Laterals in Singing and Speech

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1. Introduction

In the world of classical singing, singers are traditionally taught to use only 'light' or 'clear' /l/ sounds (laterals) and to avoid 'dark' /l/s, which are often referred to as 'velarized'. In clear laterals, the tongue tip (apex) or tongue blade (lamina) touches the upper teeth (dentes) or gum (alveolar ridge) and the tongue body (dorsum) is relatively low; in dark laterals, there is the same apico-alveolar contact, but the dorsum is raised or retracted. It is increasingly common, however, to hear singers use a dark /l/ when they have this variant in their spoken language.[1] Is this an attempt to use variants which are closer to the spoken language even in classical singing, an attempt to sound less archaic in order to reach a younger audience? Whatever the reason, we now hear dark laterals in English words like *will, shall, tell* with increasing frequency. Norwegian singers shun light /l/s in words like *skal, mål*, for fear that they might sound as if they are either German or come from county Østfold (Norway), whose accent is often ridiculed on account of its very light laterals; hence, Norwegian singers replace such laterals with the dark /l/s of the standard language.

There are other instances also where the pronunciation of classical singing has changed over time. In Standard Eastern Norwegian (SEN), we now find retroflex consonants in combination with /r/: native speakers say [baːɳ] instead of [baːrn] for *barn* 'child', and [ɭ] instead of [rl] in *perle* 'pearl'; singers also use these retroflex variants with increasing frequency, even if [rn] and [rl] are advocated in singing.[2]

A second and better-known example concerns changes to the pronunciation of /r/.[3] Until recently, it was common to use a tongue-tip vibrant or trill [r] in classical singing, and this rule applied to all languages used in the genre of classical singing. In German, however, the apical trill has been replaced with different dorso-velar or dorso-uvular variants: a velar/uvular fricative [ʁ], a velar/uvular approximant [ʕ̞], or a vocalized variant [ɐ̯]. In recent years, it has become quite common in German classical singing, especially within the genre of *Lieder*, to use the latter two variants in certain positions, whereas the apical vibrant is retained in those positions where the spoken language would have a fricative.[4]

Efforts to change an archaic pronunciation in art song to a more modern pronunciation are often met with opposition from singers and voice pedagogues alike, and not least from listeners. They seem to want to preserve the singing techniques of classical singing, as well as its ideals of resonance and pronunciation, in a timeless form. Whether this is a question of habit, differences in taste, or of good and bad diction, is uncertain – it is probably a complex combination of all of these. But with regard to pronunciation, it is not uncommon for experts to discuss whether or not certain sounds are in fact incompatible with classical singing on purely articulatory grounds. Of course, it is the same articulatory organs which produce beautiful sounds and voices with great carrying power on the one hand, and clearly and correctly pronounced speech sounds on the other. However, fully exploiting the resonation qualities of the vocal apparatus has primary importance, and a good diction often plays second fiddle.

In this context, it is important to note that dark laterals tend to be thought of as incompatible with art song. In singing, the resonance chamber behind the palate should be as open as possible, for the sake of good resonance. A dark or velarized /l/, however, involves raising the tongue dorsum towards the soft palate (velum), which makes it ill-suited as a lateral in singing, as it greatly reduces the size of the resonance chamber behind the primary articulatory contact. Obviously, it is important to avoid articulations that affect the sound quality and carrying power of the voice adversely, but very often experts disagree on which sounds they think are compatible or incompatible with the resonance ideals of classical singing.

In textbooks on good diction for singers there are manifold erroneous and confusing descriptions of the 'correct' pronunciation of sounds. Precise descriptions of speech sounds belong to the domain of phonetics. Teachers of good song diction are not always well versed in phonetics and, conversely, phoneticians are rarely, if ever, experts on classical singing. It would be useful indeed if experts in these two fields could co-operate. It must be admitted, however, that even among phoneticians there is often imperfect agreement as to the description and classification of speech sounds, not least with respect to the sounds examined here, the laterals.

In what follows, we would like to examine some of the available secondary literature and its somewhat chaotic presentation of laterals, in books on both diction and phonetics, and also on the Internet (for example, You Tube videos demonstrating how laterals are made and which only add to the confusion). Secondly, we will review the discussions and findings of more recent research on the two main lateral types, clear and dark /l/, and thirdly, introduce some of the results of our own acoustic research on laterals. It is our aim in later articles, when we have analysed a larger body of material, to show how this research may contribute to understanding and perhaps solving the dilemma of the classical singer: whether to sing only clear /l/s or introduce some dark variants also.

2. Types of laterals

There is a plethora of different variants of /l/. Regardless of the exact pronunciation of /l/ in our Western languages, the sound belongs to the phoneme, or distinctive unit, /l/. All the different variants we use may be classified as free allophones (free variants, independent of phonetic context) or as sub-variants of allophones (bound variants, dependent on the phonetic context or results of co-articulation). In the present article, we wish to examine the two main allophones of /l/, clear and dark, whose allophones are rendered thus: [l] and [ɫ].

Some languages make use of only the clear /l/ in all positions;[5] examples are German, Italian, French, and Swedish. Other languages use only dark variants, such as American English and Dutch. Yet others vary between clear and dark allophones, but according to different phono-tactic rules: British English has clear /l/ pre-vocalically and before /j/ (*let, lute*), and dark laterals post-vocalically (*tell, told*); SEN has clear /l/ initially, and finally after all vowels except after /oː/ and /ɑː/, where it has a dark allophone. These two allophones are 'free' in the sense that both can be used in different positions, but within one and the same language they have a fixed distribution: In positions where one allophone is correct, the other is incorrect (i.e. sounds odd to native speakers), and *vice versa*. Additionally, within both main allophones there is a range of sub-allophones which are the result of co-articulation:[6] That is, they are influenced by the sounds coming before and after. Co-articulation is a universal principle, and we often do not hear these

minute differences. Still, if laterals are measured acoustically (e.g. in terms of formants, which are responsible for the sound quality), it is possible to obtain many different measurements from the same person pronouncing a lateral. If a lateral is pronounced before or after an /i/, it will have a slightly different sound or quality from when it is pronounced before or after an /u/, even if the lateral would be classified as 'clear' in both cases, or as 'dark' in both cases, in the language in question.

Some languages also tend to vocalize dark laterals completely, e.g. Cockney [mɪok] for [mɪɫk], in which case the result sounds like a back rounded vowel, i.e. [o], [u] or [ʊ].[7] Vocalization is simply the loss of the apical contact: The consonantal characteristic of /l/, caused by a considerable obstruction of the air, is lost, and what is left is the vocalic characteristic of /l/, i.e., the elevation or retraction of the dorsum towards the velum or uvula.[8] Back vowels also involve an elevation of the dorsum towards the soft palate, and this is the reason why a vocalized dark lateral sounds like a back vowel. Vocalization of clear laterals is also heard, albeit less frequently, in Spanish, in which case the result sounds like a high front vowel [i], since clear laterals – like front close vowels – involve an approximation of the articulators at the front end of the vocal tract.[9] In German, however, a syllable-final lateral sounds like [e] or [ø].[10]

3. Textbooks on good diction

LaBouff[11] may serve as a typical example of how laterals are described (and prescribed) in textbooks on diction for singers. LaBouff states that the tongue touches the alveolar ridge, and that the "middle of the tongue drops so that there is space between tongue and upper molars",[12] which is correct. Further on, however, it is claimed that dark laterals are "never used in standard stage speech and *should not* be used in singing";[13] the first claim seems incorrect, the second is standard fare in textbooks of this kind. More importantly, the dark allophone is not reproduced correctly: It is given as [l], which is the symbol for a clear lateral, instead of the correct [ɫ]. Moreover, a singer is advised not to "anticipate medial and final" laterals, but sound the /l/ "as late as possible",[14] which would make for very short final laterals compared to what we typically find in normal speech.[15] Finally, LaBouff states that initial laterals "that begin grammatically stressed words may be doubled or tripled for greater stress and emphasis",[16] as in *love* [l:lʌv] and *little* [l:lɪtɫ]. This is a phenomenon that we have indeed observed in singers in our own data, and which again reverses the normal duration of initial and final laterals. In the natural speech of non-singers, however, doubling or tripling of the lateral's duration never occurs. In summary, although we do not wish to downplay the many virtues of LaBouff's textbook, it sometimes suffers from imprecision with respect to phonetic details.

The famous phonetician John Wells keeps a phonetics blog and takes issue with Adams's[17] treatment of laterals,[18] although he points out – and we agree – that Adams's book is excellent as far as it goes. Like us, Wells rather addresses the imprecision with which phonetic issues are handled by vocal instructors, and like us, he laments the lack of collaboration between vocal teachers and phoneticians. The passage in question deals with laterals in Italian and American English, and is worth quoting in full:

> A few more observations about /l/. Of the sounds that appear to be equivalent in English and Italian, this is perhaps the most problematic. English /l/ is usually pronounced with the tongue rather tense and making contact with the palate well behind the teeth, as well

> as with a collapsed pharynx. Many students have such an ingrained English /l/ position that it is very difficult to speak or sing an idiomatic Italian /l/, especially a short intervocalic /l/ as in **fatale** or **crudele**. The tongue must not only be forward, but the vowel shape of the preceding vowel must be behind the tongue as /l/ is pronounced, an aspect that is even more crucial for double *ll* and when *l* begins a consonant cluster. The sound must have resonance as well as forwardness.[19]

Wells interprets Adams's claims that the tongue makes "contact with the palate well behind the teeth" and "the tongue must be forward" to mean that Italian /l/ is dental, while English /l/ is alveolar, which is correct; the two claims also correctly point to the difference in the configuration of the back of the tongue in the production of laterals in the two languages. However, the statements regarding the tenseness of the tongue and "the collapsed pharynx" have absolutely no known articulatory correlates. The claim that "the vowel shape of the preceding vowel must be behind the tongue" could be true, if it means that Italian laterals have a front vowel resonance, but the statement is vague and in a sense vacuous, as is the last statement that the lateral "must have resonance" – laterals always do. As Wells puts it, "The question is, of what kind?"

Wells goes on to describe a lesson in lateral production as he would give it to phonetics students (not singers, mind you). In short, Wells would point out that laterals involve contact between the tongue tip and the upper gum, whereas the rest of the tongue body is free to assume different positions or configurations. He would then make the students pronounce /l/ and simultaneously anticipate all the different vowel sounds they know, and try to hear how this changes the quality of the lateral. Next, he would make the students compare the various laterals in different languages to determine whether they have front-vowel resonance and are 'clear', or have back-vowel resonance and are 'dark'. Finally, even if Wells admits that his approach might not work better than that of Adams, he would at least have "taught [his] students something true rather than obfuscate the matter with nonsense". This matches our view exactly: Good and useful instructions on how to produce laterals in singing need not be phonetically imprecise or inaccurate.

The following are examples of YouTube videos that purport to describe and demonstrate the pronunciation of different kinds of /l/. At https://www.youtube.com/watch?v=pejo6YC_BnM, all the speaker's examples are of dark laterals, even if she states that some are clear and others dark. She also claims that there is only one symbol in the IPA for the two laterals; she probably means there is only one phoneme, which is usually IPA /l/. Worst of all, the speaker states that a dark /l/ has two parts: first, a vowel-like sound (which in all her examples is a glide schwa that she inserts between the stressed vowel and the following dark lateral) and secondly, the lateral itself. Another demonstration is found at https://www.youtube.com/watch?v=4P63VPV4rgk; again, the speaker is American and all the examples given are of dark laterals, even if the speaker states otherwise. Similarly for the video found at https://www.youtube.com/watch?v=U4En7vG1wV4. All the instructors show knowledge of the supposed distribution of clear and dark allophones, but are unable to pronounce a clear lateral. The descriptions and terminology are also partly incorrect: The instructors use expressions like "the /l/ should be inside the mouth" and "the tip of the tongue should be between the teeth". At https://www.youtube.com/watch?v=ipqDNqUDiMI

(probably Canadian speaker), the instructor in fact also uses singing as a method to help Asians acquire the correct pronunciation of /l/ versus /r/.

4. Recent research on laterals

In this section we would like to present some of the conclusions that have been reached in recent research on the articulatory and acoustic-perceptual characteristics of laterals, especially those that are relevant to laterals in singing.

Most research on English laterals has used data from speakers of American English (AmE), which entails that the laterals measured are all somewhat dark. As early studies showed that intervocalic laterals were different from both initial and final laterals,[20] researchers have focused much attention on trying to determine whether laterals fall into categorical types, i.e. allophones, or rather form a continuum, ranging from very clear to very dark. Most studies have concluded that there is indeed a gradient of laterals, and that the quality of laterals is sensitive to their position in the syllable, the presence of morpheme boundaries, etc.[21] Some studies, especially on British English (BrE), have found evidence for the more traditional division of laterals into categorical allophones,[22] which is not surprising, given the complementary distribution of clear and dark lateral allophones in BrE.

Articulatorily, research on laterals has concluded that most laterals involve the same tongue movements or gestures: an apical gesture, which is consonantal in kind, as it involves a considerable obstruction of the air-stream, and a dorsal gesture, which is more vocalic in nature, as it does not involve a radical constriction of the air. The dorsal gesture has, however, been found to involve retraction rather than velarization.[23] Besides, laterals tend to involve (a) a lowering of that part of the tongue which is between the tip and the back,[24] (b) inward lateral compression of the middle and posterior parts of the tongue, which creates lateral flow channels for the air, and (c) a generally convex tongue body shape.[25] These are parameters that need to be taken into account in singing. There is also general consensus that clear laterals always involve full contact between the tongue tip and the alveolar ridge, whereas that is not the case for dark laterals; this is referred to as 'undershoot'.[26] The timing of the two gestures is also crucial for the quality of laterals: Whereas the apical contact is made before the pre-dorsal lowering or retraction in clear laterals, the reverse is the case in the production of dark laterals. Sproat & Fujimura also suggest that duration seriously affects the quality of the lateral, in that final laterals are longer and thus may be perceived as darker than for instance medial laterals, which are shorter.[27] If so, it is not merely the configuration of the tongue that makes a lateral sound dark, but also its duration, which is something that should be kept in mind in the present context.

Acoustic research on laterals has identified the precise acoustic differences between clear and dark /l/s; as laterals are vowel-like sounds, their spectral energy is also shown as bands or formants, which can be measured in Hertz (Hz). Clear laterals generally have a low first formant (F1) and a high second formant (F2); by comparison, dark laterals have a slightly higher F1 and a much lower F2.[28] The F1 is typically in the range 250-500 Hz for laterals; the F2 tends to be in the region 1400-2000 Hz for clear laterals, and in the range 800-1200 Hz for dark laterals,[29] though there is of course variation both across languages and across varieties of the same language.

The difficulty lies in identifying the articulatory correlates to these acoustic differences, as there is no one-to-one relationship between the different formants and the different lingual gestures – there are many different articulatory ways to achieve the same acoustic signal, and there are different resonance chambers in the vocal tract, each of which contributes to the acoustic signal. However, since clear laterals produce similar spectrograms as the close front vowel [i], and dark laterals similar spectrograms as back (and rounded) vowels [u] or [o], it is likely that the differences in F2 correlate with the frontness or backness of the tongue. In other words, the lower F2 in dark laterals is likely caused by the retraction or raising of the back of the tongue, which in fact lengthens the tongue.[30] Some find that it is principally the *back* cavity (the resonance chamber behind the apico-alveolar constriction) that plays a role in the acoustic fingerprint of laterals.[31]

5. CO-LATERAL: Laterals in a cross-linguistic perspective, in speech and song

5.1 Introduction

For the last two years, the authors have been compiling, and continue to compile, a corpus of laterals for acoustic analysis which we call CO-LATERAL. The corpus consists of spoken or sung samples of laterals in Norwegian, English and German, pronounced by native speakers, either in words or in sentences. So far, the corpus consists of the following three components.

A Speech in Norwegian and English (1 female;[32] 29 lateral tokens for English, of which 12 tokens were analysed; 33 lateral tokens for Norwegian, of which 11 tokens were analysed)

B Speech in varieties of English
- (i) Vancouver English (4 males, 4 females; 144 lateral tokens)
- (ii) Southern British English (12 females, 14 males; 3250 tokens[33])
- (iii) A few samples of diverse accents of English (1 female speaker of Australian English, 1 male speaker of Irish English, 1 male speaker of Scottish Standard English; 375 tokens in total)[34]

C Speech and song in Norwegian and German (756 lateral tokens)
- (i) Norwegian (3 male singers)
- (ii) German (3 male singers)

Corpus A formed the basis of our pilot study. We will report some of the findings of our analysis of the laterals of sub-corpora A, C and B(i) in this section and the next; conclusions are as yet preliminary, and we will continue to publish further findings in the future.

5.2 The darkness of dark laterals

Which factors contribute to giving dark laterals their dark quality? At the outset, we identified four variables, which we arrived at from reading previous research and from our own observations. The four variables are (a) velarization or retraction of the tongue dorsum/root, which gives a lower F2; (b) lip rounding, which elongates the supra-glottal tube and lowers the F3; (c) longer duration, which creates the *impression* of a darker lateral; and (d) a lowered larynx, which elongates the supra-glottal tube and gives a lower F2.

Our measurements of the laterals in Corpus A revealed a significant difference in the F2 of dark laterals in SEN and BrE, in that such laterals have a lower F2 in BrE. That is, even in phonetically similar contexts (/l/ after the vowel /ɔ:/), in which both languages have *impressionistically* dark laterals, the BrE laterals demonstrably have a lower F2 (Table 1).

Table 1: Mean formant values in Hz (c/s) for RP and SEN laterals in final position.

Language		Lateral F1	Lateral F2	Lateral F3
RP	Mean	**500,42**	**904,42**	**2953,00**
	N	12	12	12
	Std. Deviation	39,473	94,474	154,999
SEN	Mean	**496,09**	**1009,91**	**3041,45**
	N	11	11	11
	Std. Deviation	46,758	76,966	187,449

Similarly, we found a significant difference between SEN and BrE in respect of the duration of dark laterals: BrE laterals are longer by more than 60%. We measured both the length of the lateral alone, and of the vowel and the lateral taken together. Interestingly, it is only the total length (vowel+lateral) that is different, which must mean that the lateral effectively 'eats up' part of the vowel in BrE, because the length of the entire syllable coda (vowel+lateral) is roughly the same in the two languages (Table 2).

Table 2. Mean duration of vowel+lateral and of lateral in RP and SEN.

Language		Total duration (vowel + lateral) in ms.	Duration of lateral in ms.
Brit.	Mean	,3837	**,1627**
	N	12	12
	Std. Deviation	,10626	,04876
Norw.	Mean	,4022	**,1049**
	N	11	11
	Std. Deviation	,08613	,03556

Lip rounding seems not to have an effect on the acoustics of laterals in either SEN or BrE, and we have not yet been able to measure larynx position. In summary, our pilot study lends support to previous research in so far as both a lower F2 and a longer duration of dark laterals are concerned – in natural speech.

5.3 Allophones vs. a continuum of laterals

Our second question was whether clear and dark laterals are separate categories (allophones) with an observable 'gap' between them, or if they form a continuum. Analysis of Corpus A

showed a clear gap between light and dark laterals, in both near-native British English and native Norwegian; similar results were obtained for the Norwegian section of Corpus C, as shown in Figure 1. Figure 1 reveals an unequivocal gap along the F2 axis between clear and dark laterals, especially in speech. The gap is considerably less clear in singing, but there is still no overlap along the F2 axis. Along the F1 axis, on the other hand, there is overlap between the two lateral types, in both speech and song, and the dark laterals approach the F1 values of the clear laterals in singing. In Corpus B(i) of Vancouver English, in which we expected only dark laterals, we found an indisputable continuum from clearer to darker laterals, although all tokens are within the 'dark range', cf. section 4. These results support previous research which has found evidence of two separate allophones for British English, but a continuum for Canadian English.

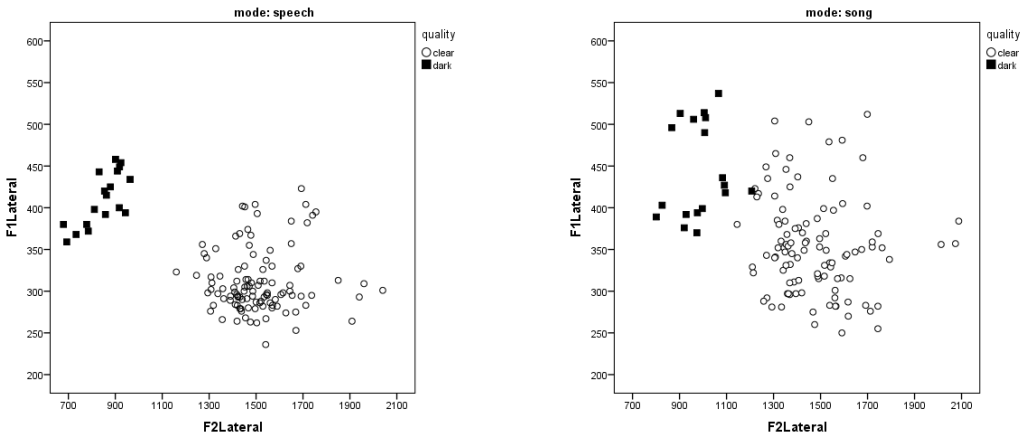

Figure 1. Lateral allophones in Norwegian speech (left) and song (right)

A surprising finding for Corpus B(i) Vancouver English is that the female informants use clearer laterals word-initially than word-finally, even if all the tokens are within the range of dark laterals (Figure 2); no such positional variation is found in the male subjects, which suggests a gender-based difference. To our knowledge, no such finding has been reported in the research literature before.

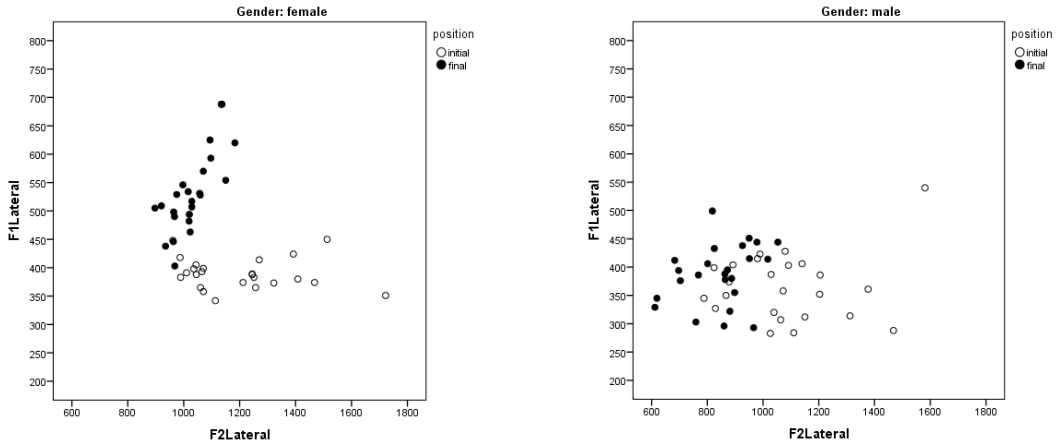

Figure 2. Laterals in Vancouver English: gender differences

5.4 The special German final lateral

In a previous study, Ophaug[35] has found that final laterals in German are especially sonorous, and that they differ from Norwegian clear final *l*'s by having demonstrably higher F1 values, combined with the fact that the F2 seems not to change very much from initial laterals. This is hence **not** a typical lateral on a continuum in which the F1 rises and the F2 decreases; in fact, it seems to form its very own category or allophone, with high values for **both** F1 and F2. The question then is whether this lateral is clear or dark. Perceptually, it sounds very much like an [e] or an [ø], and thus it appears to be in the light end of the spectrum. In the German part of Corpus C, we found a considerable difference between initial and final laterals, and that the final laterals show formant values which corroborate Ophaug's earlier conclusions (Figure 3, from which dark Norwegian final laterals have been excluded, and Figure 4).

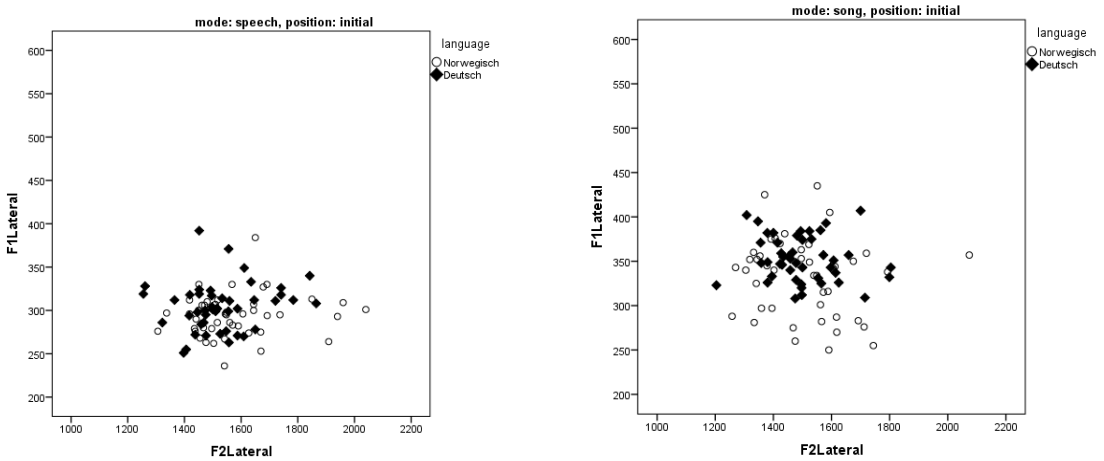

Figure 3. Initial laterals in German and Norwegian, speech (left) and song (right)

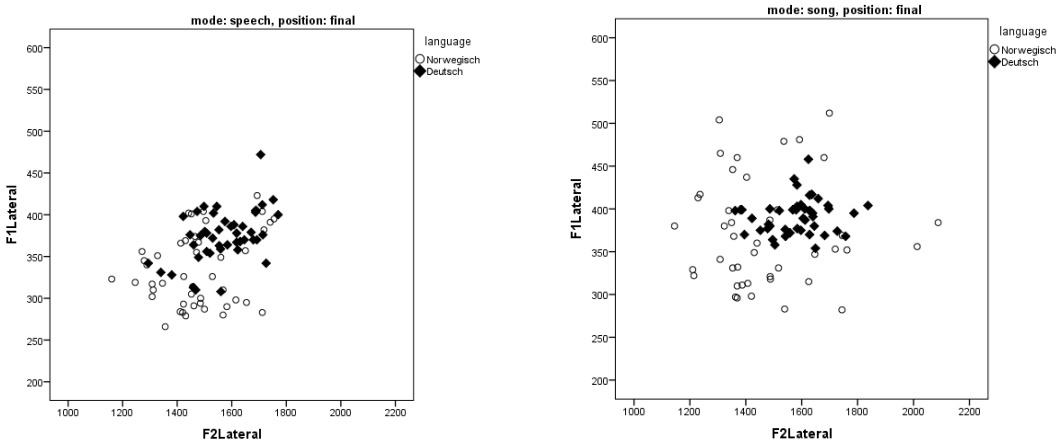

Figure 4. Final laterals in German and Norwegian, in speech (left) and song (right)

German shows a greater spread of values along both axes in speech than in singing; the opposite is the case for Norwegian. In speech, German final laterals have unmistakably higher F1 and F2 values than does Norwegian. In singing, the difference is even clearer: German final laterals have a 'compact' lateral quality with very little spread, whereas Norwegian shows major diffusion along both axes. Thus, the German final lateral appears to be very special indeed: It has a high F1, a high F2, and shows little spread (i.e. there is little co-articulatory effect from neighbouring vowels).

5.5 More on duration

In classical singing, singers are taught to "sing on the vowels", as it is they which carry the pitch and which have such a strong carrying power that a classical singer can be heard by the audience without the use of microphones; this is down to effective resonance techniques. The vowels therefore have the full duration of the musical score. The consonants are supposed to be short and simply act as the onset and offset of the vowel in classical singing.

Scotto di Carlo[36] has shown for French that in speech, vowels vary in length between 38 and 408 ms. In singing, their duration varies between 40 and 3120 ms. Consonants vary between 16 and 324 ms in speech, but also between 16 and 340 ms. in singing. That is, consonants have a short duration in both modes, with only slight variation; and although they are never shorter in song than in speech, they may be a little longer in singing.

It is logical to assume that it is primarily consonants with pitch (voice) and a certain intensity which are to be found among the longest consonants in both modes – i.e., nasals and laterals. In other genres of singing, such as jazz, blues and folk music, it is a fact that the singer may "sing on" nasals and laterals also; in other words, these consonants carry a good portion of the note value, especially in final position.

To our knowledge, there is no study which systematically compares nasals or laterals in initial vs. final positions, and in speech vs. classical singing. We do, however, but only for laterals, and so far for only a sub-part of our corpus.

To measure any difference in duration between initial and final laterals, we analysed the spoken laterals in Corpus B(i), i.e. Vancouver English. Table 3 (upper part) shows that initial laterals are shorter than final ones, and that (lower part) the difference is significant.

Table 3. The duration of laterals in Vancouver English

Group Statistics

	position	N	Mean	Std. Deviation	Std. Error Mean
DurLateral	initial	48	,0854	,02010	,00290
	final	48	,1502	,02678	,00386

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
DurLateral	Equal variances assumed	1,558	,215	-13,407	94	,000	-,06479	,00483	-,07439	-,05520
	Equal variances not assumed			-13,407	87,206	,000	-,06479	,00483	-,07440	-,05519

Corpus C allows us to measure duration in both Norwegian and German, and in both modes. We included clear laterals only, so the dark allophone in Norwegian (after /o:/ and /a:/) has been excluded (Tables 4 and 5).

Table 4. The duration of laterals in Norwegian and German (raw duration)

Group Statistics

language	mode		position	N	Mean	Std. Deviation	Std. Error Mean
Norwegian	speech	DurLateral	initial	45	,135353	,0307724	,0045873
			final	45	,119284	,0383719	,0057202
	song	DurLateral	initial	44	,164614	,0313363	,0047241
			final	44	,148341	,0318102	,0047956
German	speech	DurLateral	initial	45	,120084	,0274004	,0040846
			final	45	,131527	,0336179	,0050115
	song	DurLateral	initial	45	,159404	,0219097	,0032661
			final	45	,174367	,0566588	,0084462

Table 5. The duration of laterals in Norwegian and German (significance)

Independent Samples Test

				Levene's Test for Equality of Variances		t-test for Equality of Means						
											95% Confidence Interval of the Difference	
language	mode			F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Norwegian	speech	DurLateral	Equal variances assumed	2,168	,144	2,192	88	,031	,0160689	,0073323	,0014974	,0306404
			Equal variances not assumed			2,192	84,036	,031	,0160689	,0073323	,0014878	,0306500
	song	DurLateral	Equal variances assumed	,293	,590	2,417	86	,018	,0162727	,0067316	,0028907	,0296548
			Equal variances not assumed			2,417	85,981	,018	,0162727	,0067316	,0028906	,0296548
German	speech	DurLateral	Equal variances assumed	2,887	,093	-1,770	88	,080	-,0114422	,0064652	-,0242904	,0014060
			Equal variances not assumed			-1,770	84,560	,080	-,0114422	,0064652	-,0242977	,0014133
	song	DurLateral	Equal variances assumed	27,957	,000	-1,652	88	,102	-,0149622	,0090557	-,0329585	,0030341
			Equal variances not assumed			-1,652	56,871	,104	-,0149622	,0090557	-,0330968	,0031724

These tables show that laterals in Norwegian speech and singing are in fact longer in initial than in final position; the difference is, however, significant only in singing. In German, the lateral has a longer duration in final position than in initial position, in both speech and song, and the differences are significant in both modes. In both languages, the numbers reveal that all laterals, regardless of position, are longer in singing than in speech.

6. Laterals in German and Norwegian singing

6.1 Introduction

It has been pointed out that dark laterals have a similar timbre as a back vowel, and that when dark laterals vocalize, they sound like an [o] or [u]. This raises an important question: If we can sing an /u/, why should we not be able to sing a dark [ɫ]? What is it about its quality that is so offensive to vocal instructors and singers alike? Part of the answer probably lies in the simple articulatory and acoustic facts that have been presented in the preceding: The reduced size of the back resonance chamber for [ɫ] may result in reduced resonation for [ɫ]; but in dark laterals, the F1 and F2 are closer in frequency, and the closer two formants are, the more they strengthen each other mutually.[37] To this should be added that dark laterals tend to have a higher intensity.[38] But part of the answer may also lie in the received wisdom and traditional beliefs concerning the 'correctness' and beauty of certain sounds, and the corresponding incorrectness and 'ugliness' of certain others.

A second point to be made is that we know that vowels are equalized in singing:[39] Front vowels are pulled slightly backwards (possibly due to a lowered larynx) compared to their position in normal speech, and close vowels are pulled downwards (and therefore have a higher F1 than in speech). It is logical to assume that the same happens to laterals, given their vowel-like properties.[40]

6.2 Laterals in singing vs. speech

Are different lateral qualities used in speech and song? We have already pointed out that only clear laterals are expected in classical singing. Corpus C is the only part of our corpus which thus far has any contrastive material (German and Norwegian) for speech and song, and we would like to present a few findings, some of which will be analysed and presented in more detail in the MA thesis of one of Ophaug's students.[41] Contrary to expectations, the Norwegian singers use a darker quality for final laterals after /o:/ and /a:/, which is in keeping with modern Norwegian pronunciation.

We know that vowels are equalized in singing, in the sense that the vowel space is smaller and more centralized.[42] We checked this for Corpus C also, and the findings are clear: Both the Norwegian and the German singers use a reduced vowel space in song. Are laterals also equalized in singing? We found clear indications that they are, but to varying degrees in the different informants. That is, the dark laterals are still different from light laterals, but they move closer to the light variants, and the perceived 'gap' is less distinct. Our findings for clear laterals are similarly interesting: In Norwegian, the F1 increases considerably in song compared to speech, but only marginally so in German. The unique German final lateral which we find in speech and which has especially high F1 values seems to be retained in singing. It therefore seems to be particularly well suited for singing. Given that F1 values increase considerably in Norwegian singing compared to speech, one could certainly argue that Norwegian final laterals

become more like the German variant with respect to F1. However, while F2 values are scattered for Norwegian, they are more stable and centered for German.

6.3 The intensity of laterals

With regard to intensity (decibel), we have measured all tokens for Corpus C (laterals and vowels). In Norwegian, the intensity of the dark lateral is significantly higher than that of the clear variant, which is as expected, but the difference between singing and speech is not significant (Table 6). In German, the unique and highly resonant final lateral is significantly more intense than the light initial allophones.

Table 6. The intensity of Norwegian laterals

Group Statistics

mode		quality	N	Mean	Std. Deviation	Std. Error Mean
speech	dBLat	clear	107	55,1799	4,76146	,46031
		dark	18	59,7333	2,99454	,70582
song	dBLat	clear	106	57,9674	2,93007	,28459
		dark	18	61,4028	2,01946	,47599

Independent Samples Test

			Levene's Test for Equality of Variances		t-test for Equality of Means						
										95% Confidence Interval of the Difference	
mode			F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
speech	dBLat	Equal variances assumed	5,373	,022	-3,921	123	,000	-4,55343	1,16124	-6,85203	-2,25482
		Equal variances not assumed			-5,404	33,562	,000	-4,55343	,84265	-6,26673	-2,84012
song	dBLat	Equal variances assumed	1,885	,172	-4,777	122	,000	-3,43542	,71912	-4,85900	-2,01184
		Equal variances not assumed			-6,195	30,692	,000	-3,43542	,55458	-4,56696	-2,30388

A comparison between light final laterals in German and Norwegian reveals that the unique German final lateral has a higher intensity than the Norwegian final lateral, and the difference is significant for both speech and singing (Table 7).

Table 7. The intensity of clear final laterals in German and Norwegian, speech and song

Group Statistics

mode		language	N	Mean	Std. Deviation	Std. Error Mean
speech	dBLat	Norwegian	45	55,5013	3,60922	,53803
		German	44	58,2691	3,81664	,57538
song	dBLat	Norwegian	44	58,0152	3,06036	,46137
		German	45	64,6518	4,97830	,74212

Independent Samples Test

mode			Levene's Test for Equality of Variances		t-test for Equality of Means						
										95% Confidence Interval of the Difference	
			F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
speech	dBLat	Equal variances assumed	,138	,711	-3,516	87	,001	-2,76776	,78724	-4,33249	-1,20303
		Equal variances not assumed			-3,514	86,467	,001	-2,76776	,78774	-4,33362	-1,20190
song	dBLat	Equal variances assumed	12,828	,001	-7,556	87	,000	-6,63655	,87834	-8,38234	-4,89076
		Equal variances not assumed			-7,595	73,369	,000	-6,63655	,87384	-8,37797	-4,89513

Table 8 shows the difference between final laterals: the dark variety in Norwegian (after /o:/ and /a:/) vs. the unique German variant. It indicates that the Norwegian dark lateral has a significantly higher intensity than the corresponding German lateral in speech; in song, it is the other way round, and the values are statistically significant.

Table 8. The intensity of Norwegian and German final laterals

Group Statistics

mode		language	N	Mean	Std. Deviation	Std. Error Mean
speech	dBLat	Norwegian	18	59,7333	2,99454	,70582
		German	122	57,9416	4,15982	,37661
song	dBLat	Norwegian	18	61,4028	2,01946	,47599
		German	121	63,0226	4,54617	,41329

Independent Samples Test

mode			Levene's Test for Equality of Variances		t-test for Equality of Means						
										95% Confidence Interval of the Difference	
			F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
speech	dBLat	Equal variances assumed	2,711	,102	1,759	138	,081	1,79178	1,01868	-,22246	3,80601
		Equal variances not assumed			2,240	27,742	,033	1,79178	,80001	,15234	3,43121
song	dBLat	Equal variances assumed	11,328	,001	-1,486	137	,139	-1,61978	1,08979	-3,77476	,53519
		Equal variances not assumed			-2,570	48,397	,013	-1,61978	,63038	-2,88697	-,35260

Finally, is it possible for the lateral to have a higher intensity than the vowel? This may in fact be a better measure than the intensity of the lateral only, in so far as the strength of laterals depends on the strength and intensity of the whole word or syllable in which they occur. Figure 5 is typical of our findings regarding the intensity of the lateral compared to the strength of the vowel in Norwegian: The lateral is only very rarely more intense than the vowel, even when the lateral is dark after /o:/ and /a:/. The same was found for light laterals, both in speech and in song.

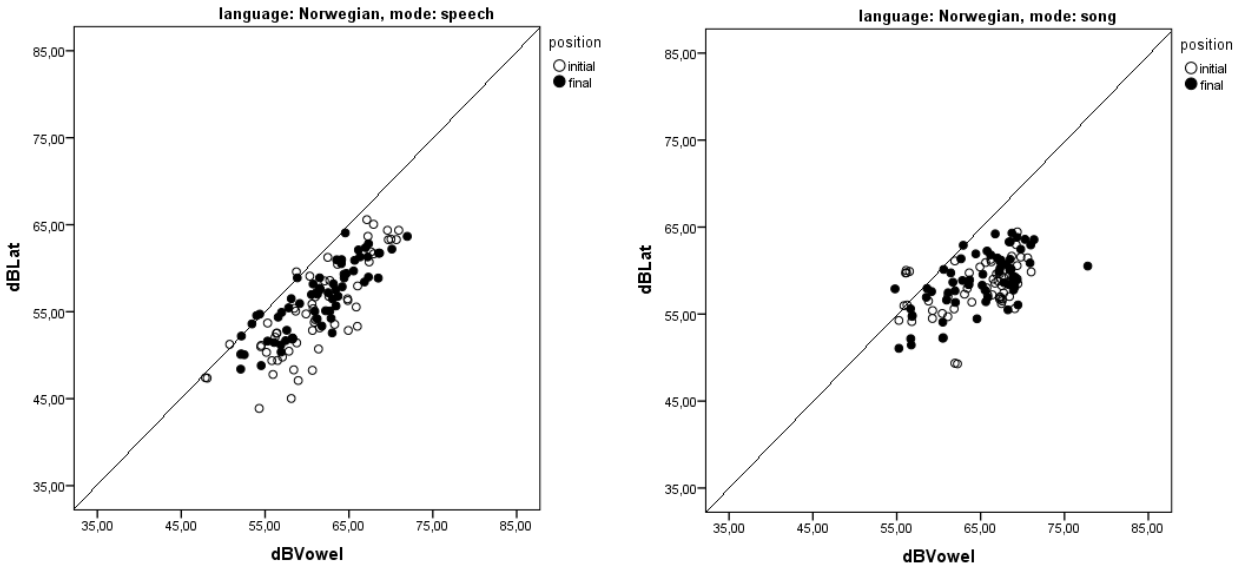

Figure 5. The intensity of Norwegian initial and final laterals compared to the vowel (song)

Figure 6 in turn is typical of the intensity of German final laterals compared to the intensity of the vowel: The lateral is frequently stronger than the vowel. The same pattern is seen in speech, but it is less frequent. Initial German laterals, however, tend not to be more intense than the vowel. Thus, the special German final lateral behaves differently – again – than both the dark laterals and the other light laterals.

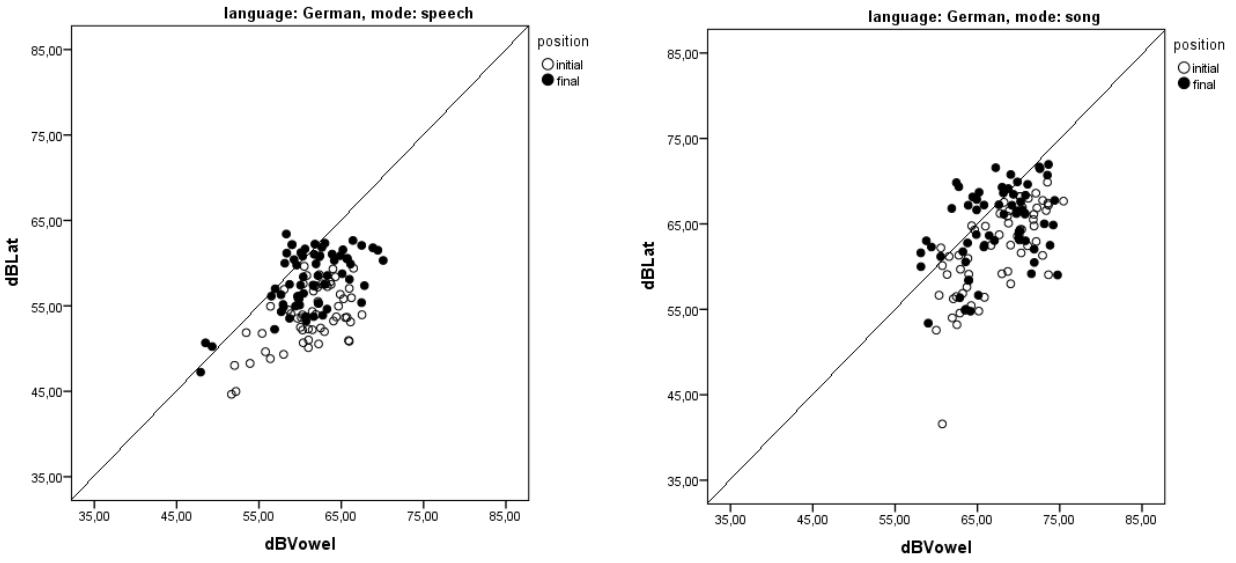

Figure 6. The intensity of German initial and final laterals compared to the vowel (song)

7. Conclusions

This paper has made an attempt at giving precise answers to questions pertaining to the acoustic differences between laterals in two modes, speech and singing, and in three languages, German, Norwegian and English. We have made highly interesting and promising discoveries so far, and will continue to use our CO-LATERAL corpus to uncover the fascinating, but elusive, properties of laterals.

In our pilot study, we found that BrE dark laterals have a significantly lower F2 than their Norwegian counterparts, and are therefore perceived as darker. They are also longer, but it is only the duration of the vowel and the lateral combined that is significantly longer in BrE, which suggests that the lateral eats up part of the vowel.

We have also found that BrE and Norwegian laterals, in terms of F2 values, form two groups that are clearly separate, which means that the traditional dichotomy between two lateral allophones is correct for these varieties. There is overlap in the F1 values, however, and the gap between the allophones is less distinct in singing. In Canadian English, on the other hand, the lateral realisations form a continuum within the 'dark range'. Female speakers of Canadian English also have clearer initial than final laterals, whereas no positional difference is found in the males.

The final German lateral is clearly a lateral type of its own, in having high values for both F1 and F2, and in showing little co-articulatory effect from neighbouring vowels. For Norwegian laterals, conversely, the values are diffused or spread along both axes.

Measurements of the duration of laterals in Vancouver English show that initial laterals are shorter than final ones, and that the difference is statistically significant. Comparison between German and Norwegian reveals that all laterals, in both languages and regardless of position, are longer in song than in speech. The two languages demonstrate differences with respect of position, in that German laterals are longer finally than initially (like in English), whereas it is the other way round for Norwegian. However, we are not sure that this finding would hold for more natural speech than that provided by singers, who are systematically taught good diction and who seem to exaggerate initial *l*'s.

In the mode of singing, our data support earlier studies and show that vowels are equalized, in that the available vowel space is smaller and more central. Equalization also affects laterals: There is still a difference between clear and dark *l*'s, but the dark variants move closer to the light ones. The F1 increases in singing in Norwegian laterals, and so they are more similar to German laterals in this particular mode.

As regards decibel, Norwegian dark laterals are significantly more intense than clear allophones, in both modes. The special final lateral in German is significantly more intense than clear initial variants in the same language, and when German and Norwegian clear final allophones are compared, the German allophone has a higher intensity, and significantly so, in both speech and singing. Measurements of the intensity of the vowel vs. the lateral offer interesting findings: In Norwegian, the lateral is only very rarely more intense than the vowel, and this is true of both

lateral types and both modes; in German, the same pattern is found for initial laterals, but the special final lateral is frequently more intense than the vowel.

Literature

Adams, D. *A Handbook of Diction for Singers. Italian, German, French*. Oxford: Oxford University Press, 2008.

Barry, M. C. "A phonetic and phonological investigation of English clear and dark syllabic /l/", *Bulletin de la Communication Parlée* 5 (2000): 77-88.

Bladon, R.A.W. "The production of laterals: some acoustic properties and their physiological implications". In H. Hollien and P. Hollien, eds. *Current Issues in the Phonetic Sciences* (1979): 501-508. Amsterdam: John Benjamins, 1979.

Fevang, K. MA thesis on laterals in singing in German and Norwegian. University of Oslo, forthcoming.

Giles, S. and K. Moll. "Cinefluorographic study of selected allophones of English /l/." *Phonetica* 31 (1975): 206-227.

Hardcastle, W. and W. Barry. "Articulatory and perceptual factors in /l/ vocalisations in English." *Journal of the International Phonetic Association* 15, no. 2 (1989): 3-17.

Johnson, W. and D. Britain. "L-vocalisation as a natural phenomenon: explorations in sociophonology." *Language Sciences* 29 (2007): 294-315.

LaBouff, K. *Singing and Communicating in English. A Singer's Guide to English Diction*. Oxford: Oxford University Press, 2008.

Lehiste, I. "Acoustical characteristics of selected English consonants." *Indiana University Research Center in Anthropology, Folklore and Linguistics* 34 (1964): 10-50.

Narayanan, S.S., A.A. Alwan and K. Haker. "Toward articulatory-acoustic models for liquid approximants based on MRI and EPG data. Part I. The laterals." *Journal of the Acoustic Society of America* 101, no. 2 (1997): 1064-1077.

Ohala, J.J. "Coarticulation and Phonology." *Language and Speech* 36, nos.2-3 (1993): 155-170.

Ophaug, W. "Vowel Migration and Equalisation in Classical Singing: A Formant-Based Acoustic and Perception Study of German and Norwegian Long Vowels in Speech and Singing." PhD dissertation, University of Oslo, 1999.

Ophaug, W. "The Vowel-like Lateral in German. A contrastive acoustic comparison of German and Norwegian prevocalic and postvocalic laterals." *Arbeitsberichte des Germanistischen Instituts der Universität Oslo* 19 (2002): 53-76.

Ophaug, W. *Sangfonetikk: En innføring*. Bergen: Fagbokforlaget Vigmostad og Bjørke, 2010a.

Ophaug, W. "The Pronunciation of /r/ in German Classical Singing." *Journal of Singing* 66, no. 5 (2010b): 561-574.

Ophaug, W. "Troubleshooting Norwegian Pronunciation in Classical Singing." *Journal of Singing* 69, no. 1 (2012): 49-56.

Proctor, M. "Towards a gestural characterization of liquids: Evidence from Spanish and Russian." *Journal of Laboratory Phonology* 2 (2011): 451-485.

Recasens, D. "An articulatory-perceptual account of vocalization and elision of dark /l/ in the Romance languages," *Language and Speech* 39, no. 1 (1996): 63-89.

Solon, M. "L2 Spanish /l/: The Roles of F2 and Segmental Duration in Foreign Accent Perception." In E. W. Willis *et al*., eds. *Selected Proceedings of the 6th Conference on Laboratory Approaches to Romance Phonology*; 83-94. Somerville, MA: Cascadilla Proceedings Project, 2015.

Sproat, R. and O. Fujimura. "Allophonic variation in English /l/ and its implications for phonetic implementations." *Journal of Phonetics* 21 (1993): 291-311.
Turton, D. "Some /l/s are darker than others: Accounting for variation in English /l/ with ultrasound tongue imaging." *U. Penn Working Papers in Linguistics* 2, no. 2 (2014): 189-198.
Wells, J. C. Phonetics blog on laterals. http://phonetic-blog.blogspot.no/2012/02/what-ell.html
West, P. "Long-Distance Coarticulatory Effects of English /l/ and /r/." PhD dissertation, University of Oxford, 2000.

Notes

[1] W. Ophaug, "Troubleshooting Norwegian Pronunciation in Classical Singing," *Journal of Singing* 69, no. 1 (2012): 54.
[2] Ibid., 55.
[3] W. Ophaug, "The Pronunciation of /r/ in German Classical Singing," *Journal of Singing* 66, no. 5 (2010).
[4] W. Ophaug, "Troubleshooting Norwegian Pronunciation in Classical Singing," *Journal of Singing* 69, no. 1 (2012).
[5] Researchers use different terms for the position of the lateral: some focus on whether the lateral is pre-vocalic or post-vocalic, others focus on the lateral's position in the syllable or the word.
[6] J. J. Ohala, "Coarticulation and Phonology," *Language and Speech* 36, nos. 2-3 (1993); P. West, "Long-Distance Coarticulatory Effects of English /l/ and /r/," (PhD dissertation, University of Oxford, 2000).
[7] W. Hardcastle and W. Barry, "Articulatory and perceptual factors in /l/ vocalisations in English," *Journal of the International Phonetic Association* 15, no. 2 (1989): 3-17; W. Johnson and D. Britain, "L-vocalisation as a natural phenomenon: explorations in sociophonology," *Language Sciences* 29 (2007).
[8] S. Giles and K. Moll, "Cinefluorographic study of selected allophones of English /l/," *Phonetica* 31 (1975); R. Sproat and O. Fujimura, "Allophonic variation in English /l/ and its implications for phonetic implementations." *Journal of Phonetics* 21 (1993).
[9] D. Recasens, "An articulatory-perceptual account of vocalization and elision of dark /l/ in the Romance languages," *Language and Speech* 39, no. 1 (1996); M. Proctor, "Towards a gestural characterization of liquids: Evidence from Spanish and Russian," *Journal of Laboratory Phonology* 2 (2011).
[10] K. Fevang, MA thesis on laterals in singing in German and Norwegian, forthcoming.
[11] K. LaBouff, *Singing and Communicating in English. A Singer's Guide to English Diction* (Oxford: Oxford University Press, 2008).
[12] Ibid., 180.
[13] Ibid., 180 (original emphasis).
[14] Ibid., 181.
[15] In normal speech, our measurements show that initial laterals (and initial consonants in general) are very short, e.g. 4 ms., whereas final laterals tend to be considerably longer, e.g. 17 ms.
[16] K. LaBouff, *Singing and Communicating in English. A Singer's Guide to English Diction* (Oxford: Oxford University Press, 2008), 182.
[17] D. Adams, *A Handbook of Diction for Singers. Italian, German, French* (Oxford: Oxford University Press, 2008).

[18] The URL address is http://phonetic-blog.blogspot.no/search?q=what+the+ell.

[19] D. Adams, *A Handbook of Diction for Singers. Italian, German, French* (Oxford: Oxford University Press, 2008), 21.

[20] I. Lehiste, "Acoustical characteristics of selected English consonants," *Indiana University Research Center in Anthropology, Folklore and Linguistics* 34 (1964).

[21] R. Sproat and O. Fujimura, "Allophonic variation in English /l/ and its implications for phonetic implementations." *Journal of Phonetics* 21 (1993), 293.

[22] S. Giles and K. Moll, "Cinefluorographic study of selected allophones of English /l/," *Phonetica* 31 (1975); D. Turton, "Some /l/s are darker than others: Accounting for variation in English /l/ with ultrasound tongue imaging," *U. Penn Working Papers in Linguistics* 2, no. 2 (2014).

[23] S. Giles and K. Moll, "Cinefluorographic study of selected allophones of English /l/," *Phonetica* 31 (1975); R. Sproat and O. Fujimura, "Allophonic variation in English /l/ and its implications for phonetic implementations." *Journal of Phonetics* 21 (1993).

[24] S. Giles and K. Moll, "Cinefluorographic study of selected allophones of English /l/," *Phonetica* 31 (1975), 211.

[25] S. S. Narayanan, A.A. Alwan and K. Haker, "Toward articulatory-acoustic models for liquid approximants based on MRI and EPG data. Part I. The laterals," *Journal of the Acoustic Society of America* 101, no. 2 (1997).

[26] S. Giles and K. Moll, "Cinefluorographic study of selected allophones of English /l/," *Phonetica* 31 (1975), 212.

[27] R. Sproat and O. Fujimura, "Allophonic variation in English /l/ and its implications for phonetic implementations." *Journal of Phonetics* 21 (1993), 293-300.

[28] R. A. W. Bladon, "The production of laterals: some acoustic properties and their physiological implications", in H. Hollien and P. Hollien, eds. *Current Issues in the Phonetic Sciences* (Amsterdam: John Benjamins, 1979).

[29] S. S. Narayanan, A.A. Alwan and K. Haker, "Toward articulatory-acoustic models for liquid approximants based on MRI and EPG data. Part I. The laterals," *Journal of the Acoustic Society of America* 101, no. 2 (1997); M. C. Barry, "A phonetic and phonological investigation of English clear and dark syllabic /l/," *Bulletin de la Communication Parlée* 5 (2000); M. Solon, "L2 Spanish /l/: The Roles of F2 and Segmental Duration in Foreign Accent Perception," in E. W. Willis *et al*., eds. *Selected Proceedings of the 6th Conference on Laboratory Approaches to Romance Phonology* (Somerville, MA: Cascadilla Proceedings Project, 2015).

[30] S. S. Narayanan, A.A. Alwan and K. Haker, "Toward articulatory-acoustic models for liquid approximants based on MRI and EPG data. Part I. The laterals," *Journal of the Acoustic Society of America* 101, no. 2 (1997), 1074; M. C. Barry, "A phonetic and phonological investigation of English clear and dark syllabic /l/," *Bulletin de la Communication Parlée* 5 (2000), 85.

[31] S. S. Narayanan, A.A. Alwan and K. Haker, "Toward articulatory-acoustic models for liquid approximants based on MRI and EPG data. Part I. The laterals," *Journal of the Acoustic Society of America* 101, no. 2 (1997), 1074.

[32] 1 speaker was recorded, who speaks native Norwegian and near-native British English (Stenbrenden).

[33] This number may be smaller when segmentation of the recordings is complete.

[34] The intention is to record a variety of accents of English systematically.

[35] W. Ophaug, "The Vowel-like Lateral in German. A contrastive acoustic comparison of German and Norwegian prevocalic and postvocalic laterals," *Arbeitsberichte des Germanistischen Instituts der Universität Oslo* 19 (2002).

[36] S. di Carlo, "L'intelligibilité de la voix chantée," Médicine des Arts 10 (1994).

[37] J. Sundberg, "The singer's formant revisited," Voice, 4 (1995).

[38] W. Ophaug, "The Vowel-like Lateral in German. A contrastive acoustic comparison of German and Norwegian prevocalic and postvocalic laterals," *Arbeitsberichte des Germanistischen Instituts der Universität Oslo* 19 (2002).

[39] W. Ophaug, "Vowel Migration and Equalisation in Classical Singing: A Formant-Based Acoustic and Perception Study of German and Norwegian Long Vowels in Speech and Singing" (PhD dissertation, University of Oslo, 1999); Wencke Ophaug, *Sangfonetikk: En innføring* (Bergen: Fagbokforlaget Vigmostad og Bjørke, 2010).

[40] W. Ophaug, "The Vowel-like Lateral in German" (2002).

[41] K. Fevang, MA thesis on laterals in German and Norwegian singing (University of Oslo, forthcoming).

[42] W. Ophaug, "The Vowel-like Lateral in German" (2002).