The Articulation of the East Norwegian Apical Liquids /l ɾ ɽ/

Inger Moen†, Hanne Gram Simonsen†, Arne Martinus Lindstad† and Steve Cowen‡

† University of Oslo, Norway

‡ Queen Margaret University College, Edinburgh, UK

E-mail: inger.moen@ilf.uio.no, h.g.simonsen@ilf.uio.no, a.m.lindstad@ilf.uio.no, scowen@qmuc.ac.uk

ABSTRACT

In East Norwegian there are three apical liquids, /l ɽ ɾ/. /l/ has traditionally been described as a retroflex lateral, /ɽ/ as a retroflex flap, and /ɾ/ as an alveolar (non-retroflected) tap or trill. Our EPG and EMA investigation of the East Norwegian apicals shows (i) individual variation with regard to retroflexion: /ɽ/ and /l/ are sometimes, but not always, retroflected, and – what is more surprising – /ɾ/ is frequently retroflected; (ii) a tendency to have a more retracted area of contact for /ɽ/ than for /l/ and /ɾ/; (iii) the trajectory of the tongue, combined with the velocity of the movement, distinguish the three sounds from each other. Our analyses show that the traditional classifications and descriptions do not capture the articulatory characteristics of the apical liquids.

1. INTRODUCTION

In the traditional *classifications* of the three Norwegian apical liquids /ɾ l ɽ/, /ɾ/ has been classified as an alveolar tap or trill, /l/ as a retroflex lateral, and /ɽ/ as a retroflex flap. In the more detailed phonetic *descriptions* in the literature /l/ is described as a retroflex alveolar, or postalveolar, lateral, /ɽ/ as a retroflex alveolar, or postalveolar, flap, and /ɾ/ as an apical alveolar or postalveolar tap or trill [1,2,3]. All of these use the place of articulation in the palate, the passive articulator, as the basis for their descriptions. A notable exception is Endresen [4] who uses both the passive and the active articulator in the description of the place of articulation. He refers to these consonants as apico-alveolar, apico-postalveolar, or (for /ɽ/ and /l/ only) sublamino-prepalatal.

We have focused on the following: (i) to what extent are the apical liquids retroflex, (ii) what are the contact areas between tongue and palate, (iii) what are the articulatory features distinguishing between the three sounds.

2. INSTRUMENTATION

We used electropalatography (EPG) and electromagnetic articulography (EMA) in our investigation.

For EPG we used the Reading EPG system, with 62 electrodes arranged in 8 rows, the front row containing 6 electrodes and the rest 8 electrodes each [5].

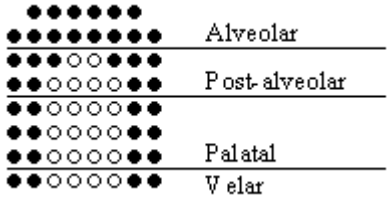

Figure 1. The Reading EPG palate. Filled electrodes indicate contact between tongue and palate.

For EMA we used the Carstens Articulograph AG100 EMA system [6]. For these particular recordings, four coils were glued to the tongue along the midsagittal line – on the tongue tip, the tongue blade, the tongue body, and the tongue dorsum, with an approximately equal space between the coils.

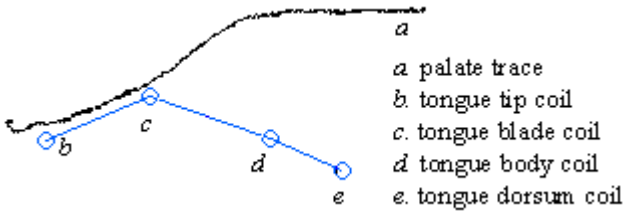

Figure 2. Example of EMA picture.

The subjects were fitted with an EPG palate during the EMA recordings. The combination of these two techniques has clear advantages for accurate analysis of articulation. However, the combination of EPG and EMA may interfere with the EPG contact patterns [7]. To control for this, we compared the EPG patterns obtained here with EPG patterns obtained without the use of EMA.

3. DATA REDUCTION

The main basis for articulatory comparisons was the articulation point marked by *the EPG frame of maximal lingual-palatal contact* for each consonant.

Our comparisons of EPG frames obtained alone and EPG frames obtained in combination with EMA, showed that in some cases there was interference between EMA and EPG resulting in fewer activated electrodes in the combined EPG and EMA condition. We therefore chose not to quantify the various contact areas using any of the several place of articulation indexes which have been developed

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(see e.g. [8]), and just look at general tendencies by comparing the actual EPG patterns.

To quantify the tongue configuration at the main articulation point – the frame of maximal contact – in particular with regard to retroflexion of the tongue, we used the so called "r tip y value" [9]. This measurement is based on the configuration of the first three tongue coils (coils b, c, and d in figure 2). For each token, the line joining the tongue blade and the tongue body coils is used as a baseline, and the distance in mm of the tongue tip coil from this line is measured. This is illustrated in Figure 3 below. This measure yields a positive "r tip y" value if the tongue is bent upwards (retroflected), a negative "r tip y" value if he tongue tip is bent downwards, and a "r tip y" value of 0 if the tongue tip is flat in relation to this tongue plane.

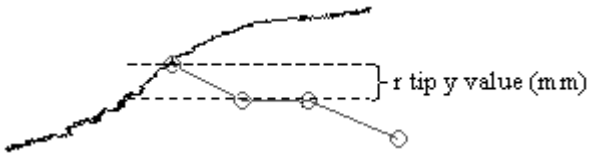


Figure 3. Quantification of "r tip y" value.

For the measurement of velocity of tongue movement we used the velocity of the tongue tip coil along the y-axis of the EMA diagram.

4. RESULTS

Our investigation is based on the articulation of seven adult East Norwegian speakers reading a set of words in a carrier phrase ten times in random order. The words are: *lar, farlig, lir, sirlig, Cola* for /l/, *ra, lar, ri, lir, jorda* for /ɾ/, and *gale, gul, Ola* for /ɽ/. /ɽ/ has a limited distribution and does not occur adjacent to the close vowel /i:/. We therefore used a word with the close vowel /ʉ:/.

The EPG patterns show individual variation, and a great deal of between-sound overlap, for the contact area between tongue and palate during the articulation of all three sounds. The contact area for /l/ varies between maximum contact in the first and second rows, second and third rows, or third and fourth rows. For /ɾ/ the variation is between maximum contact in the first row, in the second row, in the second and third rows, or in the third and fourth rows, and for /ɽ/ between maximum contact in the second row, the third row, the fourth row, or the fifth row. This indicates that all the three sounds /l ɾ ɽ/ can be alveolar or postalveolar, while /ɽ/ can also be prepalatal. Thus, the place of articulation in the palate is to a large extent the same for these liquids. However, for most speakers there is a tendency to have a more retracted area of contact for /ɽ/ than for /l/ and /ɾ/. Furthermore, there is always *more* contact in the alveolar/postalveolar area for the continuant /l/ than for the tap /ɾ/ and the flap /ɽ/.

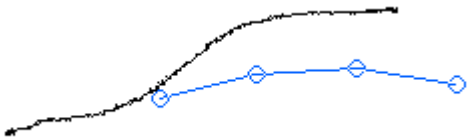
The EMA patterns show that there is considerable individual variation with regard to retroflexion. /ɽ/ and /l/ are not always retroflex, and – more surprisingly – /ɾ/ is frequently retroflected. The "r tip y" values in table 1 show that only two of the speakers have a non-retroflex tongue configuration for /ɾ/, while the other five speakers retroflect. Three speakers retroflect and four speakers do not for the articulation of /l/. Five speakers retroflect and two do not for the articulation of /ɽ/. Two speakers retroflect for all three consonants, and one speaker never retroflects.

sp.	l		ɾ		ɽ	
	mean	sd	mean	sd	mean	sd
aml	-1,7	1,6	1,7	1,8	1,8	1,3
an	-1,1	1,7	0,8	1,3	5,4	1,3
hl	7,0	1,0	5,0	1,0	4,4	0,9
hs	0,1	1,4	1,0	1,7	1,9	1,3
im	1,5	2,1	-0,4	1,0	-0,2	1,7
kb	-2,6	1,8	-5,8	1,7	-0,7	1,2
re	-0,5	1,3	2,3	1,2	0,8	2,2

Table 1. Mean r tip y values with standard deviation (sd) for all speakers (sp.).

For the subjects that retroflect, there is a tendency to more retroflexion following an open vowel than following a close one. This is particularly marked in the case of /ɽ/. Retroflex and non-retroflex articulations for the three liquids are illustrated in figure 4 below.

Speaker hl: /l/ in /fa:la/.



Speaker an: /l/ in /fa:la/.

Figure 4.1. EMA profiles for /l/ showing retroflex and non-retroflex tongue configuration at maximum point of contact between tongue and palate.

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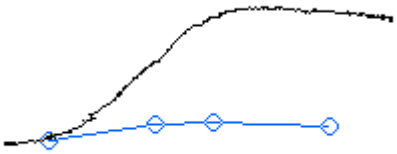
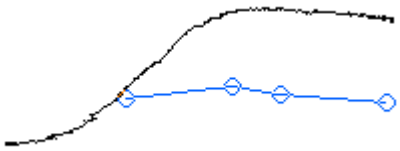
Speaker hl: /ɾ/ in /ɭaːɾ/.



Speaker im: /ɾ/ in /ɭaːɾ/.

Figure 4.2. EMA profiles for /ɾ/ showing retroflex and non-retroflex tongue configuration at maximum point of contact between tongue and palate.

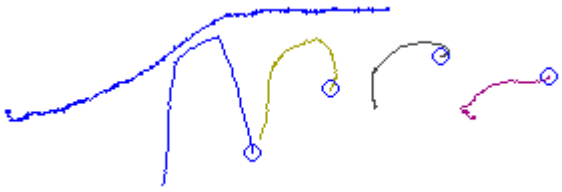
Speaker hl: /ʈ/ in /gaːʈe/.



Speaker im: /ʈ/ in /gaːʈe/.

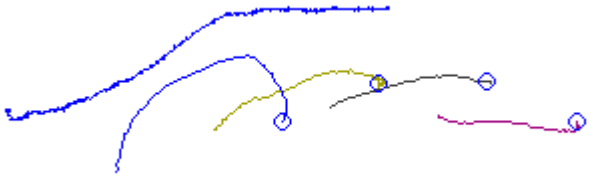
Figure 4.3. EMA profiles for /ʈ/ showing retroflex and non-retroflex tongue configuration at maximum point of contact between tongue and palate.

The EMA-patterns also show that the trajectory of the tongue, combined with the velocity of the movement, distinguish the three sounds from each other. During the articulation of /ɾ/ the apex moves quickly downwards in a direct vertical line from the contact area in the palate. During the articulation of /ʈ/ there is a movement of the apex along the palate before the apex is lowered. For some of the speakers the trajectory of the tongue for /ɭ/ shows a similar forward movement in the palate as for /ʈ/ (see below). The main difference between these two sounds is in this case the velocity of the tongue movement. The tongue is lowered more quickly for /ʈ/ than for /ɭ/.



ɭ/uː_a

ɾ/uː_a



ʈ/uː_a

Figure 5. Trajectory of the tongue movement for the four tongue coils, /ɭ ɾ ʈ/ in the context /uː_a/. Speaker is hs.

Figure 5 shows the movement of the four tongue coils during the articulation of /ɭ/, /ɾ/, and /ʈ/ in the sequence /uː_a/. This particular sequence was chosen because it is one of the few where the consonants appear in the same segmental context. The timespans for the interval shown in the figures are equal for /ɭ/ and /ɾ/, 177 ms, and slightly longer for /ʈ/, 241 ms. The movement starts in the position indicated by the EMA coil.

sp.	ɭ		ʈ	
	mean	sd	mean	sd
aml	201	22	241	52
an	161	11	207	9
hl	139	24	212	18
hs	196	21	224	33
im	232	28	268	40
kb	203	8	265	23
re	130	24	237	41

Table 2. Mean velocity values (mm per ms) with standard deviation (sd) for /ɭ/ and /ʈ/ for all speakers (sp.).

Table 2 compares /ɭ/ and /ʈ/, showing maximum velocity of the downward movement of the tongue tip coil from the point of maximal contact in the palate to the end of the consonant, measured as millimeters per millisecond. The table shows that for all speakers, the velocity is higher for /ʈ/ than for /ɭ/.

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5. DISCUSSION

In the literature /ɾ/ has been described as a tap or a trill, /ɽ/ as a flap, and /ɭ/ as a lateral. In our investigation /ɾ/ is always articulated as a tap, not a trill. The apex touches the alveolar ridge once. /ɽ/ differs from /ɾ/ in that the apex has a forward movement in the palate before it is lowered. /ɭ/ is a lateral continuant. The differences in manner of articulation between these three consonants in our investigation fit the traditional classifications and descriptions quite well.

Our investigation also agrees to some extent with the *descriptions* in the literature of the place of articulation in the palate for these liquids. Where we differ from the traditional descriptions is in showing the relatively large inter- and intra-individual variations in the contact areas between tongue and palate.

Concerning the *classification*, however, our investigation differs from the traditional ones. Our data with regard to tongue configurations clearly demonstrate that retroflex is not an apt term to use to refer to place of articulation in the classification of the Norwegian apical consonants. If the aim is a classification which is close to the articulatory facts and at the same time brings out the relevant articulatory differences between the phonemes, the use of the term retroflex does not meet this aim.

In the traditional classification of /ɭ/ and /ɽ/, the term retroflex is used as a place of articulation term, and placed between postalveolar and palatal. Our investigation shows that the so called "retroflex" phonemes /ɭ/ and /ɽ/ are not always retroflected. Furthermore, we have also shown that the contact area in the palate varies between alveolar, postalveolar, and prepalatal for these phonemes. Thus, the term retroflex neither describes the articulatory facts in a correct manner, nor can it be used in the classification to refer to a restricted area of contact in the palate, the way the traditional classifications do. It is also noteworthy that /ɾ/, which is frequently retroflected, is never classified as a retroflex in the literature. On the basis of our data, we will suggest that in the classification of Norwegian consonants, the term retroflex is inappropriate.

Instead of using the passive articulator for classification purposes, we suggest, in accordance with Endresen [4], that the active articulator be used. Furthermore, there does not seem to be evidence for a different place of articulation for /ɾ/ than for /ɭ/ and /ɽ/. Rather we suggest that these liquids should all be classified as apicals: /ɭ/ is an apical lateral, /ɾ/ is an apical tap, and /ɽ/ is an apical flap.

ACKNOWLEDGEMENT

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