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Alveolar and Velarized Laterals in Albanian and in the Viennese Dialect

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Sylvia Moosmüller
Acoustics Research Institute, Austria

Carolin Schmid
Acoustics Research Institute, Austria

Christian H. Kasess
Acoustics Research Institute, Austria

Abstract
A comparison of alveolar and velarized lateral realizations in two language varieties, Albanian and the Viennese dialect, has been performed. Albanian distinguishes the two laterals phonemically, whereas in the Viennese dialect, the velarized lateral was introduced by language contact with Czech immigrants. A categorical distinction between the two lateral phonemes is fully maintained in Albanian. Results are not as straightforward in the Viennese dialect. Most prominently, female speakers, if at all, realize the velarized lateral in word-final position, thus indicating the application of a phonetically motivated process. The realization of the velarized lateral by male speakers, on the other hand, indicates that the velarized lateral replaced the former alveolar lateral phoneme. Alveolar laterals are either realized in perceptually salient positions, thus governed by an input-switch rule, or in front vowel contexts, thus subject to coarticulatory influences. Our results illustrate the subtle interplay of phonology, phonetics and sociolinguistics.

Keywords
Laterals, Albanian, Viennese dialect, Natural Phonology, Sociophonetics

1 Introduction

In the world's languages described up to now, lateral approximants are mostly produced in the dental or alveolar region, the tongue body being relatively low in the mouth (Ladefoged & Maddieson, 1996, p. 183). The UCLA Phonological Segment Inventory Database (UPSID, Maddieson, 1984;

Corresponding author:
Sylvia Moosmüller, Acoustics Research Institute, Austrian Academy of Sciences, Wohllebengasse 12-14, A-1040 Vienna, Austria.
Email: sylvia.moosmueller@oeaw.ac.at

see also Maddieson & Precoda, 1990; Reetz, 1999)[1] lists 174 languages (38.58% of all languages in UPSID) that exhibit an alveolar place of articulation, 136 languages (30.16%) with a dental/alveolar place of articulation and 35 languages (7.76%) with a dental place of articulation. Standard German (Kohler, 1999) as well as Standard Austrian German (Moosmüller, Schmid, & Brandstätter, 2015) belong to the group of languages that feature an alveolar place of articulation. Throughout this contribution, the term "alveolar laterals" will be used for lateral approximants with this articulatory configuration.[2] However, laterals may exploit many more articulatory configurations and languages may contrast up to four laterals (see Ladefoged & Maddieson, 1996).

Our study focuses on the production of the alveolar and the velarized lateral in Albanian and in the Viennese dialect (VD). We chose Albanian and the VD, because Albanian features two lateral phonemes, whereas in the VD, the velarized lateral was introduced by language contact as a variant of the alveolar lateral. From a phonological point of view, a categorical distinction between the two lateral phonemes is to be assumed in Albanian, whereas the status of the velarized lateral in the VD is not entirely clear. The following possibilities will be considered: the velarized lateral is either an allophone or a free variant of the alveolar lateral, or, alternatively, it has replaced the former alveolar lateral phoneme.

It should be noted that, from a sociolinguistic perspective, what is called free variation is mostly guided by sociopsychological factors, and is, consequently, not "free" at all. This, for instance, is the case when speakers of a (negatively evaluated) dialect use a (prestigious) standard variety. Within the framework of the two-competence model developed by Wodak-Leodolter and Dressler (1978) and Dressler and Wodak (1982), an input-switch rule between Standard Austrian German (alveolar lateral) and the VD (velarized lateral) would govern the application of either the alveolar or the velarized lateral by speakers of the VD. If the speech situation (allegedly) would demand the application of the standard variant, speakers of the VD would (try to) apply the input-switch rule and realize the alveolar lateral. Such an analysis implies (a) that the phoneme inventory of the VD features a velarized lateral and (b) that the velarized and the alveolar lateral are categorically distinct. Since input-switch rules lack a phonetic motivation, their application is guided by sociopsychological factors rather than by phonetic principles.

If, on the other hand, the application of the velarized lateral is phonetically motivated, an (optional) phonological process would apply.

Phonetic analyses proved that velarization of an alveolar lateral is governed by phonetic principles and, consequently, is gradual in nature (Browman & Goldstein, 1995; Huffman, 1997; Sproat & Fujimura, 1993). The traditional assumption of a categorical distinction between the two lateral allophones in English (Clark & Yallop, 1990; Halle & Mohanan, 1985) was most prominently challenged by Sproat and Fujimura (1993). From the asynchronous timing of the anterior and dorsal gestures involved in lateral production, Sproat and Fujimura concluded that "[p]roperties of the syllable-initial and syllable-final versions of /l/ are phonetically predictable and there should therefore be no need to list distinct allophones to encode these properties" (1993, p. 308).

Their results were corroborated by Browman and Goldstein (1995), Carter (2003), Gick (2003)[3] and Proctor (2011). Browman and Goldstein (1995) showed that in initial position, the tongue tip and the tongue dorsum gesture are roughly synchronous, whereas word-finally, the wider tongue dorsum constriction precedes the narrower tongue-tip closure. Moreover, they demonstrated that the tongue tip gesture in word-final position might start to be inaudible due to a reduction of the tongue tip gesture, thus paving the way for vocalization in word-final position. Missing tongue tip contacts have also been observed by Scobbie and Wrench (2003) and Scobbie and Pouplier (2010) for other varieties of English. Articulatory analyses thus provide a phonetic motivation for the process of velarization. In addition, the majority of phonetic analyses observed gradience in the production of alveolar and velarized laterals across those varieties of English that feature two lateral allophones. A categorical distinction is only maintained in received pronunciation (RP; Turton, 2015). From the descriptions of English laterals, it can be concluded that both gradience and categoricity are present in allophonic variation (see also the discussion in Turton, 2014).

Similar results were obtained by Recasens (2004), Recasens, Pallarès, and Fontdevila (1998), and Recasens and Espinosa (2005) on Catalan and by Recasens and Farnetani (1990, 1994) and Marotta and Nocchi (2003) on Italian. From his analysis of 23 languages, Recasens (2012) concluded that velarization is a gradual process rather than a categorical matter. In order to account for the observed gradience across languages, Recasens (2012) draws on the concept of intrinsic and extrinsic allophony, whereby extrinsic allophony is assumed if the difference in F2 between initial and final laterals exceeds 400 Hz.[4]

Recasens does not consider the phonological status of the laterals; consequently, out of the 23 languages analysed, only one, namely Russian, holds two lateral phonemes, a palatalized and a velarized one;[5] the other languages and language varieties feature only one lateral. Unsurprisingly, the Russian velarized lateral is relatively stable, showing strong velarization/pharyngealization in all vowel contexts (see Table 1 in Recasens, 2012, p. 373; see also Halle, 1959). Stability has also been observed in Serbo-Croatian (Gick, Campell, Oh, & Tamburri-Watt, 2006), a further language that features two lateral phonemes. These results on Russian and Serbo-Croatian point to a categorical distinction between the two lateral phonemes involved. Thus, as concerns Albanian, we assume categoricity between the alveolar and the velarized lateral.

What about the lateral(s) in the VD? Is the application guided by phonetic principles that imply gradience, the sociopsychological factors being of a secondary nature? Or, conversely, has the velarized lateral replaced the former alveolar lateral, and variation is guided by sociopsychological factors?

If the application of the velarized lateral under the assumption of an alveolar lateral phoneme–is guided by phonetic principles, velarization will most prominently occur in final position and between back vowels. Moreover, we assume that velarization is gradual in nature.

If the suppression of the velarized lateral under the assumption of a velarized lateral phoneme–is guided by sociopsychological principles, the velarized lateral is suppressed most prominently in the perceptually salient stressed positions. Suppression is also guided by external factors such as gender-specific application. The two lateral variants are distinguished categorically.

1.1 The laterals in Albanian

The Albanian language is divided into two principal dialects, Tosk (toskërishtja), spoken south of the river Shkumbin, and Gheg (gegërishtja), spoken north of the river. A transition zone along the river connects the two dialects (for an overview, see Byron, 1976; Hetzer, 1995; Moosmüller & Granser, 2006).

As concerns the laterals, all varieties of Albanian, including the standard variety, phonemically distinguish an alveolar and a velarized lateral approximant. Orel (2000, p. 50ff) portrays the historical development of the velarized lateral. Historically, Indo-European *l was preserved in initial position in Early Proto-Albanian. In this position, the velarized lateral only occurred in a few expressive nouns. The lateral was, however, velarized in intervocalic position. In Late Proto-Albanian, the intervocalic velarized lateral changed to /j/ if followed by a front vowel. In this period, the velarized lateral is also found word-finally and in the plural of certain nouns. The historically restricted distribution of the velarized lateral explains why, synchronically, the velarized lateral shows a reduced incidence as compared to the alveolar lateral. Yet, phonological distinction is attested as exemplified by the following minimal pairs taken from Beci (1995, p. 415):

/ˈłuˑłen/ llullen “pipe”, acc. /ˈluˑlen/ *lulen* “flower”, acc.
/pła:k/ *pllakë-a* “slab” /pla:k/ *plakë-a* “old woman”

Palatograms depicted by Beci (1995, pp. 415, 418) show considerable differences; the velarized lateral exhibiting a contact in the dental-alveolar region, the alveolar lateral in the alveolar region. Based on cine x-ray studies performed by Bothorel (1969–1970, cited after Ladefoged & Maddieson, 1996), the velarized lateral is to be described as apical dental, with a retraction and subsequent pharyngeal narrowing of the back of the tongue; the alveolar lateral is to be described as apical alveolar, with no pharyngeal narrowing.

The following formant frequency values characterize the velarized and the alveolar laterals, respectively: 410–420 Hz for F1, 1000–1100 Hz for F2 and 3020 Hz for F3 (Beci, 1995, p. 416); 290–395 Hz for F1, 1750–1890 Hz for F2 and 2700–3100 Hz for F3 (Beci, 1995, p. 418).

1.2 The lateral in the Viennese dialect

The varieties spoken in the city of Vienna belong to the Middle Bavarian dialects. As has been noted by Labov (2001, p. 227), varieties are rather "differentiated by social class, ethnicity, gender, and race" in large metropolises, whereas in rural areas, geographic limits, accompanied by social factors, play the decisive role. The predominance of social factors in the determination of linguistic variation holds also for the city of Vienna. The VD is generally associated with less well-educated people who might be described as lower social class. Due to the strong interaction between–among others[6] the Standard Austrian German variety as spoken in Vienna and the VD, a considerable amount of dialect speakers raise their children in a variety that could be termed a "dialect-based Standard variety". Among young speakers of the lower social classes, this variety is prevalent and constitutes a newly emerged variety that is clearly distinguishable from both Standard Austrian German and the VD. The variety stereotypically associated with the VD is, consequently, prevalent among the older speakers (>40 years) of the lower social classes of Vienna (Moosmüller, 2012, 2016).

The phoneme inventory of the VD contains one lateral, described as an alveolar lateral approximant by Wodak-Leodolter and Dressler (1978). The lateral is vocalized in word-final position and preceding consonants, a process that dates back to the 13th century (Kranzmayer, 1956).

In intervocalic position, in initial position and after consonants, the lateral is realized as a sonorant in the VD. As mentioned above, the lateral is vocalized in word-final position and preceding consonants. However, as a result of a reduction process affecting the diminutive suffix <–erl>, a word-final, syllabic lateral might surface, for example /ˈb̥isɛrl/ [ˈb̥isɐɫ] [ˈb̥isɫ̩] bisschen "a bit".

The velarized lateral was adopted by VD speakers as a result of extensive contact with Czech immigrants. Immigration of Czech workers started in the second half of the 19th century (Steinhauser, 1953) and ceased around 1920. They settled mainly in the 10th district of Vienna, one of the traditional labourer's districts.[7] As with many other sound changes due to contact with Czech, the adoption of the velarized lateral might have started around 1900 and might have been completed by about 1940 (Kranzmayer, 1953). In phonetic descriptions from around 1900 (see, e.g., Luick, 1904), the velarized lateral was not yet mentioned. Around 1950, the velarized lateral is already described in treatises on the VD (Koekkoek, 1955). Our own analyses from recordings of the 1950s and 1970s brought a diverging picture. The recordings conducted in the 1950s showed fewer instances of velarized laterals than expected; however, none of these speakers was raised in the 10th district. The recordings conducted in the 1970s among homeless people revealed that one of the four subjects analysed consistently applied velarization of the lateral in the following contexts (examples described under the assumption of an alveolar lateral phoneme):

- word-initially, for example /ˈlæːd̥ɛr/ → [ˈɫæːdɑ] *leider* "unfortunately";
- after alveolar and postalveolar consonants, for example /ˈsæːd̥ɛl/ → [ˈsæːɫ̩] *Seidel* "small glass of beer" or /ˈʃlɔːg̊ɛn/ → [ˈʃɫɔːŋ] *schlagen* "to beat";
- in the vicinity of back vowels, for example /ˈholɛr/ → [ˈhoɫɑ] *Holler* "elder".

An alveolar lateral is realized after bilabial and velar consonants, if they occur within the same syllable. After bilabial consonants, the lateral might be retroflexed; after velar consonants, it might be palatalized.

It holds for the remaining speakers that if velarization occurs, it only and without exception occurs in the above-mentioned contexts, and never after bilabial or velar consonants. The results of historical data point to a speaker-specific application of the velarized lateral, most probably based on differences according to districts, speakers from the 10th district being the most susceptible to the adoption of variants from Czech immigrants.

It follows from articulatory analyses that velarization in initial position is not phonetically motivated. This strongly advocates the view that the velarized lateral replaced the former alveolar one, especially for speakers raised in the 10th district. An input-switch rule will therefore govern the variation between the alveolar and the velarized lateral.

The velarized lateral belongs to the most negatively evaluated features of the VD (Moosmüller, 2010, 2012, 2016) and, consequently, speakers try to suppress its application in any (formal) situation where they assume that a standard variety is expected.[8] However, its application is not suppressed by all speakers and in every position. Therefore, the question remains whether, at least for some speakers, the application follows phonetic principles in such a way that, for example, the final position is more prone to velarization than the initial position. If the answer is yes, even in a situation of opposing forces sociopsychological factors demanding a suppression, articulatory forces demanding an application in certain contexts phonetic principles apply. Otherwise, sociopsychological factors override phonetics.

1.3 Hypotheses

From the observations discussed above, we formulate the following hypotheses.

1. Languages that phonemically contrast two or more laterals show a categorical distinction of the laterals involved. In order to maintain the contrast, only intrinsic allophony is allowed. Application is independent on stress or position within the word.
2. As concerns the VD, a velarized lateral phoneme is assumed that is severely challenged by sociopsychological factors. An input-switch rule governs the application of the velarized and the alveolar lateral. The result is a categorical distinction between the two lateral variants involved. Since the application is guided by sociopsychological factors, the input-switch rule applies predominantly in perceptually salient, that is, stressed positions.

We will test these hypotheses by analysing laterals in two language varieties, one contrasting an alveolar and a velarized lateral (Albanian), the other exhibiting two lateral variants (the VD). By doing so, we aim at illustrating the subtle interplay of phonology, phonetics and sociolinguistics.

2 Method

Semi-structured interviews, comprising 15–30 minutes of spontaneous speech, were conducted with 11 speakers (six female and five male speakers, all between 45 and 60 years old) of the city dialect of Vienna and with 13 male[9] speakers of Albanian (in the same age range). Since, in Albanian, the two laterals are discerned phonemically, neither gender-specific differences nor differences concerning the speaking task (spontaneous versus repeated sentences) are expected. In order to equalize the amount of lateral realizations in the two varieties, a task of repeated sentences was included in the analysis of Albanian.

By this means, 1161 laterals for the VD (773 for male and 388 for female speakers) and 788 laterals for Albanian were subjected to analysis. Since in Albanian, for historical reasons, the velarized lateral occurs less frequently than the alveolar lateral, our data are imbalanced in this respect ($n = 213$ velarized laterals and 575 plain alveolar laterals). Segmentation, annotation and acoustic measurements were carried out with STx software.[10]

Voiced laterals were segmented manually. Changes in the waveform and intensity were used as the main parameters, supported by abrupt changes in formant frequency patterns in cases of voiced sonorants and by listening. In the worst case, this method rendered an inaccuracy of one period.

F1, F2 and F3 over time were extracted automatically by means of Linear Predictive Coding (LPC).[11] We concentrated our analysis on F2, which most reliably indicates the degree of velarization of laterals (see, e.g., Recasens, 2012; and also Andrade, 1999; Carter & Local, 2007) and which is hardly affected by spectral zeros and was thus readily extractable.

In addition to the extraction of formant frequencies, segment duration was measured, and information regarding the word position (word-initial, word-medial or word-final), syllable stress (lateral within a syllable with primary stress or unstressed) and phonetic context (directly preceding and following sounds) was annotated.

2.1 Statistics

In order to obtain a realistic picture of lateral production, we focused on spontaneous speech in our analysis. By this means, we are able to draw more meaningful conclusions about the actual interaction of the variation involved in lateral production. As a well-known drawback of spontaneous speech we have to deal with unbalanced data. Therefore, different approaches were selected in order to test the effect of the independent variables on F2. For Albanian, velarized and alveolar laterals were categorized according to their phonological status, and the effect of the independent variables on lateral production was tested within each category. By doing so, we were able to test whether the phonological opposition puts constraints on the actual phonetic realization. In the VD, two approaches were applied. Firstly, all laterals were pooled to see the overall effects of the independent variables on lateral production. Then, the laterals were divided into velarized and alveolar laterals according to their actual F2 values (velarized = <1300 Hz, alveolar = >1400 Hz)[12] to see the percentage distribution of the laterals in dependence of the variables, further broken down by gender.[13]

In both languages, linear mixed effects models were carried out. A full factorial model for the second formant with word-position (word-initial, word-medial or word-final), syllable stress (primary stress or unstressed), phonetic context (preceding and following sounds) and gender (only relevant for the VD) was not possible in either of the two varieties without considerably curtailing the scope of the analysis, as the data consists of spontaneous speech and therefore was heavily imbalanced across conditions often lacking data of more than half of the participants (see Table 1 for the frequency distribution of the Albanian speakers and Table 2 for the VD speakers).

Thus, analyses were carried out on reduced data sets and models in order to limit the degree of imbalance.

Since, for historical reasons, velarized laterals occur less frequently than alveolar laterals, less material was available for velarized laterals in Albanian. The speech material of one subject completely lacked phonologically velarized laterals. As a consequence, the effect of velarized versus alveolar laterals was investigated (excluding this particular subject) in a linear mixed effects model with subject as a random factor and phonetic context, word position and syllable stress nested within subjects. For further analysis, alveolar and velarized laterals were divided into two data sets. For alveolar laterals, word position and syllable stress were collapsed into a single factor of five

Table 1. Frequencies of the Albanian speakers realizing laterals in the given context (a = front vowel, b = back vowel, c = consonant, the first vowel symbolizes the vowel preceding and the second the vowel following the lateral. Where the numbers are not shown in bold, the given context was not included in the mixed effects models.).

Lateral category	Position	Stress	Phoneme context							
			aa	ab	ac	ba	bb	bc	ca	cb
Alveolar	Initial	Unstressed	**3**	**4**		**3**	**1**		**2**	**1**
		Stressed	**9**	**6**		**6**	**3**		**7**	**6**
	Medial	Unstressed	**8**	**4**	**1**	**9**	**9**	**5**	**3**	**3**
		Stressed	**7**	**4**	**4**	**7**	**8**	**2**	**7**	**6**
	Final	Unstressed			3					
		Stressed			**3**	**4**	**2**	**7**		
Velarized	Initial	Unstressed		1						
		Stressed		2						3
	Medial	Unstressed	**3**	**1**		**6**	**3**	**5**		**2**
		Stressed	**5**	**7**		**4**	**6**	**4**	**1**	**5**
	Final	Unstressed		1				3		
		Stressed		1	4		1	4		

Table 2. Frequencies of the Viennese dialect speakers realizing laterals in the given context (a = front vowel, b = back vowel, c = consonant, the first vowel symbolizes the vowel preceding and the second the vowel following the lateral. Where the numbers are not shown in bold, the given context was not included in the mixed effects models.).

Position	Stress	Phoneme context							
		aa	ab	ac	ba	bb	bc	ca	cb
Initial	Unstressed					1		2	1
	Stressed	**10**	**10**		**10**	**11**	**1**	**11**	**11**
Medial	Unstressed	**11**	**10**	**9**	**11**	**9**	**3**	**11**	**11**
	Stressed	**11**	**10**	**8**	**11**	**9**	**4**	**7**	**11**
Final	Unstressed		**2**	**1**	**2**	**2**	**7**	**6**	**7**
	Stressed	**2**	**5**	**9**	**4**	**4**	**8**		

levels, due to a lack of data in the unstressed word-final position. The phonetic context having a vowel preceding and/or following the lateral was also modelled as a single factor, with eight levels (front vowel, back vowel or consonant).

Due to the imbalance of phonetic contexts across position/stress conditions, two separate models were estimated: one with word-position/syllable stress, the other with phonetic context as fixed effect. For both models the remaining factor (phonetic context or word-position/syllable stress, respectively) was modelled as a random effect nested within subjects in order to take into account the variability caused by this remaining factor. In the case of significant effects, the main effects of position, stress and context, as well as the possible interactions of position and stress, could still be tested in a post-hoc procedure.

For velarized laterals, the effects of stress and phonetic context were analysed. The data were restricted to word-medial position, as word-initial and word-final position did not contain sufficient data, thus testing only syllable stress. The phonetic context with a front vowel preceding and a consonant following the velarized lateral had to be excluded for lack of data.

Since stress is mainly assigned syllable-initially in the VD, fewer stressed laterals appear word-finally and virtually no unstressed laterals appear syllable-initially. Moreover, as outlined above, occurrence of laterals in word-final position is limited, since in this position, the lateral is mostly vocalized. Still, there was sufficient data for all but the unstressed, word-initial laterals. Thus, in the analysis of the VD as well, word-position and syllable stress were collapsed into a single factor of five levels. The phonetic context was modelled as for Albanian.

Once again, due to an imbalance across contexts, in particular in the word-final position, two separate models were estimated, as was done for Albanian. In addition, however, gender as a between-subject factor was included.

All statistical analyses were carried out in R (R Core Team, 2012). The models were built using the lme4-toolbox (Bates, Maechler, Bolker, & Walker, 2013). For the analysis, data were averaged per subject for each available combination of syllable stress, word-position and phonetic context. The significance of the factors was deduced using the type III analysis of variance (ANOVA) with the Kenward–Roger approximation for the degrees of freedom, as implemented in the package lmerTest (Kuznetsova, Brockhoff, & Christensen, 2013).

For significant effects in the omnibus test, post-hoc tests were performed using the general linear hypothesis testing function (glht) of the multcomp package (Hothorn, Bretz, & Westfall, 2008). *P*-values are reported Bonferroni-corrected, that is, multiplied by the number of post-hoc tests applied. The post-hoc contrasts were constructed so as to investigate the effects of word-position, syllable stress, possible interactions of position and stress and preceding and following phonetic context accordingly.

For the sake of readability, results are presented separately for Albanian and for the VD. In each section, descriptive statistics of the complete data set, related to the different parameters potentially influencing the F2 values, are shown first. Subsequently, the results of the mixed effect models and the post-hoc tests are shown, which represent statistically solid results, but are yielded on a reduced data set.

3 Results: Albanian

3.1 Overall distribution of F2 values

Our corpus on Albanian contained 213 (27%) phonologically velarized and 575 (73%) phonologically alveolar laterals. The difference between velarized and alveolar laterals is reflected in the global distribution of F2 in Figure 1, broken down by phoneme category (velarized versus alveolar). The distribution of F2 of alveolar laterals and velarized laterals shows little overlap, with the alveolar laterals having a higher and wider distributed F2 than the velarized laterals.

A look at the F2 distributions of each single speaker (Figure 2) reveals that 8 out of 11 speakers show a categorical distinction between velarized and alveolar laterals, with a break between the velarized and the alveolar laterals. The corpus of two of the three speakers who show no clear bimodal distribution contains either no (m14) or only a few (m10: 15 out of 73) velarized lateral phonemes. More detailed analyses of the lateral realizations of m13 revealed that he realized 50% of the phonologically alveolar laterals with an F2 between 1000 and 1300 Hz, with all of his laterals being produced in back vowel contexts.

In Table 3, mean F2 and coefficient of variation (VarCo) are provided.

A closer inspection of the two phoneme classes reveals that F2 of 95% of all phonologically velarized laterals is lower than 1300 Hz. F2 of 2% of the phonologically velarized laterals is

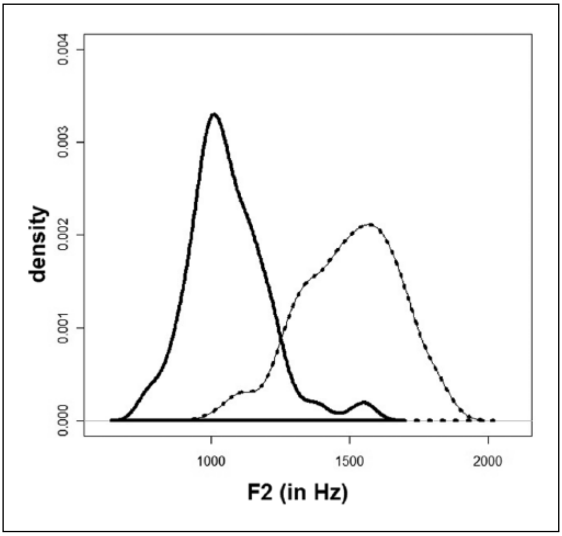

Figure 1. Distribution of F2 (in Hz) of velarized (solid line) and alveolar (dotted line) laterals in Albanian.

Table 3. Mean F2 and coefficient of variation (VarCo) of velarized and alveolar laterals.

Overall statistics		Lateral category	
		Velarized	Alveolar
Albanian speakers	Occurrence of velarized/ alveolar laterals (in %)	27	73
	Mean F2 of laterals (in Hz)	1069	1501
	VarCo of F2	14	12

between 1300 and 1400 Hz and F2 of 3% exceeds 1400 Hz. As concerns the phonologically alveolar laterals, F2 of 71% exceeds 1400 Hz, F2 of 15% is between 1300 Hz and 1400 Hz and F2 of 14% is lower than 1300 Hz. Overall, the effect of alveolar versus velarized turned out to be significant in the linear mixed effect model ($p < 0.001$).

Nevertheless, these results call for a more in-depth analysis of the distribution of phonologically alveolar and velarized laterals in Albanian.

3.2 Influence of word position/syllable stress on F2

Figure 3 illustrates the distribution of F2 of velarized and alveolar laterals with respect to word-position. Word-initially, F2 of the velarized laterals is stable. Word-finally, F2 tends to be raised for velarized and lowered for alveolar laterals. Consequently, in word-initial position, the difference between alveolar and velarized laterals is most pronounced, whereas in word-final position, F2 of velarized and alveolar laterals are moving closer together. This is also reflected in the mean F2 values presented in Table 4.

Mean F2 of word-final alveolar laterals is substantially lower than mean F2 of word-initial and word-medial laterals. As mentioned above, in word-final position, F2 of some alveolar laterals falls

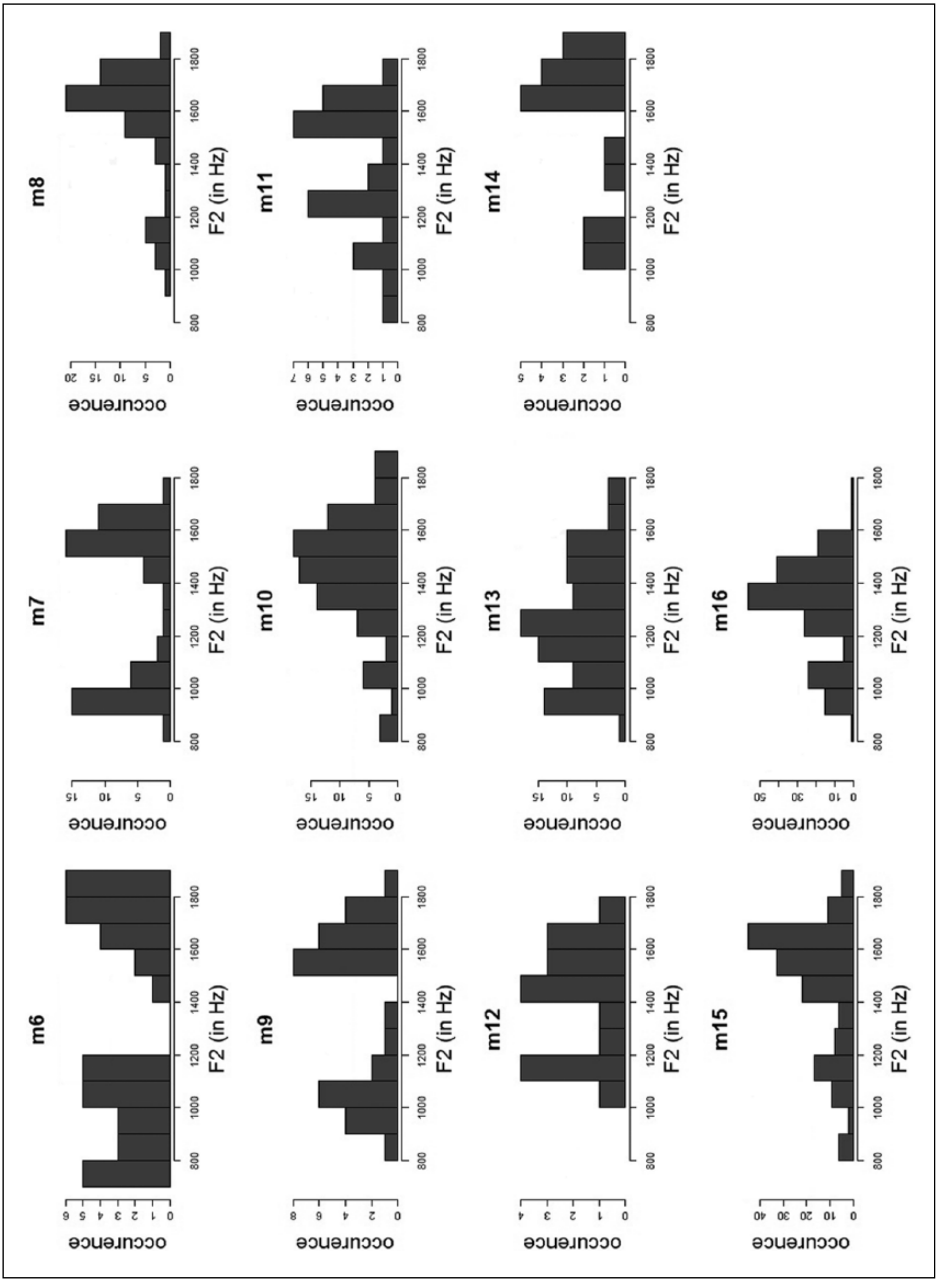

Figure 2. F2 distributions (in Hz) according to the individual speakers of Albanian.

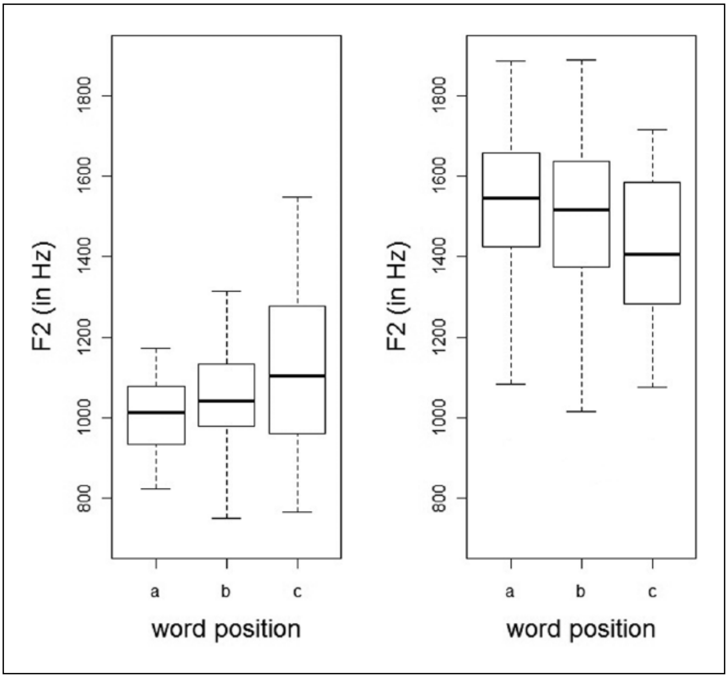

Figure 3. Influence of word position on F2 (in Hz) (a = word-initial, b = word-medial, c = word-final). Left: velarized laterals; right: alveolar laterals. Figures contain all phonetic contexts analysed.

Table 4. Mean F2 and coefficient of variation (VarCo) of phonologically velarized and alveolar laterals according to word position.

Laterals by word position		Word-initial		Word-medial		Word-final	
		Velarized	Alveolar	Velarized	Alveolar	Velarized	Alveolar
Albanian speakers	Occurrence of laterals (in %)	12	88	33	67	22	78
	Mean F2 of laterals (in Hz)	1026	1534	1056	1506	1121	1418
	VarCo of F2	13	11	13	12	20	12

below the threshold of 1400 Hz and F2 of some velarized laterals exceeds the threshold of 1300 Hz. This result calls for an explanation. Therefore, we performed a qualitative analysis that revealed coarticulatory influences: word-final alveolar laterals with a lowered F2 were preceded by a back vowel and word-final velarized laterals with a raised F2 were preceded by a front vowel. Therefore, the word-final position, which is generally unstressed, seems to be more susceptible to coarticulatory influence.

Figure 4 and Table 5 show the influence of syllable stress on F2 of the laterals. No dependencies of F2 on syllable stress can be observed, neither for the velarized nor for the alveolar laterals.

The linear mixed effect model did not show a significant effect of word-position/syllable stress for either the alveolar or the velarized laterals.

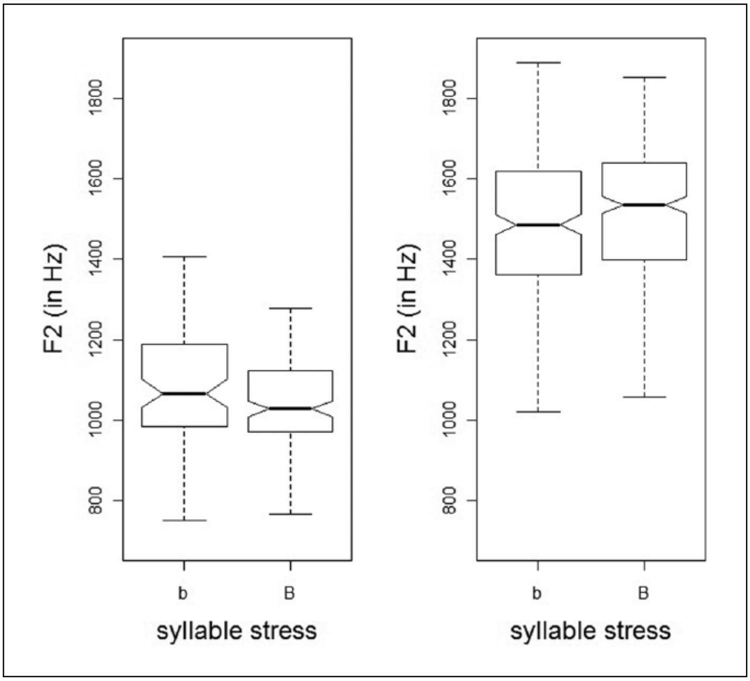

Figure 4. Influence of syllable stress (b = unstressed, B = primary stressed) on F2 (in Hz). Left: velarized laterals; right: alveolar laterals. Figures contain all phonetic contexts analysed.

Table 5. Mean F2 values and coefficient of variability (VarCo) of velarized and alveolar laterals according to syllable stress.

Laterals by syllable stress		Stressed		Unstressed	
		Velarized	Alveolar	Velarized	Alveolar
Albanian speakers	Occurrence of laterals (in %)	29	71	24	76
	Mean F2 of laterals (in Hz)	1053	1508	1072	1493
	VarCo of F2	13	12	14	12

3.3 Influence of the phonetic context on F2

The quality of both velarized and alveolar laterals is affected by the quality of the surrounding vowels (see Figure 5). Between back vowels, F2 of both velarized and alveolar lateral phonemes tend to be lower than between front vowels. Considering only one of these two vowel context positions (before the lateral or after the lateral), a difference between F2 values as a function of front or back vowel context is still observable, although less obvious for the velarized laterals.

Table 6 presents the mean value and VarCo of velarized and alveolar laterals in the respective phonetic context. F2 of velarized laterals is raised between front vowels. Conversely, F2 of alveolar laterals is lowered between back vowels. Except for the context before back vowels, the VarCo is higher for velarized laterals.

The linear mixed effect model for alveolar laterals as well as for velarized laterals showed that the effect of phonetic context is significant ($p < 0.001$). Three post-hoc contrasts were defined testing the laterals either between, before or after a front versus a back vowel. All post-hoc

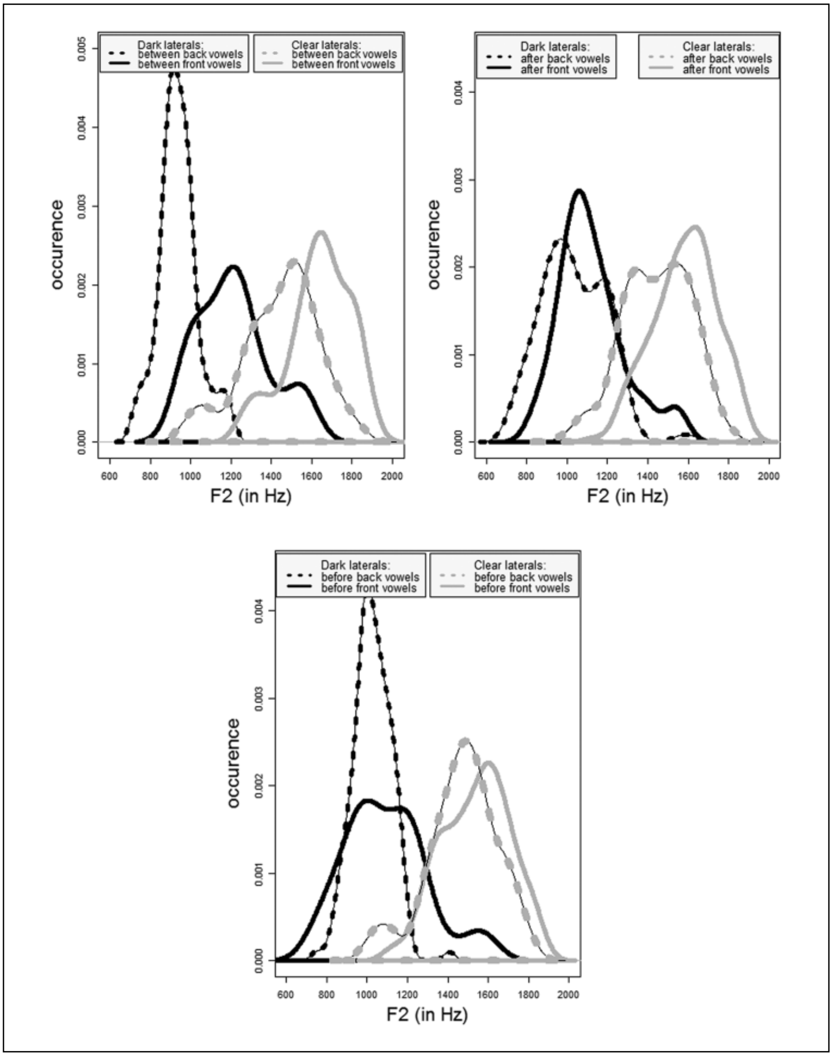

Figure 5. Influence of the surrounding vowels on F2 (broken down by front-vowel (solid lines) and back-vowel (dotted lines) contexts and by alveolar (grey lines) and velarized (black lines) laterals).

Table 6. Mean F2 and coefficient of variation (VarCo) of velarized (v.) and alveolar (alv.) laterals as a function of vowel context.

Laterals by vowel context	Before back vowels		Between back vowels		After back vowels		Before front vowels		Between front vowels		After front vowels	
	v.	alv.	v.	alv	v.	alv.	v.	alv.	v.	alv.	v.	alv.
Occurrence of laterals (in %)	43	57	20	80	20	80	12	88	29	71	29	71
Mean F2 of laterals (in Hz)	1025	1471	1060	1457	1035	1446	1094	1538	1210	1634	1122	1582
VarCo of F2	9	12	20	14	15	12	18	11	16	10	15	10

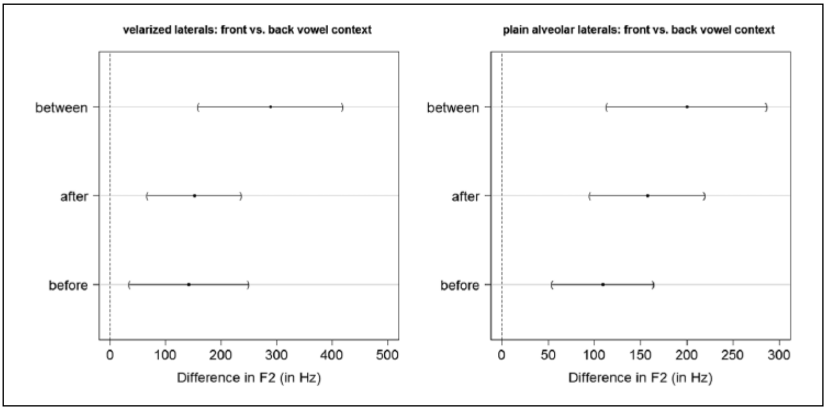

Figure 6. 95% confidence intervals estimated from the linear mixed model difference of the mean F2 in Albanian across position and stress for laterals between two front versus between two back vowels, after a front versus after a back vowel, and before a front versus before a back vowel (from top to bottom). The left panel shows the difference for velarized laterals, the right panel for alveolar laterals. All differences are significant, that is, the confidence intervals do not cross the zero-line.

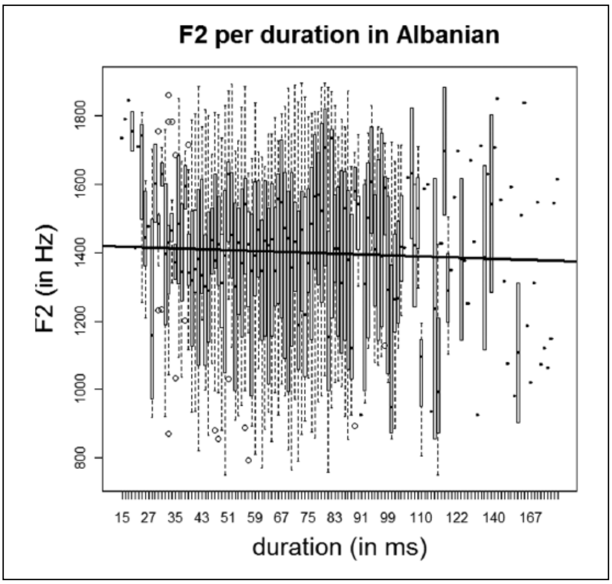

Figure 7. Correlation between F2 and duration in Albanian.

contrasts were significant as well ($p < 0.001$), with laterals in front vowel context having higher F2 values and laterals in back vowel context having lower F2 values (see Figure 6).

3.4 Correlation between F2 and duration

Figure 7 shows the distribution of F2 values for laterals in dependence of duration. F2 of the lateral is slightly decreasing with longer duration, but Pearson's correlation test, $r(982) = -.03$; $p = 0.36$, reveals no significant correlation between these two parameters.

4 Results: Viennese dialect

4.1 Overall distribution of F2

Since the alveolar and the velarized lateral are not phonemically distinct in the VD, a global view on the distribution of the laterals is necessary in order to answer the question of whether a gradual progression from alveolar to velarized laterals takes place or whether alveolar and velarized laterals are distinguished categorically. As outlined in the section on statistics, the global results on men's and women's realizations are presented separately.

Overall, women have a higher mean F2 (1583 Hz) than men (1279 Hz), which is consistent with the fact that only 9% of all lateral productions of female speakers are velarized laterals (F2 < 1300), whereas 50% of all laterals of male speakers were below this threshold. With a VarCo of 21, men's F2 values are more widely distributed than females' (VarCo = 14, see also Figure 8).

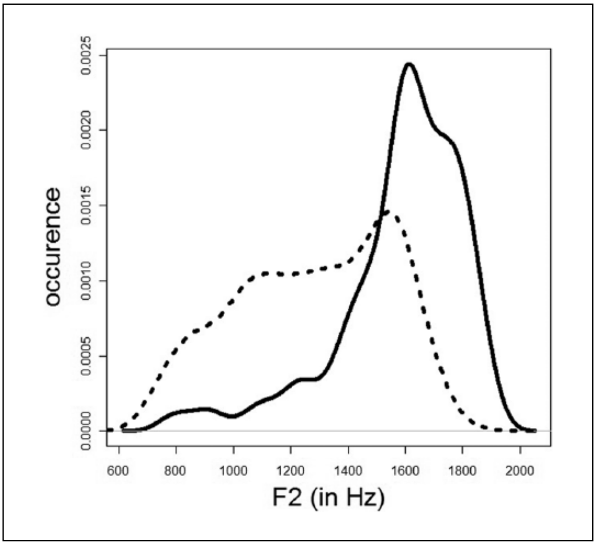

Figure 8. Overall distribution of F2 of all measured laterals broken down by gender. Broken line: male Viennese dialect speakers; solid line: female Viennese dialect speakers.

Both linear mixed effect models (position/stress and phonetic context) calculated for the speakers of the VD found the expected significant gender effect with the mean F2 being higher for female speakers ($p < 0.001$).

A closer inspection of the individual speakers (Figures 9 and 10) reveals that none of the speakers seem to distinguish two qualitatively different laterals. For all speakers, one pronounced peak (mostly in the frequency region of an alveolar lateral) appears. A gradual pacing towards this peak can be observed. A second peak might be acknowledged in the results of m1; however, this peak is widely distributed and no clear disruption emerges. Two speakers, m2 and w4,[14] have three peaks.

4.2 Influence of word position/syllable stress on F2

In Figure 11, the influence of word-position on F2 is presented. In the VD, word-final laterals seem to be realized with a lower F2 than word-medial laterals. This holds for both male and female speakers. Gender-specific differences are observed in word-initial position. Male speakers

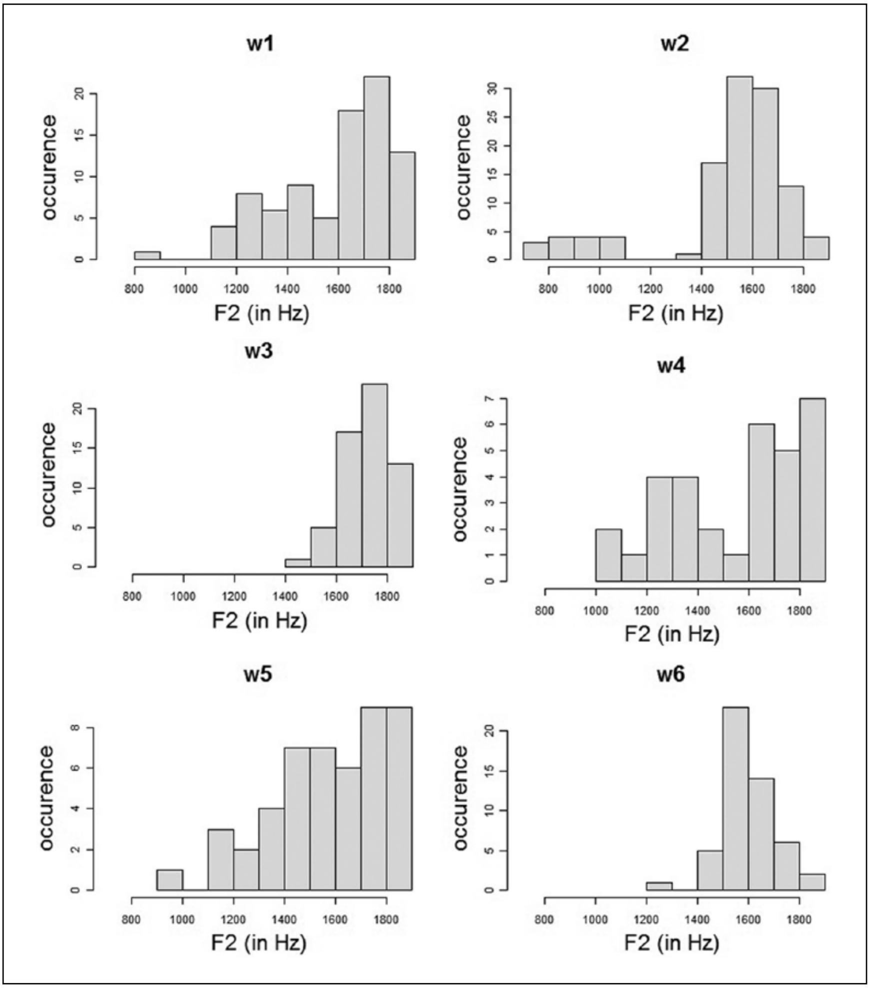

Figure 9. F2 distribution (in Hz) according to the individual female Viennese dialect speakers.

tend to realize the laterals in word-initial position with a lower F2 than in word-medial position, whereas there is no difference between word-initial and word-final laterals. As concerns female speakers, F2 in word-initial position as well as F2 in word-medial position tend to be higher than F2 in word-final position. No difference can be observed between word-initial and word-medial positions.

In Table 7, the results are broken down by velarized and alveolar laterals according to F2 < 1300 Hz (for velarized laterals) and F2 > 1400 Hz (for alveolar laterals). Table 7 illustrates that male speakers of the VD produce significantly more velarized laterals (65%) than alveolar laterals (26%) in word-initial position, whereas for female speakers, it is the other way round (6% versus 90% for velarized and alveolar laterals, respectively). In word-medial position, laterals are mainly realized as alveolar laterals by both sexes. Again, female speakers show a strong preference for alveolar laterals (93%), whereas a more balanced relation is obvious for male speakers (38% velarized realizations, 49% plain alveolar realizations). In word-final position, the relation of velarized versus alveolar realizations of the lateral is the same as in word-initial position in male speech, that is, significantly more velarized laterals are produced in word-final

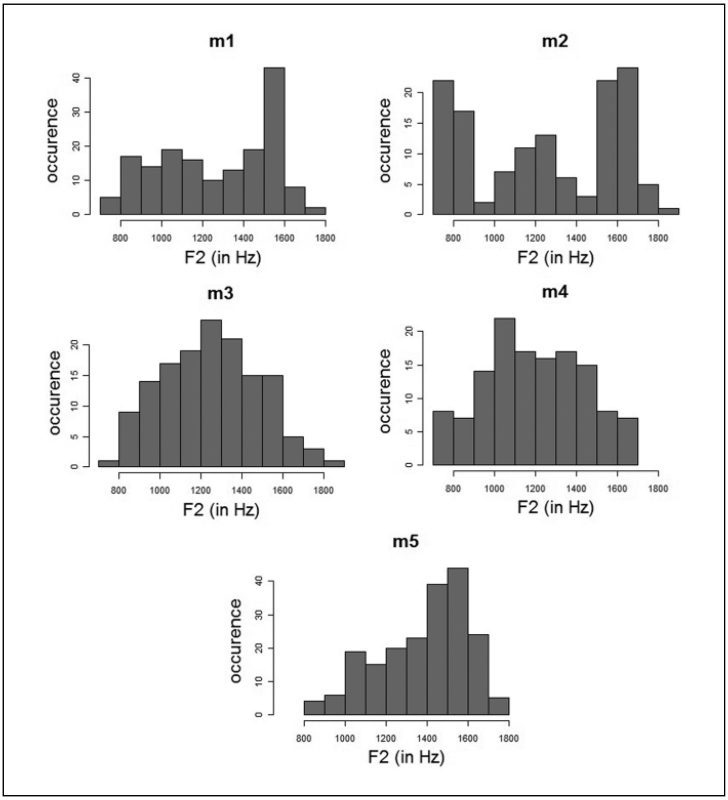

Figure 10. F2 distribution (in Hz) according to the individual male Viennese dialect speakers.

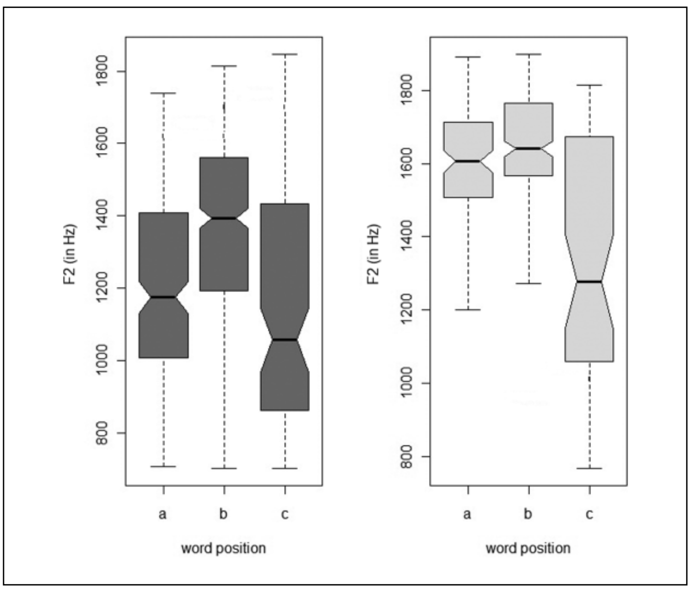

Figure 11. Influence of word position (a = word-initial, b = word-medial, c = word-final) on F2 (in Hz). Left: male Viennese dialect speakers, right: female Viennese dialect speakers. Figures contain all phonetic contexts analysed.

Table 7. Mean F2 values and coefficient of variability (VarCo) of velarized (v.) and alveolar (alv.) laterals for word-position. Velarized and alveolar laterals were categorized according to F2 (F2 < 1300 Hz, F2 > 1400 Hz for velarized and alveolar laterals, respectively).

Laterals by word position		Word-initial		Word-medial		Word-final	
		v.	alv.	v.	alv.	v.	alv.
Male speakers	Occurrence of laterals (in %)	65	26	38	49	69	27
	Mean F2 of laterals (in Hz)	1041	1540	1093	1557	950	1537
	VarCo of F2 of laterals	15	5	14	6	17	7
Female speakers	Occurrence of laterals (in %)	6	90	3	93	47	52
	Mean F2 of laterals (in Hz)	1194	1635	1176	1666	1036	1657
	VarCo of F2 of laterals	6	7	11	7	17	8

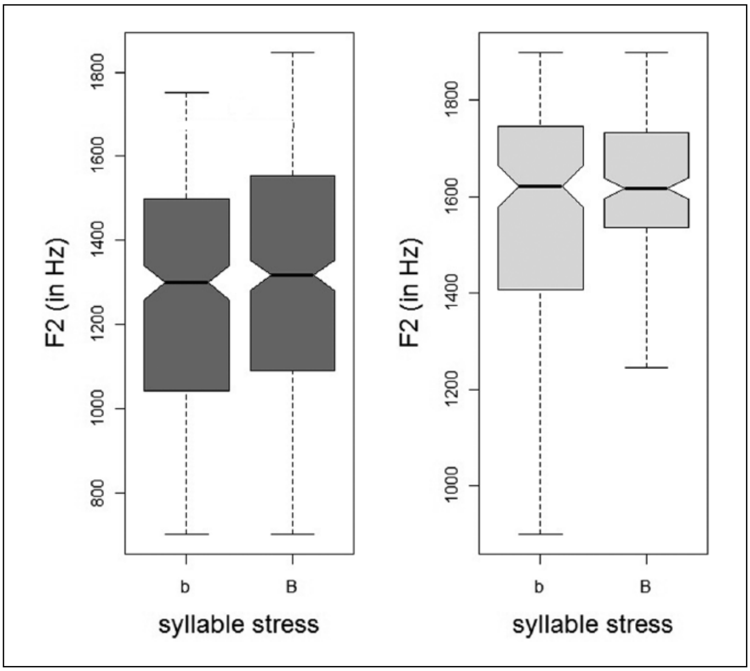

Figure 12. Influence of syllable stress (b = unstressed, B = primary stressed) on F2 (in Hz). Left: male Viennese dialect speakers, right: female Viennese dialect speakers. Figures contain all phonetic contexts analysed.

position (69% versus 27%, respectively). The relation between velarized and alveolar laterals in word-final position is more balanced in female speech (47% versus 52%, respectively). Since only 9% of all laterals are velarized in female speech, the observed proportion of velarized and alveolar laterals in word-final position suggests that, if at all, velarized laterals are preferred in word-final position.

Figure 12 reveals the distribution of F2 in dependence of the stress of the syllable in which the lateral is embedded. F2 of male speakers tends to be higher in stressed syllables as compared

Table 8. Mean F2 and coefficient of variability (VarCo) of velarized (v.) and alveolar (alv.) laterals according to syllable stress. Velarized and alveolar laterals were categorized according to F2 (F2 < 1300 Hz, F2 > 1400 Hz for velarized and alveolar laterals, respectively).

Laterals by syllable stress		Stressed		Unstressed	
		v.	alv.	v.	alv.
Male speakers	Occurrence of laterals (in %)	48	43	50	38
	Mean F2 of laterals (in Hz)	1058	1564	1029	1536
	VarCo of F2 of laterals	15	6	17	5
Female speakers	Occurrence of laterals (in %)	4	93	18	79
	Mean F2 of laterals (in Hz)	1208	1648	1045	1670
	VarCo of F2 of laterals	6	8	16	7

to unstressed syllables, indicating that more alveolar laterals are realized in stressed syllables, even though this effect is rather small. This result does not hold for realizations of female speakers, meaning that female speakers realized alveolar laterals in both stressed and unstressed positions.

In Table 8, results are broken down by velarized and alveolar laterals. The results for female speakers reveal that the percentage of velarized lateral realization is raised in unstressed syllables in female speech (18% versus 4%), indicating that, if at all, women realize velarized laterals in unstressed syllables. The proportion of velarized and alveolar laterals is more balanced in male speech (48% and 50%). Therefore, contrary to female speech, men realize velarized laterals in both positions.

The linear mixed effect models showed that the main effect of word-position/syllable stress is significant ($p < 0.001$, see also Figure 13), whereas the interaction with gender was not significant ($p = 0.13$). Thus, post-hoc tests were not split for gender.

The effect of syllable stress was further analysed in several ways. For stressed laterals, this effect yielded a significantly higher F2 ($p < 0.001$), by comparing the average of the stressed laterals of all positions to the average of unstressed laterals in word-medial and word-final position. If only word-medial and word-final positions are taken, the effect is also significant ($p < 0.001$). By separating them further into either word-medial laterals or word-final laterals, the effect of syllable stress is only significant in the word-final position ($p < 0.001$).

The effect of word-position was investigated overall, and also as a function of syllable stress. Overall, the post-hoc analysis yielded a significantly lower F2 in the word-initial than in the word-medial position ($p < 0.001$). The difference between word-initial and word-final laterals was not significant. However, F2 in the medial position was significantly higher than in the final position ($p = 0.027$). Splitting the analysis with respect to syllable stress yielded a different picture for the contrasts in the word-final position, which showed a steady increase in F2 for stressed laterals. However, only the difference between word-initial and word-medial, on the one hand, and word-initial and word-final, on the other hand, was significant ($p = 0.0017$ and $p < 0.001$, respectively), whereas the contrast between word-medial versus word-final position was not significant ($p = 0.055$). Concerning the unstressed laterals, only the word-medial and the word-final position can be compared, due to the unavailability of unstressed laterals in initial position. This comparison shows a significantly higher F2 in word-medial position ($p < 0.001$), which also hints at a significant interaction between word-position and syllable stress, additionally indicated by the crossing lines in Figure 13 and a significant 2 by 2

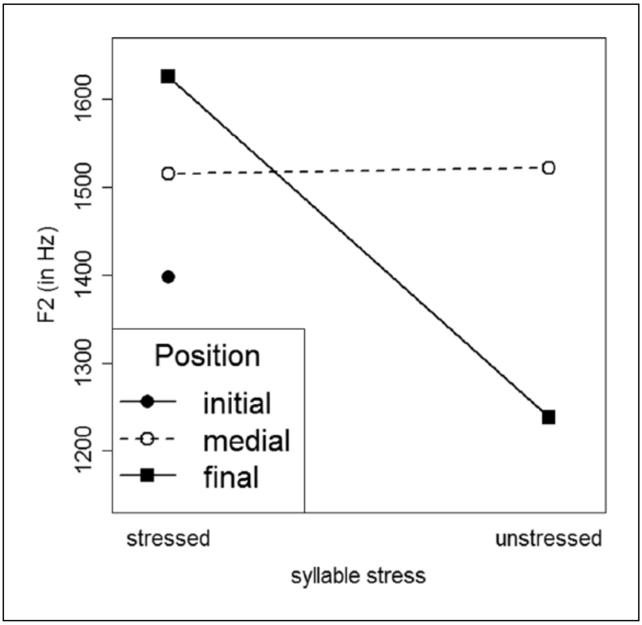

Figure 13. Effect of word position in dependence of syllable stress on the realization of F2 (in Hz). Each data point gives the mean F2 value for one position/stress combination across gender and vowel context estimated from the accordingly linear mixed model. Lines are shown to better display the effect of stress for a given position. F2 values of unstressed laterals in the word-initial position were excluded for lack of data.

interaction post-hoc contrast between stressed and unstressed, as well as word-medial and word-final position.

4.3 Influence of phonetic context on F2

F2 of laterals is influenced by vowel contexts. Figures 14(a) and 14(d) reveal that especially the front–front vowel contexts trigger a rise of F2, whereas F2 drops in the back–back vowel contexts. Similarly, the context of back or front vowels following the lateral leads to a drop or a rise of F2, respectively, as shown in Figures 14(c) and 14(f). Contrary to the results on Albanian, vowels preceding the lateral have no influence on the F2 of laterals, see Figures 14(b) and 14(e), neither in male speech nor in female speech. Overall, F2 of laterals of female speakers tends to be less influenced by vowel contexts, which is visible in the Figures 14(d)–(f).

Table 9, which presents results broken down by velarized (F2 < 1300 Hz) and alveolar laterals (F2 > 1400 Hz), reveals that male speakers of the VD realize more velarized laterals before (68%) and even more between (81%) back vowels. More alveolar laterals are produced before and between front vowels. Again, the VarCo is higher for the velarized laterals than for the alveolar laterals. For female speakers the influence of back vowel contexts is less pronounced than for the male speakers. Overall, women seem to prefer alveolar laterals in all vowel contexts.

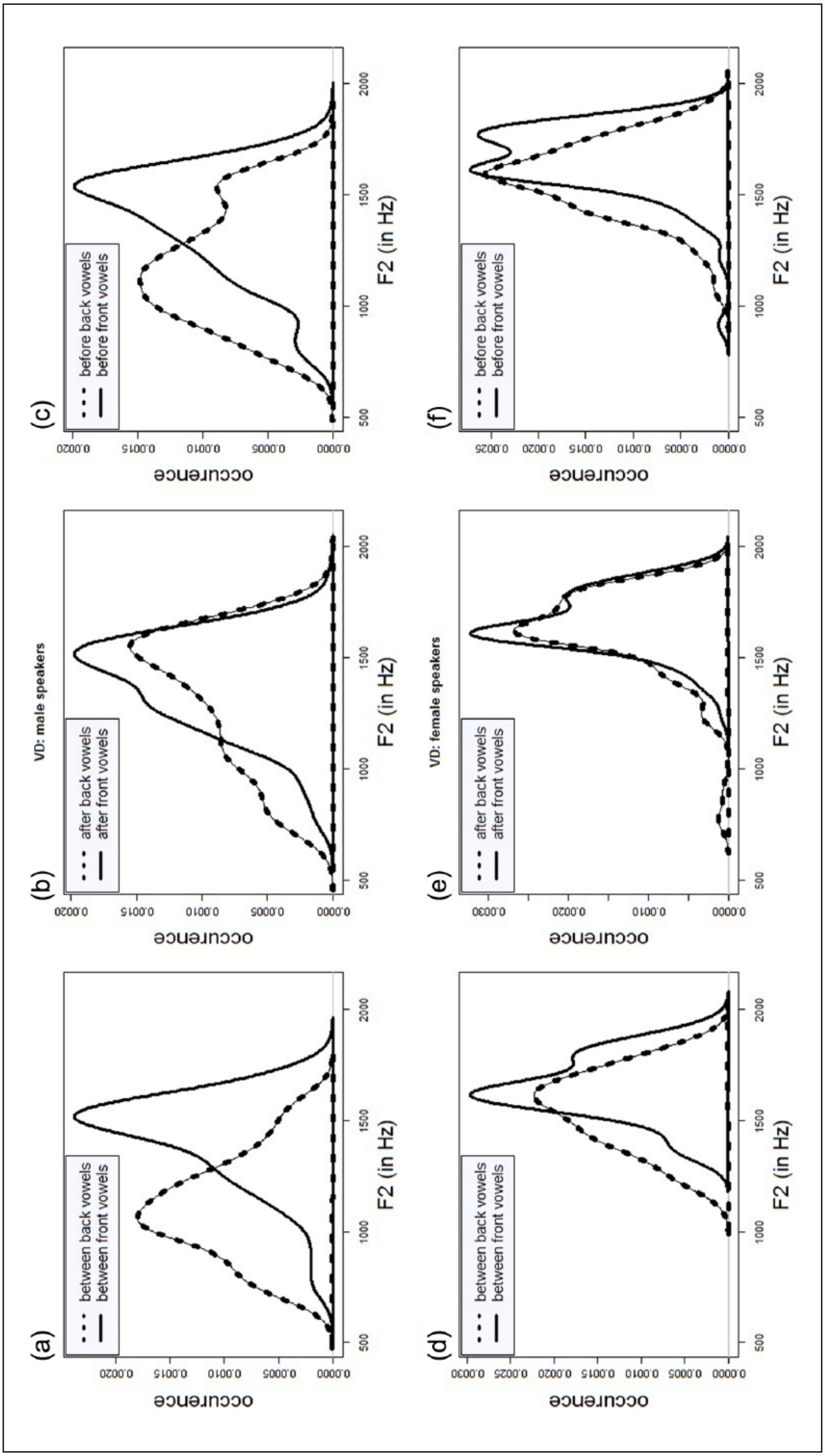

Figure 14. Influence of the surrounding vowels on F2 (in Hz). (a)–(c) Male Viennese dialect speakers. (d)–(f) Female Viennese dialect speakers.

Table 9. Mean F2 and coefficient of variability (VarCo) of velarized (v.) and alveolar (alv.) laterals by vowel context. Velarized and alveolar laterals were categorized according to F2 (F2 < 1300 Hz, F2 > 1400 Hz for velarized and alveolar laterals, respectively).

Laterals by vowel context		Before back vowels		Between back vowels		Before front vowels		Between front vowels	
		v.	alv.	v.	alv.	v.	alv.	v.	alv.
Male speakers	Occurrence of v./.alv. laterals (in %)	68	23	81	12	33	54	27	63
	Mean F2 of laterals (in Hz)	1047	1534	1026	1501	1102	1552	1113	1539
	VarCo of F2 of laterals	15	5	16	5	14	6	15	5
Female speakers	Occurrence of v./alv. laterals (in %)	6	87	10	80	2	96	0	94
	Mean F2 of laterals (in Hz)	1195	1614	1247	1609	1069	1683	–	1671
	VarCo of F2 of laterals	7	8	3	7	17	7	–	7

The linear mixed effect model showed that the main effect of context was significant ($p < 0.001$), whereas interaction with gender was not significant ($p = 0.13$). In the same way as for the Albanian speakers, the phonetic context was modelled by calculating the post-hoc contrasts concerning the differences between front and back vowels preceding or following the lateral, respectively, and also the difference for symmetric vowel contexts (front and back vowels, respectively). As also shown in Figure 15, the results indicate that there is a significantly higher F2 for laterals preceding front vowels than for laterals preceding back vowels. This is also the case for the symmetric vowel contexts (both $p < 0.001$). Laterals following front vowels were not found to be significantly different from laterals following back vowels.

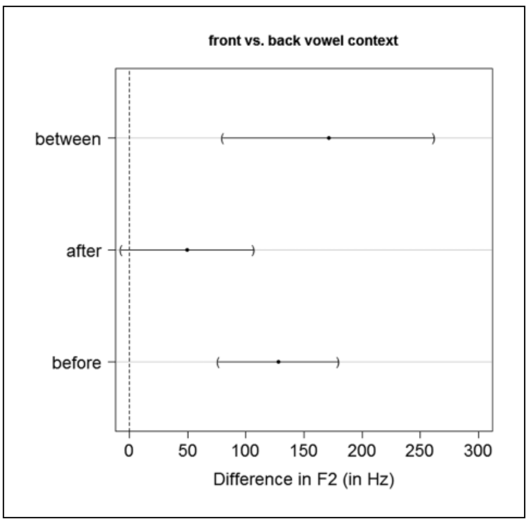

Figure 15. 95% confidence intervals estimated from the linear mixed model of the difference of the mean F2 in the Viennese dialect across gender, position, and stress for laterals between two front versus between two back vowels, after a front versus after a back vowel, and before a front versus before a back vowel (from top to bottom). If the confidence interval crosses the zero-line, the difference is not significant.

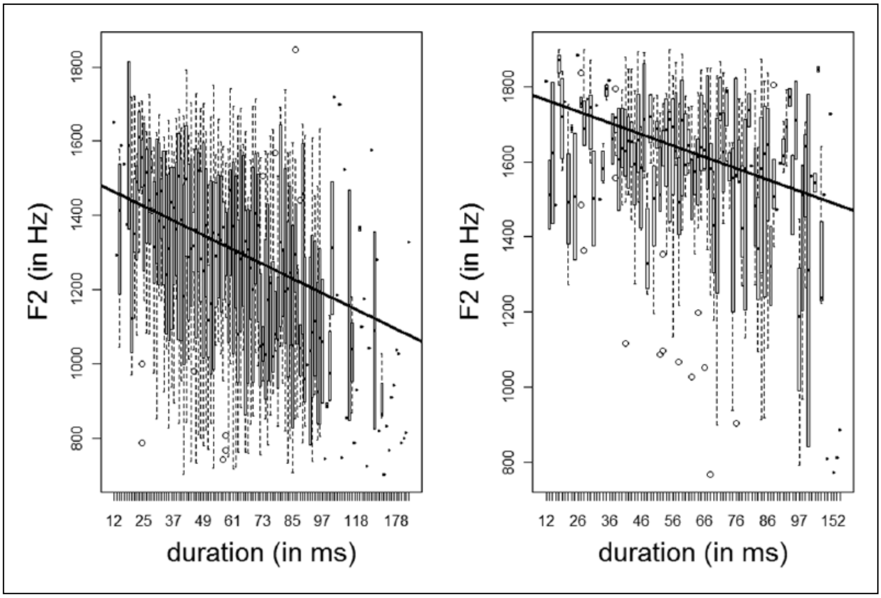

Figure 16. Correlation between F2 (in Hz) and duration of the lateral. Left: male Viennese dialect speakers; right: female Viennese dialect speakers).

4.4 Correlation between F2 and duration

Figure 16 reveals a highly significant correlation between F2 and the duration of the lateral, both for male speakers, $r(771) = -.34$, $p < 0.001$, and for female speakers, $r(386) = -.34$, $p < 0.001$. Therefore, it can be concluded that in the VD, the duration of a lateral increases with the degree of velarization.

Further analyses revealed that this result holds only for word-medial and word-final positions, that is, word-initially, velarized and alveolar laterals are not distinguished by duration.

5 Discussion

Our results on Albanian confirm the hypothesis that a categorical distinction occurs in a language that distinguishes two lateral phonemes. Overall, the distribution of F2 shows little overlap of alveolar and velarized laterals. Moreover, the realization of one or the other phoneme is not influenced by stress, position within the word, or duration. Coarticulatory influences occur: in front vowel contexts, F2 of velarized laterals is raised, whereas a drop in F2 of alveolar laterals arises in back vowel contexts. From these results follows that in Albanian, the distinction between the alveolar and the velarized lateral is fully maintained.

Findings on lateral production are not as straightforward in the VD. The female speakers hardly ever realize velarized laterals. If at all, they surface in the unstressed, word-final position. This result calls into question the assumption of a velarized lateral phoneme in the VD. Rather, it is much more plausible to assume an alveolar lateral that is velarized in word-final position, that is, an (optional) phonetically motivated process. As a consequence, gradience is observed in the data of the female speakers.

On the other hand, in male speech, velarized laterals occur in initial and in final position. This result speaks for a velarized lateral phoneme, the alveolar lateral being governed by an input-switch rule. In front vowel contexts, the application of alveolar laterals is the result of an (obligatory) phonetically motivated phonological process. However, the question arises why, if we assume a velarized lateral phoneme, alveolar laterals occur in final position. From an articulatory point of view, a process of alveolarization in word-final position is completely implausible. Also, the perceptually non-salient, unstressed word-final position is not a context prone for the application of input-switch rules. However, the suppression of l-vocalization in final contexts, for example, [hoˈtɛl] instead of [hoˈtœː] *Hotel* "hotel", would provide an explanation for the realization of alveolar laterals in word-final position. In these cases, the lexeme as a whole is the result of an input-switch rule. Indeed, alveolar laterals in word-final position of male speakers are the consequence of suppressed l-vocalization. Thus, from the results on male speech, we assume a velarized lateral phoneme. In word-initial position, an input-switch rule applies when an alveolar lateral is produced, in word-medial position, a phonetically motivated phonological process operates in front vowel contexts, and word-finally, again, an input-switch rule applies on non-genuine dialect lexemes. Therefore, we observe both categoricity and gradience for male VD speakers.

In the introductory chapter, we outlined the historical development of the velarized lateral. It was shown that it was introduced by contact with Czech immigrants who mostly settled in the 10th district. According to statements made by VD speakers, the velarized lateral was not spread over all working class districts of Vienna. Thus, we assume some regional differences. A qualitative analysis of two male speakers who were raised in the 10th district (m2 and m4) corroborates this assumption. Both speakers consistently realize the velarized lateral word-initially. An alveolar realization occurred only once for each speaker. The same holds for both speakers after alveolar and alveo-palatal consonants and for the word-final position of m2. For m4, 56% of all word-final laterals were produced with an F2 > 1300 Hz. The qualitative analysis revealed that the realization of word-final alveolar laterals was the result of suppressed l-vocalization. l-vocalization is mainly suppressed in non-genuine dialect words, as in, for example, *kulturell* "cultural" or *normal* "normal". In such words, l-vocalization would only apply in emotionally loaded situations or in the lowest social classes (e.g., by homeless people, in drinking holes). In medial position, a balanced relation exists between the alveolar and the velarized lateral, which is the result of vowel context; that is, alveolar laterals occur in front vowel contexts, as in, for example, *Familie* "family" or *Polizei* "police".[15] From these results it can be concluded that the velarized lateral has indeed replaced the former alveolar lateral. The intense contact with Standard Austrian German and the alleged demand to switch to the more prestigious variety leads to the application of an input-switch rule and is responsible for the overall slightly higher occurrence of alveolar laterals in word-initial position of some male speakers.

Finally, the question of whether the VD is a male matter is certainly appropriate. Our results and the results of Moosmüller (2016) strongly point in this direction. Female speakers generally show a high degree of language awareness and gear more readily to a standard language usage. Consequently, they more readily refrain from using a perceptually salient, negatively evaluated dialect feature, especially in formal speech situations. As a consequence, they are less readily assessed as VD speakers (Moosmüller, 2012, 2016). Whether female speakers abandoned the usage of the velarized laterals within the last decades or whether they never adopted it, meaning that they preserved the alveolar lateral, must remain unanswered. Unfortunately, no data of female VD speakers from the 1950s are available, and the analysis of female speakers from the late 1970s would not provide further insight into this matter. For the current state, however, we suggest an alveolar lateral phoneme for female speakers of the VD that is (optionally) velarized in word-final position. Whether the velarized lateral will continue to be produced or whether it will be abandoned altogether cannot be satisfactorily answered at this stage. The accommodation of more prestigious varieties, especially among the speech behaviour of women of the older generation and of young speakers, both male and female, rather speaks for an abandonment. On the other hand, language contact with migrant groups from former

Yugoslavia whose phoneme inventory contains a velarized lateral, and with migrant groups from Turkey who feature a velarized lateral as an extrinsic allophone, might, in the same way as Czech immigrants did more than 100 years ago, influence and stabilize the use of the velarized lateral. Therefore, for future research, we will focus on the lateral production of young speakers of the lower social classes.

Acknowledgements

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Notes

1. The UPSID database comprises a description of 451 languages.
2. Other terms are “clear” or “light” laterals; however, these terms refer rather to the auditive impression. Since we are concerned with production data only, we decided to use an articulatory term. The same holds for “velarized lateral” versus “dark lateral”.
3. As concerns the analysis of laterals, Gick’s (2003) results are based on one speaker only.
4. Recasens (2012) provides a phonetic definition of intrinsic and extrinsic allophones. For the general, phonological definition see, for example, Dressler (1985, p. 121).
5. The terminology characterizing Russian laterals differs. However, x-rays of the Russian apical alveolar and the laminal alveolar lateral show that the former is velarized, whereas the latter is palatalized (see Figure 6.5 in Ladefoged & Maddieson, 1996, p. 187).
6. The interaction with the diverse immigrant varieties and the effects of these interactions has not as yet been subjected to detailed phonetic analysis in Austria.
7. Unfortunately, due to the many political upheavals in the first half of the 20th century (world wars, civil wars), no written records are available about the individual steps the change passed through. However, many old Viennese people hold the view that the velarized lateral did not spread to all labourer’s districts, but was restricted to the 10th district.
8. In the concept of Natural Phonology, it is the speaker who defines the speech situation (Dressler & Moosmüller, 1991).
9. Unfortunately, our database on Albanian contains no female speakers.
10. http://www.kfs.oeaw.ac.at/stx
11. With a window length of 46 ms and a frame shift of 2.5 ms, 20–100 measurement values are available per segment. The number of measurement values depends on the length of the segment.
12. According to Recasens (2012), a lateral with F2 < 1200 Hz is perceived as dark and a lateral with F2 >1500 Hz is perceived as clear. Müller (2011: 22, citing Recasens) reported that “[t]ypical F2 frequency values for intervocalic clear /l/ are 1715 Hz in an /i/-context and 1222 Hz in an /a/-context, and for intervocalic dark /ɫ/ 1104 Hz in an /i/-context and 972 Hz in an /a/-context.” Our classification is based on auditive assignment. Perception tests are still missing.
13. For back rounded vowels, Fant (2004, p 43f) found out that female/male F-patterns, especially F2 and F3, were strikingly similar. He accounts for this by assuming compensatory mechanisms that level differences in perceptually important formants. Since the velarized lateral resembles a back rounded vowel, we infer that this compensation might also hold for the velarized lateral. In our data, the mean F2 of the velarized laterals produced by female speakers was 10% higher than the mean F2 produced by male speakers. In unstressed position, this difference dropped to 1.6%. Setting the threshold at 1430 Hz (= +10%) for female speakers would wrongly assign an auditively alveolar lateral to a velarized one. For

the alveolar lateral, on the other hand, F2 is supposed to be slightly higher for female speakers. Based on this assumption, and in absence of corresponding studies, our threshold seems justified for both female and male speakers.

14. The speech material of w4 only contained a total amount of 32 laterals.
15. Note that in the VD, lateral production is influenced by the following vowel, not by the preceding one.

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