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© Sidney MARTÍN MOTA
Universitat Rovira i Virgili
sidney.martin@estudiants.urv.es

On the Evolutionary Path of l-vocalization in the Occitan spoken in Val d'Aran

1. Introduction

Aranese is the Occitan spoken in Val d'Aran, which has many distinctive traits among which we find l-vocalization into a velar approximant of preconsonantal and syllable final /l/ in words such as *sau, cèu, naut* and *fauta* (Coromines, 1991). The question which prompted this study is how l-vocalization could have been implemented in Aranese as well as in other Occitan varieties. This study wants to explore the conditions needed to trigger the sound change by considering synchronic data and analyzing what conditions were more likely to trigger the change. It will provide evidence for a gradual change in the evolutionary path of l-vocalization, based on perceptual data as indirect evidence for change in articulation. Hypothesized underlying mechanisms which might have effected the perception of l-vocalization will be explored.

/l/ is a voiced apico-alveolar approximant (Catford 1977), which has been traditionally accepted as having two allophones, known as velarized (dark) and non-velarized (clear) /l/, whose basic distinction is found in the raising of the tongue dorsum (TD) towards the soft palate for the velarized /l/ (Catford 1977). It is with the lingual configuration of a velarized-l that l-vocalization into a velar approximant is possible since the tongue tip (TT) usually fails to make alveolar contact due to the phonetic context, thus resulting in a lingual configuration akin to that of a velar approximant. For instance, Vulgar Latin already had cases of velarized /l/s in preconsonantal position becoming a velar approximant as in *cau<u>c</u>ulus*, possibly due to

an incomplete closure of the TT at the alveolar region effected by the following consonant (Väänänen, 1963[1]). However, such process was sporadical.

Interestingly, incomplete closure fails to account for all the cases of l-vocalization (Recasens 1996). This study will explore the articulatory mechanisms which trigger the perception of l-vocalization apart from incomplete closure of the TT gesture.

From a more dynamical perspective, Sproat & Fujimura (1993) and Browman & Goldstein (1995) describe velarized-/l/s as the result of phasing the TD gesture before the TT gesture. Therefore, it is very likely that if the TT gesture is in any way altered, the acoustic output will be that of a velar approximant effected by the TD gesture which was phased first. It is thus critical that the TD gesture be phased before the TT gesture in order to favor vocalization into a velar approximant.

This study will show that the perception of l-vocalization, as indirect evidence of production of l-vocalization, varies as a function of phonetic context (more specifically, consonant following /l/) and speech rate, from which it is inferred that l-vocalization must have had a gradual historical implementation before all /l/s became vocalized in the Aranese lexicon, spreading from more to less favoring conditions.

2. Method

2.1 Subjects

The experiment consisted of 10 subjects[2] listening to the following sentences uttered by a Catalan speaker: *cal tintar, cal tocar, cal quillar, cal colar, cal polir, cal pintar, gel quillat, gel colat, gel polit, gel pintat, gel tintat and gel tocat*. The recruiting criterion for the perception test was that subjects had to be Aranese speakers who could also speak Catalan.

[1] "On a un premier exemple de la vocalisation de *l* dans *cauculus* = calculus (Itala, Anthine, Chiron, gloss., etc.) et *cauculatio* (gloss.), *cauculator* (gloss., édit de Dioclétien, de l'an 301)", p. 65.
[2] eight adult women and two adult men who reported no hearing disorders.

Subjects were asked to complete a questionnaire where they indicated whether they heard a Catalan or an Aranese sentence. The subject selected to read the sentences speaks a *Català Oriental* variety (Eastern Catalan), which is considered to be the standard variety of Catalan. Also, the fact that /l/s in *Català Oriental* are velarized will simulate the change of velarized /l/s into a velar approximant in Aranese[3]. Furthermore, a Català Oriental speaker was chosen because the phrases are phonemically the same as the Aranese phrases, being the vocalization of the /l/ in the words *cal* and *gel* the only difference between the two languages. The main cue listeners were expected to use is the *–au* vs *–al* and *–el* vs *-èu* distinction.

2.2. Stimuli

In order to test the hypothesis, natural speech was employed in which the following sequence V1 l # C2 V2 was included. Vowel preceding /l/ (V1), consonant following /l/ (C2) and vowel following the l#C2 sequence (V2) were the variables controlled for in the sequence. In addition, speech rate was also controlled for, being normal and fast the two levels of the variable. The focus is on the effect of speech rate and C2 on the perception of l-vocalization, but the effect of V1 (/a/ and /E/) and V2 (/u/ and /i/)[4] will also be assessed.

C2 selected for testing are /k/, /t/ and /p/. /l#k/ sequences, corresponding to *cal colar, cal quillar, gel colat* and *gel quillat*, have a TD>TT>TD sequence in terms of lingual gestures. However, as speech rate increases, and assuming that gestural economy is at work, it is very likely that the TT gesture is reduced in magnitude since after the TT gesture for the /l/ the tongue is forced to move to a posterior position in order to block the air for pressure build-up at the velar region. l#k is expected to yield more percepts of l-vocalization than the other two contexts.

[3] all the target /l/s in the utterances included in the perception test show little frequency distance between F1 and F2. *F2-F1 distance* has been previously employed to quantify degree of velarity (Recasens, Fontdevila & Pallarès 1995). The lower the distance between F1 and F2, the higher the degree of velarity. The mean *F2-F1 distance* in the utterances employed in the perception test is 692.36 Hz (±127.32 Hz). This figure is lower than the one given by Recasens, Fontdevila & Pallarès (1995) for their *Català Oriental* velarized /l/s, which is 1042.04 Hz (±337.15 Hz), indicating that the /l/s used for the perception test here can also be considered velarized.

[4] The –o- in *polit, polir, colar* and *colat* is /u/ in Aranese and Eastern Catalan.

As far as/l#t/ is concerned, corresponding to *cal tintar, cal tocar, gel tintat* and *gel tocat*, the sequence is TD>TT>TT. In this context the two TT gestures are next to each other and have similar places of articulation: one corresponding to the velarized /l/ and the other one to the following /t/. In this case TT reduction of the velarized /l/ seems to be blocked since the following gesture is also a TT gesture at the alveolar ridge. Finally, /l#p/, corresponding to *cal polir, cal pintar, gel polit* and *gel pintat*, is the sequence which shows less interference with the TT gesture corresponding to velarized /l/ since /p/ is a lip gesture. For this reason, l#p is the control condition in this study.

2.3. Procedures

The recording of the sentences to be presented in the perception test was carried out in the *Universitat Rovira i Virgili* Phonetics Lab. The speaker was instructed to utter the sentences at two self chosen speech rates, i.e. first normal speech rate and then fast speech rate, adding to a total amount of 24 sentences. The speaker read the sentences from a PowerPoint presentation, which showed each sentence at intervals of three seconds. The recordings were made on a Marantz Portable Cassette Recorder PMD222 and were digitized at 11 KHz using Macquirer® signal analysis software created by Scicon Research & Development.

The duration of the sentences was measured in order to check that normal sentences were longer than fast ones. One-way factorial yielded a significant difference between normal and fast tokens with a p.value <.01 [$F(1,23)=39.74$; $p<.01$]. Once the sentences were digitized, a perception test was designed. Each sentence was presented to the listeners five times in a randomized order, adding to a total amount of 120 percepts per subject (12 sentences x 2 rates x 5 times). Ten subjects were recruited, adding to a total number of 1200 percepts.

Listeners were asked to listen to the tokens which were presented one by one by the experimenter and to complete a questionnaire which forced them to choose either Catalan or Aranese as the language used for each token. They were told that each sentence would only be played once and if they doubted, they were supposed to tell the experimenter who would mark the corresponding question in a different questionnaire. Listeners were required to

choose one answer even if they doubted. In order to check that listeners understood the instructions, they were given an example as a warm-up exercise.

The test was carried out in a silent room where listeners sat at one side of the table and the experimenter at the other side. Listeners had to put on some headphones (AKG, K240DF, 2x600 OHMS), through which they could hear the sentences played from a PowerPoint presentation in a laptop computer. When the listener gave an answer, the experimenter would play the next token. Each session would take an average time of six to seven minutes, after which listeners were asked on what cue they had based their judgement in order to check that the purpose of the experiment had been achieved. All of them employed the *–au/-èu vs –al/-el* cue.

3. Results

The –al/-el tokens identified as Aranese from the ten subjects were pooled and are displayed in table 1. The following sections will deal with each category in order to comprehend their effect on the perception of l-vocalization, which are *speech rate*, *consonant following /l/* (C2), *vowel preceding /l/* (V1) and *vowel following C2* (V2). The data will be explored by employing percentages to identify trends underlying the data. The statistical package used for this study is SPSS.

			RATE	
			Normal	Fast
V1	C2	V2	vocalized percepts	
a	t	u	10	23
a	t	i	12	2
a	p	u	21	4
a	p	i	2	1
a	k	u	13	15
a	k	i	9	22
E	t	u	0	1
E	t	i	2	1
E	p	u	7	4
E	p	i	3	3
E	k	u	9	2
E	k	i	2	3

Table 1: identification frequency of l-vocalization as a function of speech rate, vowel preceding /l/ (V1), consonant following /l/ (C2) and vowel following C2 (V2).

3.1 Speech Rate and Consonant following /l/

In general, 47.4% of the percepts fall in the fast speech rate category and 52.6% fall in the normal speech rate category (see table 2). A closer look at the data reveals the following. Figure 1 plots percentage of l-vocalization percepts for speech rate within each consonant following /l/. l-vocalization percepts increase in /l#k/ from 33 at a normal speech rate (44% within /k/) to 42 at a fast speech rate (56% within /k/). l-vocalization percepts in /l#t/ contexts increase from 24 at a normal speech rate (47.1% within /t/) to 27 at a fast speech rate (52.9% within /t/), whereas the percepts of l-vocalization in /l#p/ behave in an opposite manner, which drop from 33 at a normal speech rate (73.3% within /p/) to 12 at a fast speech rate (26.7% within /p/).

As far as the effect of C2 is concerned (see table 2), out of a total of 171 percepts /l#k/ yielded the highest number of vocalized-l percepts which is 75 (43.9% of Total), followed by /l#t/ with 51 (29.8% of Total) and /l#p/ with 45 (26.3% of Total). The general pattern is highlighted in yellow in table 2, which is also found within fast speech rate.

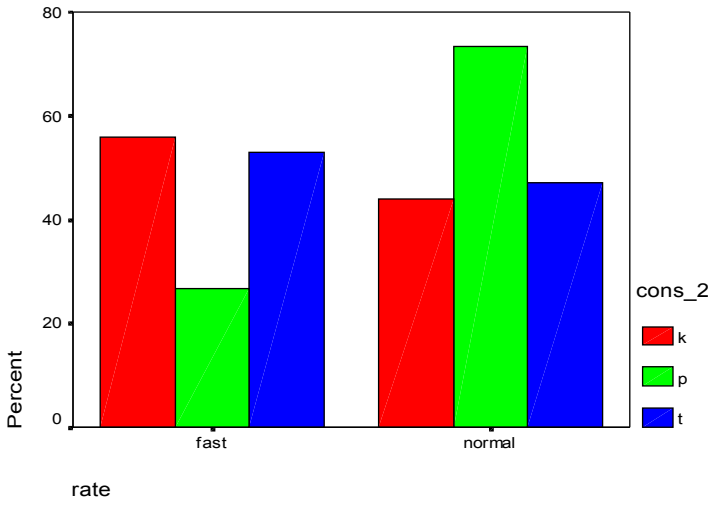

Figure 1: Bar chart displaying percentage of l-vocalization percepts (vertical axis) as a function of speech rate within each consonant (horizontal axis). /l#k/=red bars; /l#p/=green bars; /l#t/=blue bars.

			C2			Total
			k	p	t	
rate	fast	Count	42	12	27	81
		% within rate	51.9%	14.8%	33.3%	100.0%
		% within C2	56.0%	26.7%	52.9%	47.4%
		% of Total	24.6%	7.0%	15.8%	47.4%
	normal	Count	33	33	24	90
		% within rate	36.7%	36.7%	26.7%	100.0%
		% within C2	44.0%	73.3%	47.1%	52.6%
		% of Total	19.3%	19.3%	14.0%	52.6%
Total		Count	75	45	51	171
		% within rate	43.9%	26.3%	29.8%	100.0%
		% within C2	100.0%	100.0%	100.0%	100.0%
		% of Total	43.9%	26.3%	29.8%	100.0%

Table 2: Summary table of counts and percentages falling under consonant following /l/ (C2) and speech rate (rate). Percentages are read from the rows labelled % within rate, % within C2 and % of Total. General pattern of the effect of C2 on l-vocalization is highlighted in yellow.

Table 2 shows that a total of 81 percepts fall in the fast rate category (47.4% of the total) and of these 42 correspond to /l#k/ (51.9% within rate), 27 correspond to /l#t/ (33.3% within rate) and 12 correspond to /l#p/ (14.8% of the total rate). As far as normal rate is concerned, 90 percepts fall in the normal rate category (52.6% of the total) and of these 33 correspond to /l#k/ (36.7% within rate), 33 correspond to /l#p/ (36.7% within rate) and 24 to /l#t/ (26.7% within rate). Figure 2 displays percentage of percepts for each of the three phonetic contexts (l#k, l#k and l#p) within each speech rate.

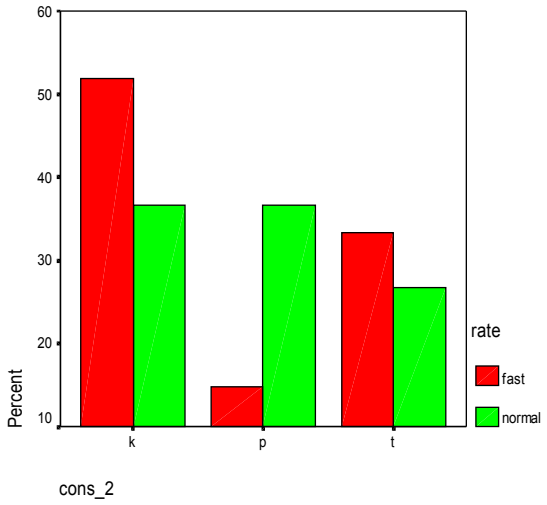

Figure 2: bar graph representing percentage of l-vocalization percepts (vertical axis) as a function of consonant following /l/ within each speech rate (horizontal axis). Fast speech rate=red bars; normal speech rate=green bars.

3.2. Vowel preceding /l/: (V1)

In order to assess the effect of V1 on the perception of l-vocalization the following steps are followed: first, the percentages of the total of percepts which fall under /a/ and /E/ are compared; second, the general pattern observed in section 3.1 for the effect of C2 on the perception of l-vocalization, l#k>l#t>l#p, will be used as reference to see whether it is modified by V1 and how; third, the number of percepts for identical sequences with different V1 are compared.

Out of 171 cases 78.4% of them fall under the /a/ category whereas 21.6% fall under /E/ (see table 3). In order to control for a third variable, V1, a new table (see table 4) has been created in order to assess whether V1 influences the general pattern, l#k>l#t>l#p.

			Total
V1	/a/	Count	134
		% of Total	78.4%
	/E/	Count	37
		% of Total	21.6%
Total		Count	171
		% of Total	100.0%

Table 3: table showing number of percepts (Count) with corresponding percentages which falls under vowel preceding /l/ (V1).

				C2			Total
				k	p	t	
a	rate	fast	Count	37	5	25	67
			% within rate	55.2%	7.5%	37.3%	100.0%
			% within C2	62.7%	17.9%	53.2%	50.0%
			% of Total	27.6%	3.7%	18.7%	50.0%
		normal	Count	22	23	22	67
			% within rate	32.8%	34.3%	32.8%	100.0%
			% within C2	37.3%	82.1%	46.8%	50.0%
			% of Total	16.4%	17.2%	16.4%	50.0%
Total			Count	59	28	47	134
			% within rate	44.0%	20.9%	35.1%	100.0%
			% within C2	100.0%	100.0%	100.0%	100.0%
			% of Total	44.0%	20.9%	35.1%	100.0%
E	rate	fast	Count	5	7	2	14
			% within rate	35.7%	50.0%	14.3%	100.0%
			% within C2	31.3%	41.2%	50.0%	37.8%
			% of Total	13.5%	18.9%	5.4%	37.8%
		normal	Count	11	10	2	23
			% within rate	47.8%	43.5%	8.7%	100.0%
			% within C2	68.7%	58.8%	50.0%	62.2%
			% of Total	29.7%	27.0%	5.4%	62.2%
Total			Count	16	17	4	37
			% within rate	43.2%	45.9%	10.8%	100.0%
			% within C2	100.0%	100.0%	100.0%	100.0%
			% of Total	43.2%	45.9%	10.8%	100.0%

Table 4: counts and percentages of l-vocalization percepts falling under speech rate and C2 within /a/ and /E/. Percentages of total cases falling under the different levels of C2 are highlighted in yellow in order to compare with the general pattern l#k>l#t>l#p.

The general pattern l#k > l#t > l#p is also observed within /a/ [l#k (44% of total) > l#t (35.1% of total) >l#p (20.9% of total)] and also for fast speech rate within /a/ [l#k (55.2% within rate) > l#t (37.3% within rate) > l#p (7.5% within rate)].

Within /E/, /l/ adjacent to /k/ yields more percepts of l-vocalization (43.2% of total) than adjacent to /t/ (10.8% of total), but fewer than /p/ (45.9% of total). This very same pattern is repeated within fast speech rate [l#p (50% within rate) > l#k (35.7% within rate) > l#t (14.3% within rate)]. Thus, the patterns observed within /E/ are different to the ones observed within /a/, which indicates that V1 has an effect on the perception of l-vocalization.

It is also possible to see the effect of V1 on the perception of l-vocalization when the number of percepts of two identical sequences with different V1 are compared (see table 1). For instance, /al#tu/ vs /El#tu/. In all the comparisons, the number of percepts is higher in /a/ than in /E/ with the only exceptions of /al#pi/ (2) vs /El#pi/ (3) within normal rate, /al#pu/ (4) vs /El#pu/ (4) within fast speech rate and /al#pi/ (1) vs /El#pi/ (3) within fast speech rate. The three exceptions fall under the /p/ category.

3.3. Vowel following l#C sequence: (V2)

In order to assess the effect of V2 on the perception of l-vocalization the following steps are followed: first, the percentages of the total of percepts which fall under /u/ and /i/ are compared; second, the general pattern observed in section 3.1, l#k>l#t>l#p, will be used as reference to see whether it is modified by V2 and how; third, the number of percepts for identical sequences with different V2 are compared.

Out of the 171 cases, /u/ yielded 63.7% of the total cases, whereas /i/ 36.3% (see table 5). A new table (see table 6) has been created in order to assess how V2 influences the general pattern observed in section 3.1, l#k>l#t>l#p, repeating the same exploration of the data carried out in section 3.2.

			Total
V2	/i/	Count	62
		% of Total	36.3%
	/u/	Count	109
		% of Total	63.7%
Total		Count	171
		% of Total	100.0%

Table 5: table showing number of percepts (Count) with corresponding percentage which falls under vowel following C2 (V2).

The data here reveal that /i/ does not interfere with the general pattern l#k (58.1% of total) >l#t (27.4% of total) >l#p (14.5% of total), whereas /u/ changes the pattern, rendering it as l#k (35.8% of total) >l#p (33% of total) >l#t (31.2% of total). Interestingly, /u/ yields similar percentages across C2, thus exerting what could be termed as a *levelling effect*. In addition, both l#p and l#t increase their number of percepts (counts) when V2 is /u/. However, /l#k/ yields similar number of percepts when V2 is /u/ (39) and V2 is /i/ (36).

				C2			Total
				k	p	t	
i	rate	fast	Count	25	4	3	32
			% within rate	78.1%	12.5%	9.4%	100.0%
			% within C2	69.4%	44.4%	17.6%	51.6%
			% of Total	40.3%	6.5%	4.8%	51.6%
		normal	Count	11	5	14	30
			% within rate	36.7%	16.7%	46.7%	100.0%
			% within C2	30.6%	55.6%	82.4%	48.4%
			% of Total	17.7%	8.1%	22.6%	48.4%
Total			Count	36	9	17	62
			% within rate	58.1%	14.5%	27.4%	100.0%
			% within C2	100.0%	100.0%	100.0%	100.0%
			% of Total	58.1%	14.5%	27.4%	100.0%
u	rate	fast	Count	17	8	24	49
			% within rate	34.7%	16.3%	49.0%	100.0%
			% within C2	43.6%	22.2%	70.6%	45.0%
			% of Total	15.6%	7.3%	22.0%	45.0%
		normal	Count	22	28	10	60
			% within rate	36.7%	46.7%	16.7%	100.0%
			% within C2	56.4%	77.8%	29.4%	55.0%
			% of Total	20.2%	25.7%	9.2%	55.0%
Total			Count	39	36	34	109
			% within rate	35.8%	33.0%	31.2%	100.0%
			% within C2	100.0%	100.0%	100.0%	100.0%
			% of Total	35.8%	33.0%	31.2%	100.0%

Table 6: counts and percentages of l-vocalization percepts falling under speech rate and C2 within /i/ and /u/. Percentages of total cases falling under the different levels of C2 are highlighted in yellow in order to compare with the general pattern l#k>l#t>l#p.

Comparing the number of percepts in identical sequences with different V2 (see table 1) shows that /u/ favors the perception of l-vocalization more than /i/ in all the comparisons with the exception of /al#tu/ (10) vs /al#ti/ (12) at normal speech rate, /El#tu/ (0) vs /El#ti/

(2) at normal speech rate, /al#ku/ (15) vs /al#ki/ (22) at fast speech rate, /El#tu/ (1) vs /El#ti/ (1) at fast speech rate and /El#ku/ (2) vs /El#ki/ (3) at fast speech rate. All the exceptions fall under the /t/ and /k/ categories.

Table 7 displays the number of percepts of l-vocalization with corresponding percentages falling under V1 and V2 combined. Out of 171 cases /al#C2u/ is the most favoring sequence (50.3%) followed by /al#C2i/ (28.1%), /El#C2u/ (13.5%) and /El#C2i/ (8.2%).

			V2		Total
			/i/	/u/	
V1	/a/	Count	48	86	134
		% within V1	35.8%	64.2%	100.0%
		% within V2	77.4%	78.9%	78.4%
		% of Total	28.1%	50.3%	78.4%
	/E/	Count	14	23	37
		% within V1	37.8%	62.2%	100.0%
		% within V2	22.6%	21.1%	21.6%
		% of Total	8.2%	13.5%	21.6%
Total		Count	62	109	171
		% within V1	36.3%	63.7%	100.0%
		% within V2	100.0%	100.0%	100.0%
		% of Total	36.3%	63.7%	100.0%

Table 7: Summary table combining vowel preceding /l/ (V1) and vowel following the /l#C/ sequence (V2), showing number of percepts (Count) which fall within each category. Percentages are read from the row labelled % of Total, highlighted in yellow.

Summary

Results show that the perception of l-vocalization varies as a function of speech rate, C2, V1 and V2, providing indirect evidence that production must also have varied as a consequence of the same factors. In general, the perception of l-vocalization increases at faster speech rates in l#k and l#t but decreases in l#p. /l/ adjacent to /k/ is the most favoring context followed by l#t and then l#p. As far as V1 is concerned, /a/ favors the perception of l-vocalization more than /E/. Furthermore, /u/ favors the perception of l-vocalization more

than /i/ within V2. Interestingly, /u/ seems to exert some kind of levelling effect on l#C2 since the three C2 contexts yielded similar percentages within /u/.

4. Discussion and Conclusions

This study relies on perceptual data, as indirect evidence of production, in order to account for sound change, more specifically l-vocalization. The hypothesis formulated here states that the percepts of vocalized-l will vary as a function of speech rate and phonetic context, thus providing evidence for a gradual historical implementation of l-vocalization. We are in a position to accept this hypothesis. First, the perception of l-vocalization increases at faster speech rates more than at normal speech rates in two out of the three phonetic contexts, e.g. l#k fast > l#k normal; l#t fast vs l#t normal. Second, the perception of l-vocalization varies as a function of the following consonant, revealing the following pattern l#k>l#t>l#p.

Following are the hypothesized underlying mechanisms in the line of what Articulatory Phonology (AP) would predict in order to account for l-vocalization. The AP model proposes that many common phonological processes such as assimilation and lenition are the result of two mechanisms: *gestural overlapping* and *gestural reduction* (Browman & Goldstein, 1989). In l#C2 sequences, the general trend is that listeners hear more vocalized /l/s when /l/ is adjacent to a velar stop than to an alveolar and bilabial stop. The underlying mechanism for the perception of l-vocalization in l#k may be tongue tip reduction which fails to complete a velarized /l/, but, interestingly, l-vocalization must be the result of other mechanisms since percepts of l-vocalization have fallen under the l#p and l#t categories. /p/ and /t/ in articulatory terms do not interrupt the TT trajectory of the velarized /l/. That is, the TT gesture for both velarized /l/ and /t/ is virtually the same. As for /l#p/ there is no interference between the labial gesture corresponding to /p/ and the TT gesture corresponding to velarized /l/. However, in both sequences percepts of l-vocalization have been identified.

It is then hypothesized that the mechanisms that may have yielded a perception of l-vocalization in l#t and l#p are *blending* and *hiding* of gestures, respectively, both being instances of *gestural overlapping* (Browman & Goldstein 1989). In l#t the TT gesture for /l/ and for /t/ may blend into one and be interpreted by the listener as one TT gesture which is assigned to /t/, thus /l/ remains with only the TD gesture, which is a lingual configuration akin to /u/. As far as /l#p/ is concerned, it seems to be that both TT and LABIAL gestures are activated at approximately the same time. As the lips close for pressure build-up for /p/ the TT is being gradually overlapped and thus acoustically hidden, which is interpreted by the listener as a similar sound to /u/. This would be in line with what Ohala (1993) proposes in his listener-based sound change where subjects misperceive /l/ for a velar approximant.

As far as speech rate is concerned, fast speech rates may be only reinforcing the underlying mechanism for each sequence, which effects the perception of l-vocalization. That is, TT reduction in l#k sequences and TT blending for l#t sequences are reinforced at fast speech rates. However, unexpectedly, the opposite has been observed for l#p sequences, possibly suggesting that gestural overlapping works more efficiently at normal speech rates in order to trigger the perception of l-vocalization.

Interestingly, the perception of l-vocalization in l#t at a fast speech rate and l#p at a normal speech rate is boosted when V2 is /u/ (see table 1). For l#p, it is thus suggested that the lip rounding of /u/ may partially overlap the TD gesture corresponding to velarized /l/, thus rendering an acoustic output similar to /u/. As for l#t, lip rounding of /u/ may overlap the blended TT gesture of /l/ and /t/ and even partially overlap the TD gesture of velarized /l/, enhancing an acoustic output akin to /u/. In /l#tu/ and /l#pu/ long distance coarticulatory effects of lip rounding reaching as far back as two "segments" may be the cause of the perception of l-vocalization.

The hypothesis focused on the fact that the perception of l-vocalization varied as a function of speech rate and C2; however, other variables have been controlled for such as V1 and V2. In general, the pattern is a>E for V1, coinciding with Recasens (1996) in that /a/ favors l-vocalization more than other vowels. As far as V2 is concerned, /u/ favors l-vocalization

more than /i/. /a/ is a low central vowel which requires that the tongue body (TB) be lowered whereas /E/ is a mid low front vowel, whose TB is higher up and more anterior in the oral cavity than /a/. The fact that /E/ hinders the perception of l-vocalization more than /a/ may be related to its more anterior articulation as well as its height properties, which would give priority to the TT gesture rather than the TD gesture of a velarized /l/.

A similar reasoning could be applied to the effect of V2 on l-vocalization. That is, the pattern observed is u>i, which in articulatory terms is the opposition of TB front vs TB back. One possible explanation is that /u/ is a back vowel, thus favoring TT reduction. However, in sequences such as /Vl#ku/ and /Vl#ki/ both yielded a similar number of percepts. That is, 39 and 36 respectively (see table 6). Therefore, in these two sequences /u/ may be only reinforcing the TD gesture of the previous velar stop, whose effect on l-vocalization may be greater than the articulatory demands of /u/ and /i/. However, /u/ seems to have a greater effect than /i/ on the other two sequences: l#t_ and l#p_, which may be caused by lip-rounding of /u/, activated well before actual achievement of labial or tongue tip closure. That is, lip rounding may have been activated during the TD gesture corresponding to velarized /l/, thus yielding an acoustic effect akin to /u/ during the transition from /l/ to /tu/ or /pu/. Here is perhaps why the number of percepts in l#tu and l#pu increased considerably.

It is also interesting to see how /u/ has a levelling effect (see table 6) across C2. Alveolar and bilabial contexts, which, in general, would not favor the perception of l-vocalization as much as velar contexts, are levelled with velar contexts possibly as a result of the gestural overlap of lip rounding of /u/ with the TD of adjacent /l/.

A word of caution is in order. One may object that l-vocalization is more frequent before apicals and labials. True, examples abound in the literature. However, one must also bear in mind that the implementation of any phonological process is always carried out on an already existing input/lexicon. Of particular interest to this study is the frequency of specific sequences within a given language. One may have the false impression that l-vocalization is more frequent before apicals, but one may forget that in the lexicon of the language under

study l+apical sequences may be more frequent than l+velar consonants. This might particularly be true of Latin and Romance languages.

Granted, it is mandatory to test these underlying articulatory mechanisms and correlate them with more perceptual data in order to understand how speech production and speech perception interact with each other. It would thus allow us to account for many synchronic and diachronic sound changes in speech such as l-vocalization in Aranese as well as in other Occitan varieties. It is also widely accepted that sound changes are historically gradual, affecting some contexts more than others; however, little is known about how the change could have been historically implemented. That is, its evolutionary path. This study has provided evidence that the historical implementation of l-vocalization (in word final /l/ and preconsonantal /l/) may have been gradual as a consequence of factors such as phonetic context and speech rate, spreading from more to less favoring conditions.

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