Intervocalic velar nasals in Galician: 
Phonetic evidence for multiple syllabic affiliation*

Sonia Colina and Manuel Díaz-Campos

The syllabic affiliation of intervocalic velar nasals in Galician, e.g. unha [ũ̃a] 'a, one (fem.)' has been a controversial topic amongst scholars for at least three decades. All solutions proposed to date (onset or coda affiliation) are costly from a phonological point of view as they run counter to well-attested principles of phonological theory, such as Structure Preservation (Kaisse and Shaw 1985; Kiparksy 1985; Mohanan 1986) and syllabic markedness generalizations (*VC.V). Recently, however, Colina (2004) has proposed an analysis that does not encounter the difficulties of previous accounts. Colina (2004) argues for an underlying velar nasal realized as a surface geminate that results from the assimilation of an epenthetic onset to the point of articulation of the preceding nasal. It was hypothesized that the phonetic level could provide additional support for the gemination proposal if there were duration differences between the surface geminate (underlying velar) and other context similar nasals syllabified in either onset or coda position. Hence the fundamental goal of this paper is to examine intervocalic nasals in forms such as unha, cunha, algunha from a phonetic point of view and determine whether there are differences between these forms and other intervocalic nasals. Ten native speakers of Galician were asked to read carrier phrases containing the target nasals in three different contexts: 1) hypothesized geminate (e.g. unha ‘a’), 2) onset position (e.g. c’un amigolo ‘with a friend’), and 3) coda position c’un curandeiro ‘with a folk healer’ (coda). Phonetic analysis of the recordings reveals that there is a phonetic distinction in terms of length between multiply-linked velar nasals (surface geminates) and other intervocalic velar nasals, thus lending further support to the gemination proposal. The findings have implications for research on the phonology and phonetics of geminates.
0. Introduction

The syllabic affiliation of intervocalic velar nasals in Galician, e.g. *unha* [ũña] ‘a, one (fem.)’ has been a controversial topic amongst scholars for at least three decades. All solutions proposed to date (onset or coda affiliation) are costly from a phonological point of view as they run counter to well-attested principles of phonological theory, such as Structure Preservation (Kaisse and Shaw 1985; Kiparsky 1985; Mohanan 1986) and syllabic markedness generalizations (*VCV*). Recently, however, Colina (2004) has proposed an analysis that does not encounter the difficulties of previous accounts. Using phonological arguments and historical and cross-linguistic facts as part of an optimality-theoretic account, Colina (2004) argues for an underlying velar nasal realized as a surface geminate. The surface geminate is the result of the assimilation of an epenthetic onset to the point of articulation of the preceding nasal. It was hypothesized that the phonetic level could provide additional support for the gemination proposal if there were duration differences between the surface geminate (underlying velar) and other context similar nasals syllabified in either onset or coda position. Hence the fundamental goal of this paper is to examine intervocalic nasals in forms such as *unha, cunha, algunha* from a phonetic point of view and determine whether there are differences between these forms and other intervocalic nasals as in the word *alemana*. The article is organized as follows: the first section contains a brief description of the phonological facts, a review of previous analyses, and a summary of the gemination proposal in Colina (2004). The second part of the paper focuses on the phonetic study: it includes a review of the literature, the methodology, results and conclusions in sections 2, 3, 4 and 5 respectively.

1. Intervocalic velar nasals in Galician: phonological analyses

1.1 Data

In Galician, a three-way phonemic distinction in nasals (bilabial, alveolar and palatal) (as in 1) is neutralized in the rhyme (2). Rhyme nasals surface with a velar point of articulation (the phenomenon is similar to that described in some varieties of Spanish, e.g. Cuban, Lipski 1994).¹

The simplest examples of velarization can be seen in word-final position before pause (2).

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(1) Martínez-Gil (1993) (Moaña dialectal)  
mora [mó:ra] ‘blackberry’  
nora [nó:ra] ‘daughter-in-law’  
ñopta [nó:p:t] ‘short-sighted’  
cama [ká:ma] ‘bed’  
cana [ká:na] ‘cane’  
caña [ká:na] ‘type of bread’

(2) lan [lañ] ‘wool’  
son [soñ] ‘sound’  
ben [beñ] ‘well’  
xovén [xoñ] ‘young’  
irmán [irman] ‘brother’

Rhyme nasals surface as velars prevocalically, postvocally, and across words. The same happens with

(3) inhumano /iñ + uman + o/ [i.nu.mano]  
benestar /beñ estár/ [be:stár]  
tren alemán /tren alemán/ [tre:n alé:man]  
alemán /aleman/ [alé:man]

Thus, in lexical-phonological terms, nasal velarization is a cyclical rule that applies before prefixation as well as postlexically. Otherwise nasals are not pronounced as word markers:

(4) a. cana /ká + na/ [ká:na]  
cano /ká + no/ [ká:ño]  
pano /pañ + o/ [pañ:o]

b. lambón /lamb + on/ [lambón]  
lambona /lamb + on + a/ [lamba:na]  
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alemana /aleman + a/ [alemana]
Intervocalic velar nasals in Galician

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cama [ká.ɾa] ‘bed’
cana [ká.ɾa] ‘cane’
caña [ká.ɾa] ‘type of brandy’

(2) lan [laŋ] ‘wool’ *lan, lan, lan
son [sɔŋ] ‘sound’ *son, son, son
ben [bɛŋ] ‘well’
xoven [ʃɔʧɛŋ] ‘young’
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Rhyme nasals surface as velars prevocically across prefixes and compounds and across words. The same happens before word-final epenthesis.2

(3) inhumano /in + uman + o/ [i.ɲu.má.nu] ‘inhumane’ *[i.ɲu.má.nu]
benestar /ben estár/ [bɛŋis.tar] ‘well-being’ *[bɛnis.tar]
tren alemán /tren aleman/ [tɾe.na.ɲi.máŋ] ‘German train’ *[tɾe.na.ɲi.máŋ]
alemán /aleman/ [a.ɲi.máŋ] ‘German (masc.)’ *[a.ɲi.máŋ]

Thus, in lexical-phonological terms, nasal velarization (NV) is a lexical, cyclical rule that applies before prefixation and compounding (Level 1) as well as postlexically. Otherwise nasals are not velarized before suffixes, such as word markers:

(4) a. cana /ká.ɾa/ [ká.ɾa] ~ *[káɾa] ‘cane’
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phonological analyses

Discussion in nasals (bilabial, alveolar and rhyme (2). Rhyme nasals surface in menon is similar to that described (lipkis 1994).1 Can be seen in word-final position

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alemana /aleman.a/ [a.ˈlɛm.ˈaŋa] ‘German (fem.)’
An important group of words, however, appear to undergo velarization before suffixation. These consist of the feminine forms of the indefinite article and its derivatives, as seen in (5–6).³

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<td>un</td>
<td>/un/</td>
<td>[uŋ]</td>
<td>‘a, one (masc.)’</td>
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<tr>
<td>algún</td>
<td>/alx + un/</td>
<td>[al.xʊŋ]</td>
<td>‘some, any (masc.)’</td>
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<tr>
<td>nengún</td>
<td>/neng + un/</td>
<td>[nɪŋ.gʊŋ]</td>
<td>‘none (masc.)’</td>
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<td>dun</td>
<td>/de un/</td>
<td>[duŋ]</td>
<td>‘of a (masc.)’</td>
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<td>cun</td>
<td>/kon un/</td>
<td>[kuŋ]</td>
<td>‘with a (masc.)’</td>
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<tr>
<td>nun</td>
<td>/en un/</td>
<td>[nuŋ]</td>
<td>‘in a (masc.)’</td>
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<tr>
<td>unha</td>
<td>/un + a/</td>
<td>[ʊŋa]⁴</td>
<td>‘a, one (fem.)’</td>
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<td>algunha</td>
<td>/alx + un + a/</td>
<td>[al.xʊŋa ]</td>
<td>‘a, one (fem.)’</td>
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<td>/neng + un + a/</td>
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<td>dunha</td>
<td>/de un + a/</td>
<td>[dʊŋa]</td>
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<tr>
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<td>/kon un + a/</td>
<td>[kuŋa]</td>
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### 1.2. Previous accounts

While most scholars seem to agree that any valid account of the forms in (6) must be refer to some type of exceptionality (but see Castro 1989 below), there is in general no agreement in the literature as to what the syllabic affiliation of the velar nasal in these examples might be. Two positions have been adopted in the past to explain the syllabification facts: [ŋ] is in the onset and [ŋ] is in the coda. The issue bears on apparent violations of exceptions to well-attested generalizations and/or universals of phonological theory. Those who argue that the velar nasal is in the coda still need to explain the resulting onsetless syllable and the extremely marked syllabification pattern in which an intervocalic consonant is syllabified as the coda of the first syllable, (e.g. [ʊŋ.a]). Thus, while the coda analysis captures the generalization that in Galician rhyme nasals are velars, it must also contend with an extremely rare, mostly unattested pattern of syllabification. The onset proposal does not incur syllable markedness costs; however, the difficulties encountered are not any less serious. Since Galician does not have underlying velar nasals and NV is a lexical rule (cf. Martínez-Gil 1993), the presence of a non-underlying segment in the lexical domain constitutes a violation of Structure-Preservation (Kaisse and Shaw 1985; Kiparksy 1985; Mohanan 1986). In other words, under the onset analysis, the Galician velarization pattern contradicts a well-known generalization with a lexical application do not normal part of the phonemic inventory of the language – thus, argues that velar nasals are phonemic in Galician and contrast [ʊŋ.a] ‘a, some (fem.)’ subjunct.

There is extensive descriptive work and literature. In most cases, however, descriptive, presenting no arguments for the position (e.g. Dapena 1976, Carballo Calero 1979 – coda – onset; see also Dubet 1998 for a comprehensive descriptive literature). Despite the lack of evidence, these studies are of value for they speak to the study of native speakers of the language. An informal survey of native speaker’s accounts by the authors confirms this view.

Within a Lexical Phonology framework like the one proposed by Castro (1989) explains that the diachronically the result of morphological adjunction to a form. She claims that in [una] the thematic vocalic stratum (level 1), leaving the nasalization applies; in [ʊŋa], however, the gen- erically, after nasal velarization. In addition, marker adjunction postlexically (in morpho-syntactic), Castro’s proposal cannot solve [lambón, lambona] in (4b), which should not be that forms with an alveolar nasal before a nasal empty V in the masculine (e.g. lambón’V). Castro’s solution is ad hoc, since there is an empty V in lambón and not in un. Further numerous forms – those with alveolar nasal are exceptional, whereas un/unha and its derived

Lipski (1976) reviews various phonetic factors that may play a role in account in Galician. Although he doesn’t take a
words, under the onset analysis, the Galician data presented above appear to contradict a well-known generalization of phonological theory—that rules with a lexical application do not normally introduce segments that are not part of the phonemic inventory of the language. A third possibility, adopted in part in Colina (2004), is to allow velar nasals to be part of the phonemic inventory of the language—thus, arguing, on the basis of these examples, that velar nasals are phonemic in Galician, despite the existence of only one known contrast [uŋ.a] ‘a, some (fem.)’ ~ [uŋa] ‘join, (3rd person, sg. pres. subjunct.)’

There is extensive descriptive work by Galician scholars on the onset/coda debate. In most cases, however, this type of work is purely descriptive, presenting no arguments for the particular position adopted (e.g., Porto Dapena 1976, Carballo Calero 1979—coda; Veiga 1976, Alvarez et al. 1986—onset; see also Dubert 1998 for a comprehensive list of references on the descriptive literature). Despite the lack of specific phonological argumentation, these studies are of value for they suggest the inability of native speakers (most of this literature is written by Galician scholars who are also native speakers of the language) to decide on the syllabic affiliation of velar nasals. An informal survey of native speaker’s syllabification intuitions carried out by the authors confirms this view.

Within a Lexical Phonology framework, and also arguing for onset affiliation, Castro (1989) explains that the difference between [una] and [uŋa] is the result of morphological adjunction taking place in different lexical strata. She claims that in [una] the thematic vowel attaches to the verb root in the lexical stratum (level 1), leaving the nasal in onset position before velarization applies; in [uŋa], however, the gender marker -a is attached postlexically, after nasal velarization. In addition to the difficulty of motivating wordmarker adjunction postlexically (in most languages it seems to be a lexical process), Castro’s proposal cannot satisfactorily account for forms like lambón, lambona in (4b), which should also have a velar nasal. She argues that forms with an alveolar nasal before the feminine word-marker, have an empty V in the masculine (e.g. lambón N’). As Dubert (1998) also points out, Castro’s solution is ad hoc, since there is no evidence to support the presence of V in lambón (and not in un). Furthermore, under this account, the more numerous forms—those with alveolar nasals before the suffix—are treated as exceptional, whereas un/unha and its derivatives are unexceptional.

Lipski (1976) reviews various phonological, historical, and cross-linguistic factors that may play a role in accounting for intervocalic velar nasals in Galician. Although he doesn’t take a stance on the onset/coda debate, he
makes an important contribution by pointing out that the solution to the problem lies in ‘the interaction of several factors’ (1976: 191).

Dubert (1998) presents a somewhat different proposal. In support of the onset analysis, he argues for an underlying velar nasal for the relevant forms (/un/ /u.na/) which is then resyllabified after suffixation. This analysis faces several difficulties, among which is the loss of an important generalization – rhyme nasals are velar in Galician. Dubert’s proposal does capture the need to somehow mark these forms as exceptional.

1.3. Colina (2004): Underlying velar nasals, output geminates

Colina argues that the forms in (6) differ from those in (4b) in that the relevant nasals in (6) are underlyingly velar. Her analysis involves a velar nasal with a multiply-linked supralaryngeal node, more specifically, a surface geminate. Geminates are the result of the assimilation of an epenthetic onset to the point of articulation of the preceding nasal.

Colina (2004) does not suffer from any of the drawbacks of previous accounts. The highly marked VC.V syllabification pattern and the onsetless syllable of the coda analysis are avoided because the second half of the geminate serves as an onset for the second syllable, [un.ña]. At the same time, the output geminate serves to preserve the generalization that coda nasals are velar. In addition, in an analysis in which velar nasals are phonemic, there is no violation of Structure Preservation, given that velar nasals are part of the phonological inventory of the language. The velar + gemination account also captures native-speaker intuitions with regard to exceptionality of the forms in (6) (expressed through the underlying point of articulation). Exceptionality, however, is not random – it appears in forms that lost an intervocalic nasal at some point in their development from Latin. Finally, Colina’s analysis accounts for ambiguous syllabification and native speakers’ difficulty in assigning velar nasals to either coda or onset, while shedding light on related developments in other Romance languages. In what follows we summarize the main points of the formalization of the analysis to help the reader understand the motivation for the phonetic study that constitutes the basis of this paper. The reader is referred to Colina (2004) for a detailed optimality-theoretic analysis of the relevant historical and cross-linguistic data.

Colina’s analysis draws on some well-known historical facts. The forms exhibiting ambiguous syllabification happen to be those that resulted from the loss of Latin intervocalic nasals among Galician and Portuguese dialects and other Romance-speaking areas (Meyers 2009). The loss of intervocalic nasals initially resulted in voicing of the preceding vowel; the nasal later reappeared in Galician and Gascon, Latin’s intervocalic nasal becoming [una], whereas in Gascon they remained intact.

<table>
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<th>Latin</th>
<th>Galician, Port., Gas.</th>
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<td>unam</td>
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(7)

Colina (2004) argues that the deletion of intervocalics left behind an empty consonantal slot, with the preceding vowel. In later diachronic stages, Galician and Portuguese (in the point of articulation of the intervocalic nasal) have been shown to allow empty slots. This allowed the re-emergence of the nasal. From the back quality of [u] produced a velar, [+round] in Portuguese, [+round] produced a bilabial in Latin. In terms, Colina (2004) proposes that the deletion of intervocalics which gives rise to the empty slot with no point of articulation and the high, back vowel. Later in the history of Romance languages, a constraint against empty slots (*X) forces intervocalic nasals to be lost in Galician and Portuguese (not in Gascon where they are preserved). In Portuguese, which does not have any occurrence of intervocalic nasals, a high-ranking markedness constraint explains the preference for the labial rather than the dental nasal of [u] in [ûa]. In Galician, [ûa], which with /um/ and an onset velar, is not selected because it violates a constraint facts in the language. Rhyme nasals are therefore not selected in word-final position; therefore /un/, the nasal is selected.
and other Romance-speaking areas (Meyer-Lübke 1921). In Galician loss of intervocalic nasals initially resulted in vowel hiatus, with nasalization of the preceding vowel; the nasal later reappeared as a velar ([uma]). In Portuguese and Gascon, Latin’s intervocalic nasals were also lost, leaving behind a nasalized vowel (Williams 1962, Rohlfs 1970); standard Portuguese forms became [una], whereas in Gascon they remained as [ya].

Colina (2004) argues that that the deletion of intervocalic nasals in Latin left behind an empty consonantal slot, with nasality preserved on the preceding vowel. In later diachronic stages, Galician and Portuguese recovered the point of articulation of the intervocalic nasal, while Gascon (Aranese Gascon), which has been shown to allow empty slots (cf. Hualde 1992), did not. This caused the reappearance of the nasal in the first two languages: the back quality of [u] produced a velar, [+back, +hi], in Galician, whereas in Portuguese, [+round] produced a bilabial nasal.\(^3\) In optimality-theoretic terms, Colina (2004) proposes that the deletion of intervocalic nasals reflects a conflict between markedness and faithfulness constraints. LAZY, which requires minimization of effort and agreement in aperture, favoring VV over VCV, dominates the constraints that require preservation of the point of articulation (MAX-IO(Place)). Preservation of nasality on the previous vowel responds to IDENT-IO (Nasal) and its domination over the constraint against non-preservation of linear order (Linearity-IO). In sum, rather than deleting the entire nasal (high ranking of MAX-IO), LAZY is satisfied by preserving a empty slot with no point of articulation and by nasality being transferred to the high, back vowel. Later in the history of the language the high ranking of a constraint against empty slots (*X) forces the reintroduction of a nasal in Galician and Portuguese (not in Gascon where *X would have a lower ranking). In Portuguese, which does not have any coda nasals and does not allow onset velar nasals, a high-ranking markedness constraint on velar nasals [*ŋ] explains the preference for the labial rather than the dorsal (+back) feature of [u] in [uma]. In Galician, [uma], which would avoid an onsetless syllable and an onset velar, is not selected because of velarization and syllabification facts in the language. Rhyme nasals are velarized in Galician, especially in word-final position; therefore /um/, the masculine singular form of the

\(\text{(7)} \quad \begin{array}{cccc}
\text{Latin} & \text{Galician, Port., Gas.} & \text{Galician} & \text{Port.} & \text{Gas.} \\
\text{(intermediate stage)} & \text{(final stage)} & \\
\text{unam} & \text{uña} & \text{uña} & \text{uma} & \text{ya}
\end{array} \)
indefinite article, is realized as [un]. Thus the existence of an independent form [un] is partly responsible for the velar nasal in the output [un.ŋa] (high-ranked Base-Identity). The other half of the explanation has to do with syllabification. In Galician [ŋ] is not permitted in the onset, although it is well-formed as a coda (*onset [ŋ] >> *ŋ). A form like [un.ŋa], however, would violate the highly-ranked ONSET constraint. The conflict is resolved by means of the ranking *onset [ŋ], ONSET >> DEP-IO(C), *ŋ which results in consonant epenthesis. The epenthetic consonant takes its features from the velar nasal and thus the resulting double-linked SL node satisfies the constraint against velar nasals in the onset *Align-Left (ŋ, c) (abbreviated as *onset [ŋ]). *onset [ŋ] is defined, in accordance with the crisp version of alignment (McCarthy and Prince 1993: 10), as a constraint against a velar nasal being aligned with the syllable onset. Since doubly-linked [ŋ] is not ‘crisply’ aligned with the onset, it does not violate *onset [ŋ]. Lack of alternation eventually leads to phonemicization of the velar point of articulation. Phonetic implementation of the doubly-linked [ŋ] produces a surface geminate.

Colina’s account offers an explanation for contrasts like [un.ŋa] vs. [ali. mà.na]. Since [ali.mà.na] does not result from the deletion of intervocalic nasals, the constraint against placeless slot is vacuously satisfied; as a result, there is no underlying velar specification to preserve and only valorization constraints are relevant (see Colina 2004 for the relevant tableaux and optimal candidate selection [ali.mà.na] vs. *[ali.màŋ.ŋa]).

2. A phonetic study of intervocalic velar nasals in Galician

2.1. Background: The role of duration in the description of geminate consonants

The goal of this section is to present some of the previous research that could be considered relevant in the study of the acoustic parameters related to syllabic affiliation. More specifically, we review studies analyzing consonant length since the present investigation is concerned with the duration of Galician nasals as potential evidence in support of the gemination proposal. Note that an exhaustive analysis of all the relevant work is not the objective pursued here.

To our knowledge, there are no phonetic studies examining the issue of gemination or double syllabic affiliation in Galician. There are relevant investigations for other languages, such as those of Lahiri and Hankamer (1988), Esposito and Di Benedetto (1999), and Hazal (1988) study the phonetic difference between consonants in order to observe whether the geminates can be supported in phonetic terms. The phonological distinction between tautomorphemes is reflected phonetically. The investigation is by Bengali and Turkish. Lahiri and Hankamer participants and three native speakers of Bengali in both Turkish and Bengali the duration of one acoustic phonetic factor distinguishing between consonants. Other acoustic measures such as vowel duration were not found significant of and Hankamer conclude that the phonetic are different representation of geminates in term.

Esposito and Di Benedetto (1999) study distinction between geminate and non-geminate sequences of vowel-consonant-vowel (non-consonant-consonant-vowel (geminate cases) in pappa ‘baby food’, fato ‘fate, and fatto ‘fate’ Italian produced 324 utterances containing in the study. They also included a perceptual acoustic phonetic cues examined in the non-native speakers of Italian participated. Speci- detto aim to define a closure length that functioning a geminate consonant. They manipulate vowel as well as the length of the occlusion. The findings of the production experiment are the consonant and the length of the preceding gemination. Consistently, the results for cate that when the preceding vowel is short the geminant required perceiving gemination is also short. point out that in this case closure duration of the vowel also increases the threshold of the close.

Ham (2001) also reports similar results re- consonants in Bernese (a dialect of Swiss Gar- gian, and Madurese (an Austronesian language languages, closure duration was the acousti- geminate and non-geminate consonants. The
the existence of an independent nasal in the output [unija] (high-
the explanation has to do with syll.
defined in the onset, although it is well-
structure [unja], however, would violate 
conflict is resolved by means of 
*$\bar{n}$ which results in consonant 
its features from the velar nasal 
nde satisfies the constraint against 
(abbreviated as $^{*}_{\text{onset}}[\bar{n}]$). $^{*}_{\text{onset}}[\bar{n}]$ is 
ion of alignment (McCarthy and 
velar nasal being aligned with the 
te ‘crisply’ aligned with the onset, 
ion eventually leads to phonemi-
Phonetic implementation of the 
ate.
for contrasts like [unja] vs. [alija]. 
from the deletion of intervocalic 
ishes vacuously satisfied; as a result, 

to preserve and only velarization 
for the relevant tableaux and opti-
.i.unija]).

Intervocalic velar nasals in Galician

The description of geminate

The previous research that could 
acoustic parameters related to syl-
review studies analyzing consonant 
concerned with the duration of Galici-
of the gemination proposal. Note 
tant work is not the objective pur-
amic studies examining the issue 
Galician. There are relevant inves-
Eposito and Di Benedetto (1999), and Ham (2001). Lahiri and Hankamer 
(1988) study the phonetic difference between geminate and non-geminate 
consolants in order to observe whether the phonological description of gemi-
can be supported in phonetic terms. They also analyze whether the 
ological distinction between tautomorphic, concatenated, and derived is 
lected phonetically. The investigation is based on two different languages: 
Bengali and Turkish. Lahiri and Hankamer recorded three native Turkish 
participants and three native speakers of Bengali. The results indicate that 
both Turkish and Bengali the duration of the consonant closure is the key 
acoustic phonetic factor distinguishing between geminate and non-geminate 
consolants. Other acoustic measures such as Voice Onset Time (VOT), and 
vowel duration were not found significant overall for both languages. Lahiri 
and Hankamer conclude that the phonetic analysis support the phonolog-
different representation of geminates in terms of timing.

Eposito and Di Benedetto (1999) study the acoustic and perceptual dis-
tinction between geminate and non-geminate stops in Italian. They analyze 
sequences of vowel-consonant-vowel (non-geminate cases) and vowel-con-
sonant-vowel (geminate cases) in words such as papa ‘pope’ and 
pappa ‘baby food’, fato ‘fate’, and fatto ‘fact’, etc. Six native speakers of 
Italian produced 324 utterances containing one of the target stops included 
in the study. They also included a perceptual study to verify the effect of the 
acoustic phonetic cues examined in the production experiment in which 20 
native speakers of Italian participated. Specifically, Eposito and Di Bene-
detto aim to define a closure length that functions as a threshold for perceiv-
ing a geminate consonant. They manipulated the duration of the preceding 
vowel as well as the length of the occlusion portion of the stop consonant. 
The findings of the production experiment reveal that the closure length of 
the consonant and the length of the preceding vowel are acoustic correlates 
of gemination. Consistently, the results for the perceptual experiment indi-
cate that when the preceding vowel is short the closure duration of the con-
sonant required perceiving gemination is also short. Eposito and Di Benedetto 
point out that in this case closure duration of 165ms is the threshold for per-
ceiving gemination. Nonetheless, an increase in the duration of the preceding 
vowel also increases the threshold of the closure consonant to 183ms.

Ham (2001) also reports similar results regarding the length of geminate 
consolants in Bernese (a dialect of Swiss German), Levantine Arabic, Hun-
garian, and Madurese (an Austronesian language of Indonesia). In all four 
languages, closure duration was the acoustical cue to distinguish between 
geminate and non-geminate consolants. The effect of the preceding vowel
was less consistent among languages. However, the general pattern observed indicates that vowels preceding voiced stops tend to be longer than those preceding voiceless stops. In sum, empirical studies agree with the generalization that geminates “have between one and a half to three times the acoustic closure duration of the short stops in careful speech” (Ladefoged and Maddieson 1997: 92). Cross-linguistic evidence shows that geminate stops have a longer closure period than their single counterpart. Given that length could be playing a role in the distinction of the analysis proposed above for Galician, the present investigation addresses the following question: Are there phonetic differences in term of duration among nasals that could correspond to the differences in syllabic structure proposed for cases such as *alguna* ‘some’ (geminate), *c’um amigilo* ‘with a friend’ (onset), *c’un curandeiro* ‘with a folk healer’ (coda)? Differences in duration are considered a parameter worth investigating as longer duration values for the hypothetical geminate velars would constitute a strong indicator of difference in syllabification when compared to velar nasals (otherwise identical) exclusively in coda or onset position.

2.3. Methodology

Ten native speakers of Galician were recorded for this study. They were all speakers of the dialect spoken in the western half of the province of La Coruña (Northwestern Spain). Participants read a total of 36 carrier phrases containing the target nasals in three different contexts: 1) geminate (e.g. *unha* ‘a’, *alguna* ‘some’, etc.), 2) onset position (e.g. *c’um amigilo* ‘with a friend’), and 3) coda position (e.g. *c’un curandeiro* ‘with a folk healer’). 36 distractors were also included. The phrases were read three times by each speaker, producing a total of 216 tokens.

The material recorded was digitized in order to obtain measurements of duration of the target nasals. Pquerir acoustical analysis software package was used for this purpose. Statistical analysis was applied to the data obtained from the ten speakers using Analyses of Variance (ANOVA).

2.4. Results and discussion

This section presents the findings of the acoustical analysis examining three different contexts in which Galician nasals may appear according to syllabic affiliation. The results are based on duration tokens.

Table 1 and figure 1 show the results of different contexts: geminate (hypoththesized) versus onsets.

<table>
<thead>
<tr>
<th>Affiliation</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypothesized Geminate</td>
<td>81.89</td>
</tr>
<tr>
<td>Onset</td>
<td>62.93</td>
</tr>
<tr>
<td>Coda</td>
<td>55.8</td>
</tr>
</tbody>
</table>

ANOVA: $F(2, 299) = \text{value}$

![Figure 1: Nasal duration according to phonetic context](image)

The results reveal that nasals in the geminate position had a mean duration of 81.89 ms, while nasals in onset position had a mean of 62.93 ms. In the case of nasals in coda position, the mean is 55.8 ms. These findings indicate a pattern suggesting that nasals are longer than nasals in onset and coda.
However, the general pattern observed in other velar stops tend to be longer than those of palatal stops.

The generalization that geminates tend to have the acoustic closure duration longer than onset geminates (Schiffrin and Maddieson 1997: 92), and geminate stops have a longer closure duration than their non-geminate counterparts, as observed above for Galician, the present investigation aims to find if there are other phonetic differences that would correspond to the differences observed in duration such as algumha 'some' (geminate), and na curandeiro 'with a folk healer' which are considered a parameter worth investigating. The study hypothesized geminate velars would be longer than onsets in syllabification when compared with coda or onset position.

Participants recorded for this study. They were all speakers born in one half of the province of La Coruña, recorded a total of 36 carrier phrases containing geminates in three different contexts: 1) geminate (e.g. unha 'hand'), 2) onset (e.g. c'un amigoto 'with a friend'), and 3) coda (e.g. na curandeiro 'with a folk healer'). 36 distractor items were also recorded three times by each speaker, in order to obtain measurements of acoustic duration. Acoustic analysis software package Praat was applied to the data obtained through analysis of Variance (ANOVA).

The results of the statistical analysis examining three comparisons: velar coda versus velar onset, and velar onset versus geminate. The results are based on duration measurements performed to 216 tokens.

Table 1 and figure 1 show the results of mean duration according to three different contexts: geminate (hypothesized), onset, and coda.

<table>
<thead>
<tr>
<th>Affiliation</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypothesized Geminante</td>
<td>81.89</td>
<td>13.28</td>
</tr>
<tr>
<td>Onset</td>
<td>62.93</td>
<td>16.13</td>
</tr>
<tr>
<td>Coda</td>
<td>55.8</td>
<td>11.1</td>
</tr>
</tbody>
</table>

ANOVA: F (2, 299) = 107.93, P = .000

Figure 1: Nasal duration according to phonetic context

The results reveal that nasals in the geminate context have an average duration of 81.89 ms, while nasals in onset position have an average duration of 62.93 ms. In the case of nasals in coda position, their average duration is 55.8 ms. These findings indicate a pattern according to which geminate nasals are longer than nasals in onset and coda position. Figures 2, 3, and 4 present examples of nasals in different contexts, namely geminate, onset, and coda.
Figure 2: Spectrogram of the word alguruha ‘some, any, cooker’

Figure 2 shows the production of a velar nasal in the geminate context. The duration of the nasal is 121 ms. In this case, one can see the pattern found in the statistical results according to which nasals are longer.

Figure 3: Spectrogram of the phrase c’unamigolo ‘with a friend’

Figure 3 shows the spectrogram for a velar nasal in onset position. Its duration is 64.3 ms. and thus shorter than the one in the word alguruha ‘some, any’.

The last spectrogram illustrates one of the examples in which the nasal is in coda position. In this case, the duration of the nasal is 45 ms. The three productions selected show the pattern found in the statistical analysis, namely that nasals in the geminate context are longer than onset and coda nasals. Even though we cannot establish a direct connection between duration and syllabic affiliation, it can be argued that they reflect the existence of an empty slot in geminate features from the preceding velar nasal as Colina (2004) claims.

Figure 4: Spectrogram of the phrase c’unamigolo

In summary, measurements of duration evidence to support the phonological analysis that phrases such as una ‘a’, alguruha ‘some’ contain unaffected geminates. Even though we have not carried out any direct tests of the findings, they go along with the claims presented in Colina (1976, Carballo and others). Further research will have to examine the possible existence of geminate nasals and onset and coda nasals, and their relationship to the perceptual analysis.

Observation of the data also suggests that geminate velar nasals are produced with an onset and coda spectrogram as milliseconds of silence. To support the analysis in Colina (2004), more research is necessary to examine the consistency as well as the possible relationship with the syllabic
sylababic affiliation, it can be argued that the results of the phonetic analysis reflect the existence of an empty slot in the syllable tier that takes its phonetic features from the preceding velar nasal as the formal analysis proposed by Colina (2004) claims.

![Spectrogram of the phrase c'uncurandeiro 'with a folk healer'](image)

In summary, measurements of duration can be taken as a piece of evidence to support the phonological analysis according to which cases such as unha ‘a’, alguma ‘some’ contain underlying velars realized as surface geminates. Even though we have not carried out a perceptual analysis, these findings go along with the claims presented in descriptive work according to which native speakers are unable to determine the sylababic affiliation of velar nasals (Porto Dapena 1976, Carballo Calero 1979, Veiga 1976, among others). Further research will have to explore whether the acoustic distinction between geminate nasals and onset and coda nasals can be supported by a perceptual analysis.

Observation of the data also suggests that there are cases in which geminate velar nasals are produced with an occlusion that can be assessed in the spectrogram as milliseconds of silence. This seems to offer additional support for the analysis in Colina (2004), more specifically for the proposal that surface geminates are the result of the adoption by an epenthetic consonant of the place features of the preceding consonant. Cross-linguistically, a glottal occlusion/stop (silence) is a common epenthetic consonant as well as an alternative realization for an empty C slot. Future research will have to examine the consistency as well as the patterns arising from the glottal stop data and its relationship with the sylababic affiliation of the nasals.
3. Conclusions

Phonetic analysis of intervocalic velar nasals in Galician supports the phonological analysis proposed in Colina (2004) in which the nasals in unha ‘a’, algúlnha ‘some’ are underlying velars realized as surface geminates. The results reveal that there is a phonetic distinction in terms of length between the unha nasals and velar nasals in other contexts. The phonetic evidence found seems to indicate that the latter are phonetically similar to phonological geminates in terms of length; they also are representationally similar in that they both contain a segment that is simultaneously parsed in two syllabic positions. The doubly-affiliated velar nasals of Galician, however, are phonologically different from geminates in that they are non-moraic and non-contrastive. The findings of the present paper have implications for research into the phonological representation of gemination and for the phonology/phonetics interface, since they suggest that certain phonetic properties could serve to convey phonological distinctions (Fourakis and Port 1986).

Notes

* The authors would like to thank Francisco Dubert, his colleagues and the students at the University of Santiago de Compostela, who helped us immensely with the data collection for this study. We also would like to express our gratitude to an anonymous reviewer for his comments and suggestions. All errors remain our own.

1. Galician is a Romance language of Northwestern Spain, closely related to Portuguese and spoken by approximately two and a half million people. Examples cited in this section (1.1) are from the Móaña dialect. Unlike other dialects, Móaña Galician has raising of /e/o/.

2. Word-final epenthesis is an optional process “introduced to satisfy foot binarity at the postlexical level of the intonational phrase (Martínez-Gil 1997:328)”. As a result, articles, because of their NP-internal position, (never final in the intonational phrase) cannot undergo word-final epenthesis.

3. A few other examples can be accounted for through the influence of the spelling, e.g. anoło ‘ring’ vs. anhelo ‘I wish’ (these forms are monomorphic).

4. Syllabification of the last two syllables in (6) is not indicated in the forms where syllabic affiliation is in question. /de/, /kan/, /en/ are posed as the underlying forms of the prepositions because they also surface as [den], [kon] and [en] in various other contexts, such as when no article follows (Carballo Calero 1979: 251 and following).

5. Additional support for this account can be vindicado nasal preceded by a high, front vowel; vinho [bjno] (Williams 1962).

6. In forms where an intervocalic nasal was lost, selecting a velar articulation for the recovered nasal, however, Base-Identity does not play a role, since the constraint requiring preservation of an underspecified position outranks Base-Identity, e.g. /aleman-a/-time, the constraint against alveolar nasals in Galician (markedness) dominates IO-faithfulness, and preference for velar nasals in the coda (velar). The relevance of the output-to-output (OO) constraint to the morphological word (IO) are no longer significant. Since what is being compared is the morphosyntactic and suffix endings), [alimana] is compared to the output of /aleman/ [alim].

7. Five subjects were from the town of Muros. O Corne, Carballo and Santa Comba. Their age ranges from five males and five females.

References

Alvarez, Rosario, Regueira, Xosé Luís y Henríquez 1986 Gramática galega. Vigo: Galaxia
Colina, Sonia 2004 Intervocalic velar nasals in Galician.
Dubre, Francisco 1998 Reflexions sobre o silabismo de unha 143–163.
Esposito, Anna and Maria Gabriella Di Benedetto 1999 Acoustical and perceptual study of...
Intervocalic velar nasals in Galician supports the phonological structure postulated by Fourakis and Port (1986), in which the nasals in unha [unha] are realized as surface geminates. The phonetic evidence is phonetically similar to phonologically similar examples to phonologically similar in words simultaneously parsed in two syllables. However, the phonetic properties of intervelar nasals in Galician, are not necessarily non-moraic and non-geminate. Certain phonetic properties could have implications for research on gemination and for the phonology/phonetics interface. (Fourakis and Port 1986).

To Dubert, his colleagues and the students of Santiago de Compostela, who helped us immensely in this work, we wish to express our gratitude for their insights and suggestions. All errors remain ours.

Western Spain, closely related to Portugal, is inhabited by a half million people. Examples cited are from the Galician dialect. Unlike other dialects, Moaña (Galicia) is “introduced to satisfy foot binarity and the strophical phrase (Martinez-Gil 1997:328).” As final position, (never final in the intonational phrase), it is not indicated in the forms where /son/, /len/ are posed as the underlying forms are monomorphemic. Additional support for this account can be found in forms in which the intervocalic nasal is preceded by a high, front vowel, e.g. Lit. vinum > vi_o > Port. vino [bino] (Williams 1962).

In forms where an intervocalic nasal was lost, BASE-IDENTITY has the effect of selecting a velar articulation for the recovered nasal (vs. labial as in Portuguese). However, BASE-IDENTITY does not play a role in selecting [n] over [ŋ] in forms that did not lose the nasal (due to its low ranking). In these the faithfulness constraint requiring preservation of an underlying non-velar point of articulation outranks BASE-IDENTITY, e.g. /aleman-a/ [alemana] * [alimanja]. At the same time, the constraint against alveolar nasals in coda positions for coda nasals in Galician (markedness) dominates IO-faithfulness and *Coda [ŋ], resulting in the preference for velar nasals in the coda (velarization, [aliman]). Preservation of the velar nasal at the postlexical level [ku.pi.mi.xo.lo] is a consequence of the relevance of the output-to-output (OO) constraint IDENT-OOMWd that refers to the morphological word (IO are no longer relevant in OO correspondence). Since what is being compared is the morphological word (including word markers and suffix endings), [aliman] is compared to the output of /aleman/ and not to the output of /aleman/ [aliman], which is a different morphological word.

Five subjects were from the town of Muros. Others were from Laracha, Santiago, Corme, Carballo and Santa Comba. Their ages ranged from 52 to 23. There were five males and five females.

References

Alvarez, Rosario, Regueira, Xosé Luis y Henrique Monteagudo
1986 Gramática galega. Vigo: Galaxia
Carballo Calero, Ricardo
1979 Gramática elemental del gallego común. Vigo: Galaxia
Castro, Obdulia
Colina, Sonia
Dubert, Francisco
Esposito, Anna and Maria Gabriella Di Benedetto
Fourakis, Marios and Robert Port

Hualde, José Ignacio

Ham, William

Kaisse, E.M. and P. Shaw

Kiparsky, Paul

Ladefoged, Peter and Ian Maddieson

Lahiri, Aditi and Jorge Hankamer

Lipski, John M.

Lipski, John M.

Martinez-Gil, Fernando

Martinez-Gil, Fernando

McCarthy, John and Alan Prince

Meyer-Lübke, Wilhelm

Mohanan, K.P.

Porto Dapena, José Alvaro

Rohlfs, Gerhard

Veiga, Amable

Williams, Edwin Bucher
1962 *From Latin to Portuguese: the Portuguese language*.
Porto Dapena, José Alvaro

Rohlfis, Gerhard

Veiga, Amable
1976  Fonología gallega. Valencia: Bello

Williams, Edwin Bucher