ˈka$^{\mu}$.li$^{\mu}$).te$^{\mu\mu}$t	*!		**			**	*
e.	...ti$^{\mu}$k$^{\mu}$.(ˈka$^{\mu\mu}$.li$^{\mu}$).te$^{\mu\mu}$t		*!	**			**	*
f.	...ti$^{\mu}$k$^{\mu}$.(ˈka$^{\mu\mu}$).li$^{\mu}$.te$^{\mu\mu}$t			*!*			**	**
g.	...ti$^{\mu}$.(ˈka$^{\mu\mu}$).li$^{\mu}$.te$^{\mu\mu}$t			*!	*		*	**
h.	...ti$^{\mu}$.(ˈka$^{\mu\mu}$).li$^{\mu}$.te$^{\mu}$t				**!		*	**
i.	...ti$^{\mu}$.ka$^{\mu}$.(ˈli$^{\mu\mu}$).te$^{\mu}$t				**!		*	*
j.	...ti$^{\mu}$.ka$^{\mu}$. li$^{\mu}$. (ˈte$^{\mu}$t$^{\mu}$)				*	*!	*	
☞ k.	...ti$^{\mu}$.ka$^{\mu}$. li$^{\mu}$. (ˈte$^{\mu\mu}$)t				*		*	

The analysis of the distribution of stress, geminate consonants and vowel length provided so far relies on moraic structure as well as on the assumption that geminate consonants consist of two C positions, one affiliated with the preceding and one with the following syllable.

5.2.2 Norwegian word game evaluations

Now reconsider the reduplication behaviour of words with geminates:

(29) *Norwegian preference for intervocalic orthographic double consonants*
sitte → *si.ˈhi.le.fi te.ˈhe.le.fe* (63.2%) > *sit.ˈhit.le.fit te.ˈhe.le.fe* (30.9%) >
sit.ˈhit.le.fit e.ˈhe.le.fe

As indicated already in 5.2.1, the most popular pattern behaves as expected from the preceding discussions. In unstressed syllables the geminate doesn't surface. Note that the first syllable (and the fourth syllable) is destressed in the reduplicated form while one of the reduplicant syllables receives stress. As is common in reduplication patterns the reduplicated parts stand in a correspondence relation with the base and avoidance of a coda consonant overapplies in the stressed reduplicant syllable, which shows a lengthened vowel to satisfy SW. The whole form is expanded to two words with four syllables in each of which the antepenultimate syllable receives stress. We don't give an account of the stress placement in the reduplicated forms, since this was an aspect of the game that was learned in the training phase. The interesting detail here is the fate of the intervocalic consonant in the base form, and vowel length.

(30) *The Norwegian pattern*

	/si$^{\mu}$t$^{\mu}$e$^{\mu}$ + REDleRED .../	SW	FTBIN	WS	MAXL$^{\mu}$	*CODA
☞	a. si$^{\mu}$.(ˈhi$^{\mu\mu}$).le$^{\mu}$.fi$^{\mu}$ ...				*	
	b. si$^{\mu}$t$^{\mu}$.(ˈhi$^{\mu}$t$^{\mu}$).le$^{\mu}$.fi$^{\mu}$t$^{\mu}$ ...			*!*		***
	c. si$^{\mu\mu}$.(ˈhi$^{\mu\mu}$).le$^{\mu}$.fi$^{\mu\mu}$ ...			*!*	*	**
	d. si$^{\mu}$t.(ˈhi$^{\mu}$t$^{\mu}$).le$^{\mu}$.fi$^{\mu}$t ...				*	*!**
	e. si$^{\mu}$.(ˈhi$^{\mu}$t$^{\mu}$).le$^{\mu}$.fi$^{\mu}$				*	*!

At this point, it looks as if we can explain why, in the word game, Norwegian speakers predominantly underparse the coda part of the geminate. The constraint against bimoraicity in unstressed syllables (WS) accounts for the open syllables in the word game. This is shown by candidate (b) which loses the competition as it violates WS twice. The second-most frequent rendition has to correspond to candidate (d). The consonant is realized (in the base) but has lost its mora. This candidate is beaten by the most frequent candidate (a) on the low ranking constraint *Coda only.

However, if we consider the whole word *sitte* the constraint ranking in (26) requires an underlying mora for the intervocalic C which should – given the standard representation for geminates, cf. (23) – be syllabified (also) in the coda of the first syllable. To solve this conundrum we propose that Norwegian geminates are normally, at least on the segmental tier, not associated with the preceding syllable and do not correspond to two C positions, but contribute to the weight of the preceding syllable nevertheless.

We assume that in the training phase subjects learned that they should keep the complete first syllable or bimoraic unit of the original word in the first syllable of the derived form, i.e., *blande* 'to blend' is turned into *blan-hanlefan de-helefe*, rather than **bla-halefa de-helefe*. We can thus expect that they add a constraint RED=σ to their hierarchy if they successfully learn the pattern.[22] The question is where in the hierarchy the constraint is placed. The data they receive in the training phase allow only one conclusion: The constraint that determines the size of the units has to be top-ranked. If RED=σ is top-ranked and never violated, evaluation of the reduplicated form of a word such as *blande* works as shown in the tableau below.

(31)

	/bla$^{\mu}$nde$^{\mu}$ + REDleRED .../	RED=σ	SW	FTBIN	WS	MAX LINK$^{\mu}$	WbyP	*CODA
	a. bla$^{\mu}$n$^{\mu}$.(ˈha$^{\mu}$n$^{\mu}$).le$^{\mu}$.fa$^{\mu}$n$^{\mu}$ ...				!**			***
☞	b. bla$^{\mu}$n.(ˈha$^{\mu}$n$^{\mu}$).le$^{\mu}$.fa$^{\mu}$n ...						**	***
	c. bla$^{\mu}$.(ˈha$^{\mu}$).le$^{\mu}$.fa$^{\mu}$...	*!	*					

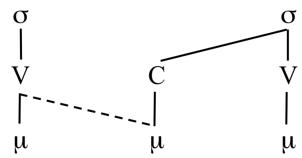
The fact that for the majority of speakers the first syllable in words like *sitte* is apparently *si* means that (for these speakers) the C is not part of the first syllable. However, the ranking explained above (cf. (26) shows that a form like *sitte* must have an underlying intervocalic geminate with a lexically specified mora, otherwise automatic vowel lengthening would apply (cf. (25)). An analysis in which the mora of the geminate contributes to the weight of the preceding syllable even though the consonant associated to this geminate is not part of that syllable can explain this fact.

To represent this we assume that, at least in Norwegian, every mora has to be licensed by a (preceding) vowel. This restriction is supported by the fact that Norwegian doesn't have any word-initial

[22] To be more precise the template for the pattern that is internalized by successful learners is /σ1-[h]<rime1>-le-[f]<rime1>- σ2-[h]<rime2>-le-[f]<rime2>/, or simply /σ-[h]<rime>-le-[f]<rime>/, which has to be repeated with every syllable (e.g., German *Kalenderblatt* 'calender sheet' → *kahalefalenhenlefenderherleferblatthattlefatt.*

geminates. (See Topintzi 2006, 2008, Davis 2011 for cases of initial geminates and their moraic analysis.) In the representation below, C and V are labels of convenience. It is absolutely sufficient that these are root nodes (with the respective contrastive features). No additional skeletal or timing tier is necessary.

(32) *Weight contributed by geminate without ambisyllabicity*



The representation in (32) explains why for the majority of speakers/cases the first syllable in *sitte* is *si*; the constraint RED=σ has to be interpreted as: RED =σ=.si.

(33)

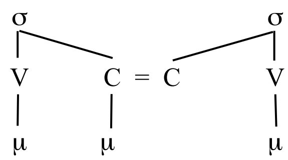
	/si$^{\mu}$t$^{\mu}$e$^{\mu}$ + REDleRED .../	RED= σ=si	SW	FTBIN	WS	WbyP	MAXL$^{\mu}$	*CODA
☞ a.	si$^{\mu}$.(ˈhi$^{\mu\mu}$).le$^{\mu}$.fi$^{\mu}$ ...						*	
b.	si$^{\mu}$t$^{\mu}$.(ˈhi$^{\mu}$t$^{\mu}$).le$^{\mu}$.fi$^{\mu}$t$^{\mu}$ ...	*!			**			***
c.	si$^{\mu\mu}$.(ˈhi$^{\mu\mu}$).le$^{\mu}$.fi$^{\mu\mu}$ ...				*!*		*	
d.	si$^{\mu}$t.(ˈhi$^{\mu}$t$^{\mu}$).le$^{\mu}$.fi$^{\mu}$t ...	*!				**		***

The proposal accounts for the majority word game pattern of words with medial geminates (63.2%). For the other significant group, in which the geminate is realised in both the coda and the onset (*sithitlefit-tehelefe*; 30.9%), the hypothesised representation then looks as given in (34a): The intervocalic C belongs to both syllables and contributes to the weight of the first syllable.

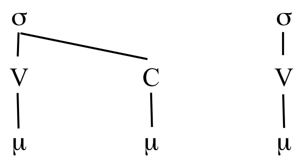
(34b) represents the 5.9% of cases in which the consonant only appears as the coda of the reduplicant of the first syllable and not in the onset of the game forms of the second syllable (*sithitlefit-ehelefe*).

(34) *Weight contributed by geminate - more options*

a.



b.



The pattern assumed to be based on the representation in (34a) corresponds to the German majority pattern, in which the orthographic double consonants are realized in the same way in the word game, as we will discuss in the next section.

As we have seen, this analysis accounts for the majority pattern with an unambiguously open syllable and for forms with a split consonant as well as those with the consonant in coda position only.

Now we briefly consider whether the proposed representation has undesired repercussions for the rest of the Norwegian stress grammar before finishing this section with a discussion of retroflexes, whose synchronic analysis is a matter of debate.

Stress shift from the syllable preceding a geminate under affixation is also still accounted for if the geminate is assumed to contribute to the weight of the preceding syllable but is not associated with this syllable's coda position. Recall that the constraint that decided between the candidate with stress shift and the one with stress faithful to the base was *CODA. If we assume for Norwegian geminates that they are not part of a coda in the syllable preceding the geminate, the constraint *CODA no longer causes degemination in unstressed environments.

However, Rice's lower ranked ALIGN-Right (AR), which wants the stress foot to stand as close to the right edge of the word as possible, does the job. Below we reproduce the tableau for *grammatikalitét* (from the base *grammatíkk*), with the candidate with orthogonal moraic and syllabic association added as (b'), since it has the same stress pattern as failed candidate (b). According to the argument above, (b') has to be the representation in the base form. As we can see, the grammar picks the candidate with stress on the rightmost bimoraic syllable and reduces the weight of any potential unstressed heavy unit.

(35) *Stress shift*

	/gra$^{\mu}$ma$^{\mu}$ti$^{\mu}$k$^{\mu}$-a$^{\mu}$li$^{\mu}$te$^{\mu\mu}$t/	SW	FTBIN	WS	MAXL$^{\mu}$	NF	*CODA	AR
b.	...(ˈti$^{\mu}$k$^{\mu}$).ka$^{\mu}$.li$^{\mu}$.te$^{\mu}$t				*		**!	***
b'.	...(ˈti$^{\mu}$. $^{\mu}$)ka$^{\mu}$.li$^{\mu}$.te$^{\mu}$t				*		*	*!**
☞ k.	...ti$^{\mu}$.ka$^{\mu}$. li$^{\mu}$. (ˈte$^{\mu\mu}$)t				*		*	

Finally, we briefly return to the behaviour of the retroflex sounds. Recall that the percentage of retroflexes realized in the coda of the reduplicants was significantly higher than for the geminates, with 61.3 % closed syllables in the retroflex context against 36.8 % of closed syllables in the context with orthographic geminates. Historically most of these derive from consonant clusters of /r/+ a coronal consonant, which is reflected in the orthography (and also realised this way in Western Norwegian, e.g., *kart* is [kɑʁt] 'map').

Accordingly, even though the retroflexes are geminates at the phonetic level, they are not 'real' or lexical geminates and can thus be assumed to span over two root nodes rather than one (as the double consonants) (see Solhaug 2010 for a synchronic analysis of retroflexes as underlying consonant clusters). Thus, they don't have a lexical mora, but receive one automatically for being affiliated to the rime of a stressed syllable. Their status as consisting of two root nodes, and the assumption that they receive a mora by position only if necessary, explains why they are 'separable' and can therefore be realized in the reduplicants more easily than lexical geminates. Since in the unreduplicated form they are two segments that share segmental features and are, more importantly, associated with two syllables, they have to be realised in the coda of the first part of the word game form and the onset of the second part.

Hence, the prosodic structure of a base with a retroflex corresponds to that of a fake geminate, which, at the segmental tier, is the same as a sequence of two consonants.

However, in the word game, since the number of forms with part of the retroflex realized in a coda is lower than for forms with a separate coda consonant in the base we can conclude that some speakers have stored them lexically as geminates. The more than 20% of forms in which the retroflex is decomposed into its (orthographic and historic) component segments can be interpreted in two ways. This either shows an influence of orthography, which might also be the ultimate explanation for the >30% of word game forms with a coda consonant from a geminate (orthographic double consonant). Alternatively, one might assume that retroflexion is, for some speakers, a process applying to surface representations and they access a more abstract form than the surface representation as the base for the word game.

5.3 Analysis of German intervocalic consonants, based on the word game patterns

5.3.1 Basic analysis

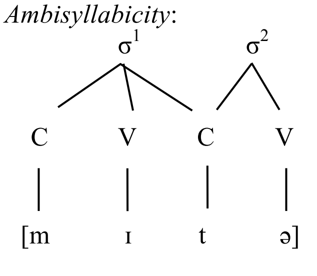
The favoured word game forms of words with a short stressed vowel followed by a consonant in German are more or less the mirror image of the Norwegian realisations. The consonant is realised preferably (77.4%) in the coda of the first part of the game form (*Sitte* - *sithitlefit...*). In altogether 46.8% of forms the consonant is found not only in the coda, but also in the onset of the second part of the game form (*Sitte* - *...tehelefe*). We can report a clear lack of the consonant in coda position only in 16.1% of the recorded forms. This bias towards coda parsing can be explained by the consonants' syllabification in the base form and can be used to support one of the analyses presented earlier (i.e., ambisyllabicity).

However, before we subscribe to an account of German intervocalic consonants as ambisyllabic, another potential explanation has to be considered. German has a very productive truncation process to derive nicknames and short forms for all sorts of nouns, i-formations, in which the proper name or noun is reduced to one syllable, and an [i] is added, resulting for example in *Otti* from the name *Otto* (Werner 1996, Wiese 2001, Alber 2001a, 2007). In i-formations, however, the first potential maximal syllable is used rather than the first actual surface syllable of the base form, as evidenced by forms such as *Gorbi* from *Gorbatschow* (Gorbachev, the former Soviet politician) or *Andi* from *Andreas*. In the base of the former the syllable break is most likely between the liquid and the stop and in the latter example, the syllable break in the base form is most likely to occur between the nasal and the stop rather than after the stop. In the training phase, our subjects were presented with forms of similar structure with a suggested division of the base, based on its surface syllabification. These test words contained only heterosyllabic consonant clusters of maximally two members, such as *Kunde* or *Karten*, but we assume that these stimuli are sufficient to lead the subjects to the conclusion that the word game operates on surface syllabification, predicting *gorhorlefor...* from *Gorbatschow* rather than *gorbhorbleforb...*, as would be expected from the truncation pattern.[23]

A geminate analysis of the word game is not easily applicable to the German data as this language normally has no phonological, tautomorphemic geminate consonants (see discussion and references above); further, in contrast to Norwegian, in German the intervocalic consonants are not realized phonetically as geminates (cf. footnote 4).[24]

With regard to German, a widespread proposal within a framework based on a timing tier is to interpret the intervocalic consonant in this context as ambisyllabic, i.e., as associated with only one C-slot, but to both syllables, as indicated below.

(36) *Ambisyllabicity*:



(German, *Mitte* 'center')[25]

This approach accounts for the asymmetry in the experimental data where German speakers clearly prefer a first closed syllable over an open one.

In moraic theory, the hypothesized status of the German intervocalic consonants as not "real" geminates implies that they are not specified underlyingly with a mora. Being not inherently moraic, it

23 A similar truncation pattern is found in Norwegian, which prioritizes maximization of preservation of consonantal material in the truncated form, as illustrated by the former professional soccer player Odd Helge Iversen's nickname *Ivers*.

24 Unfortunately we are not aware of any phonetic studies on consonant length in North-Norwegian and have to rely on our own impression for now. We perceive a length difference in the medial consonant in pairs such as *hater* 'hate(s)' vs. *hatter* 'hats', in addition to the difference in vowel length. However, it is less pronounced than in, e.g., Tuscan Italian, which undisputedly has a length contrast among consonants.

25 An alternative point of view within an analysis based on prosodic weight would be to assume that the consonant occupies two slots on the timing tier (i.e. to analyse it as a geminate). However, as already mentioned this clashes with the fact that on the surface these hypothetical geminates never contrast with single consonants.

must be by means of other prosodic demands that the intervocalic consonants are forced into the coda, such as Stress-to-Weight or the bimoraic syllable requirement which is established for German stressed syllables. As far as the status of consonants in coda position is concerned we assume that German is like Norwegian in that they receive weight by convention in this position (in satisfaction of the constraint Weight-by-Position), but that this mechanism is suspended if the syllable cannot receive stress. The only potentially relevant difference between the two languages concerns mora licensing and faithfulness. German displays right-aligned trochaic feet and quantity sensitivity[26], as Norwegian does.

A further constraint that is more important in German than Norwegian and which might play a role here is ONSET, the constraint that requires syllables to start in a consonant, as witnessed by the abundance of glottal stops in German (see, e.g., Alber 2001b and references there) and their scarcity in Norwegian.

In German, vowel length might be a by-product of tenseness, or it could be contrastive (in which case tenseness and laxness are determined by vowel length). For convenience, we assume that German has contrastive vowel length.

All these considerations result in the grammar shown below. As can be seen from this tableau, there is a problem we are still facing: Why doesn't German show long consonants?

(37) *Syllable structure in bisyllabic words (German: Sitte 'custom') - 1st attempt*

/zɪ$^{\mu}$tə/	ONSET	SW	FOOTBIN	WS	FAITH V$^{\mu}$	*C$^{\mu}$	*CODA
☞ a. [ˈzɪ$^{\mu}$t̩$^{\mu}$ə]						*	*
b. [ˈzɪ$^{\mu}$.tə]		*!	*				
c. [ˈzɪ$^{\mu}$t$^{\mu}$.ə]	*!					*	*
d. [ˈzi$^{\mu\mu}$.tə]					*!		
☞ e. [ˈzɪ$^{\mu}$t$^{\mu}$.tə]						*	*

This problem cannot be solved by simply reranking the constraints we have so far, since forms (a) and (e) tie on the present constraints. German actively bans identical adjacent consonants as can be seen in the rendition of compounds, such as *Brottüte* 'bread bag' (from *Brot* 'bread' and *Tüte* 'bag') or *Schrottteil* 'scrap part' (from *Schrott* 'scrap metal' and *Teil* 'part') which in casual speech are realized with a singleton *t* at the juncture rather than a long stop or two coronal closures interrupted by a release. The latter is produced in careful speech. This constraint, let us label it *C=̣C for convenience, must be top ranked in German and doesn't play any role in Norwegian.

(38) *Syllable structure in bisyllabic words (German: Sitte 'custom') - 2nd attempt*

/zɪ$^{\mu}$tə/	*C=̣C	ONSET	SW	FOOTBIN	WS	FAITH V$^{\mu}$	*C$^{\mu}$	*CODA
☞ a. [ˈzɪ$^{\mu}$t̩$^{\mu}$ə]							*	*
b. [ˈzɪ$^{\mu}$.tə]			*!	*				
c. [ˈzɪ$^{\mu}$t$^{\mu}$.ə]		*!					*	*
d. [ˈzi$^{\mu\mu}$.tə]						*!		
e. [ˈzɪ$^{\mu}$t$^{\mu}$.tə]	*!						*	*

Tableau (39) shows an item with an underlyingly long vowel where the intervocalic consonant is not needed in order to fulfil the bimoraicity requirement on stressed syllables.

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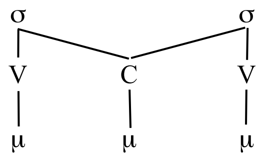
26 Wiese (2000), Eisenberg (1999) and Kaltenbacher (1994), however, assume quantity insensivity for German.

(39) *Syllable structure in bisyllabic words with long V (German: Liebe 'love')*

	/li^{μμ}bə/	*C̩=C	ONSET	SW	FOOTBIN	WS	FAITH V^{μ}	*C^{μ}	*CODA
a.	[ˈli^{μ}b̩^{μ}ə]						*!	*	
b.	[ˈli^{μ}.bə]			*!	*		*		
c.	[ˈli^{μ}b^{μ}.ə]		*!				*	*	*
☞ d.	[ˈli^{μμ}.bə]								
e.	[ˈli^{μ}b^{μ}.bə]	*!			*			*	*

Since we now have provided a constraint-based analysis of ambisyllabicity that crucially relies on moraic structure, it is instructive to present the orthogonal representation of syllable and moraic structure behind this analysis.

(40) *German ambisyllabic moraic consonants*



With these grammars and representations in place that generate ambisyllabicity in German and onsetless or heterosyllabic intervocalic consonants in Norwegian we are ready to look at our word game results once more.

5.3.2. German word game evaluations

The experimental data show that in the word game the participants often affiliate the intervocalic consonant preceded by a short vowel to both syllables (46.8%). We argue that this does not necessarily mean that the consonants are interpreted by the speakers as geminates, but we propose instead that the repetition of the intervocalic consonant by many German speakers is an effect of its affiliation with two syllables in the base form. As for Norwegian, we assume that the training phase causes successful learners to add a constraint RED=σ to their grammar that maps each syllable of the stimulus word to the template //σ-[h]-rime-[lef]-rime//. The 4.8% of cases with the intermediate consonant in the coda of the first syllable only can be neglected as statistic white noise, as well as the 16.1% with the consonant realised only in the onset of the second syllable. In 25.8% the second part was unclear since the subjects applied strategies of copying that deviated from the target pattern. If we exclude this group the percentage of realisations with the medial consonant in both syllables rises with respect to the total, further corroborating the above analysis. If we, instead, add these forms to those with clear ambisyllabicity, assuming that the presence of the base segment in the coda in the game form is evidence enough to support its ambisyllabic status in the base, we arrive at 77.4% of forms in this word group.

The assumption of ambisyllabicity is also supported by the words with a medial consonant consisting of a combination of letters in German orthography, cf., e.g., *Küche, Klatsche, Mütze, Finger*. In this group some effect of orthography was expected. Accordingly we find only 50% of forms with the segment represented by the letter combination realized in the coda in the word game forms.

6. Conclusions

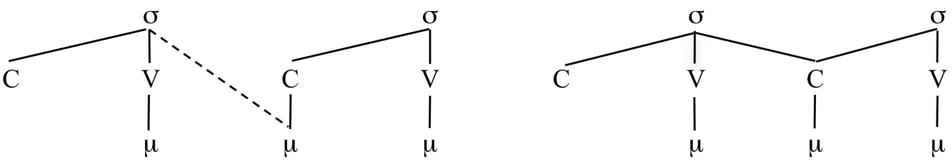
The experimental data suggests that although being similar in superficial structure, German and Norwegian exhibit several differences regarding their syllable structure and phonological features, which we clarified in the analysis. To sum up, the data is compatible with the following assumptions. In

Norwegian, consonantal quantity is underlyingly specified. The surface occurrence of the moraic consonant is, however, bound to stressed syllables, whereas in unstressed syllables the mora does not surface. In the special context of a word game it turned out that a representation that combines moraic structure and syllable structure within one hierarchic organization is not well equipped to handle the Norwegian data when considered in tandem with the core patterns of stress and syllabification of the language. An orthogonal organisation of moraic affiliation and syllabic affiliation accounts for the patterns. The geminate preceded by a stressed syllable can thus contribute weight to this syllable by licensing its mora through this syllable's vowel, while the consonant is parsed in the following syllable.

This enriched representational system leaves the representation usually assumed for geminates for the German intervocalic consonants, which were shown to have a much tighter relation to the preceding syllable than their Norwegian counterparts. Recall that the majority of researchers do not assume German to have contrastive length of consonants. The language also doesn't display any phonetically long consonants. For convenient comparison, the representations for Norwegian geminates and for German ambisyllabic consonants are repeated below.

(41) *Geminates, weight and ambisyllabicity*

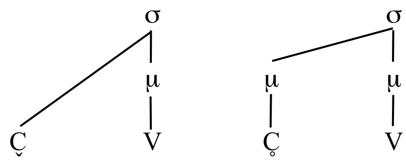
a. Norwegian b. German



We are aware that the results reported here have to be taken with caution since the study is rather small-scale and should be regarded as a test or pilot study, which is also the reason we refrained from more sophisticated statistical analysis. Further research should be carried out to produce more evidence in support of the proposed analysis, especially that of Norwegian.

The assumption of moraic onsets, though, is not new at all. It has been forwarded by Topintzi (2006, 2008). In Topintzi's parade example, Pirahã, the mora in an onset contributes weight to the syllable if this onset is filled with a voiceless stop. She proposes the structure in (41).

(41) *Onset weight in Pirahã (Topintzi 2004)*



The analysis of this language doesn't require a separation of syllable structure and moraic structure on different planes though, which has to be considered the theoretical novelty of our proposal. The theoretical consequences and potential typological predictions of this move definitely need further exploration.

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APPENDIX:

I Items used during the training:

	Monosyllabic words	Bisyllabic words
German	Tisch, Buch, Kraft, Dorn, Stuhl, Geld, Schnee	Kunde, Flügel, Leute, Karten, Name, Lampe, Frauen, Sprache, Leiter, Konto, Martin
Norwegian	bok, nett	kunde, vinter, klima, lampe, pause

II Items used during the testing:

Items with short, stressed vowel followed by a single consonant

	German	*Items:*	*Number of tokens*
I	Orthographic geminates (*tt, ss, ll, nn*)	*Sonne, Brunnen, Kralle, Hölle, Klasse, Hessen, Puzzle, Sitte*	8
II	Phonemes represented by a combination of graphs which cannot be doubled ([ç] [x] [ŋ] → <ch>, <ng>)	*Küche, Woche, Finger*	3
III	Other items without 1:1 grapheme-phoneme correlation ([tʃ] [ks] [ts] → <tsch> <x> <tz>)	*Klatsche, Hexe, Mütze*	3
	Total		14

	Norwegian	*Items:*	*Number of tokens*
I	Orthographic geminates (*tt, ss, ll, nn*)	sitte, votter, klasser, passe, klasse, banner, kjenne, tulle, spille,	9
II	Phonemes represented by a grapheme <v> or combination of graphs which cannot be doubled ([ç] [ʃ] → <kkj> <sj>)	støvel, høvel, brosje, nisje, bikkje	5
III	Items without 1:1 grapheme–phoneme correlation ([ʃ], [ʈ] → <rs>, <rt>)	vorte, hjerte, hørsel, karse	4
	Total		18

Items with long vowel, diphthong or a combination of consonants

	Norwegian	*Items:*	*Number of items*
I	Long vowel	Dame, skole, sofa, stige, løpe, leve	6
II	Diphthong	Skøyte, brøyte, gaupe, reise, feire, løype	6
III	Combination of consonants	Pulver, skerpe, vinter, salve, pussle,	5
	Total		17

	German	*Items:*	*Number of items*
I	Long vowel	Liebe, Leben, Sprache, Schule, Sofa, Hase	6
II	Diphthong	Heißen, Bauer, Augen, Freude, Leiter, Leute	6
III	Combination of consonants	Silbe, albern, Kälte, Kasten	4
	Total		16