THE PRODUCTION OF NORWEGIAN VOWELS BY FRENCH AND RUSSIAN SPEAKERS

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ABSTRACT

This study looks into the production of Norwegian front and central vowels spoken by native and second language speakers with backgrounds from French and Russian, respectively. The vowels' first three formants were measured and normalized to reduce the effect of speaker gender. Based on the vowel systems of the three languages involved, larger deviations in Russian than in French L2 productions were hypothesized. The expectations were to a certain degree borne out by the data. Apart from vowel pattern deviations, the two L2 groups' productions differ in terms of the scatter of the formant values. The results demonstrate the difficulty of explaining L2 acquisition behaviour by existing models.

Keywords: second language acquisition, vowel quality, French, Norwegian, Russian

1. INTRODUCTION

The goal of the present study is to shed some light on the production of vowels by second language (L2) users of Norwegian. For foreign learners a correct pronunciation of this language may be difficult to acquire particularly with respect to its vowels. Norwegian is one of the relatively few languages having a rather crowded vowel space, especially due to the occurrence of rounded front vowels and rounded central vowels. In total, the vowel system comprises nine long monophthongs with their short counterparts. Table 1 presents the vowels investigated here. Existing descriptions of the Norwegian vowels differ with respect to the phonetic values of the short vowels compared with their long counterparts. Also, the position of /ʉː/ and /ʉ/ is sometimes considered to be front rather than central. For all practical purposes, we follow the conventions proposed by Kristoffersen [6].

Because of space limitations, only two groups of L2 speakers were selected from a larger speech corpus. The first one had French as their native language. The vowel system of French lacks quantity but has both unrounded and rounded front vowels. The second group consisted of Russian natives. Russian possesses merely five different vowels, and there are no front [±rounded] pairs. Therefore, it was hypothesized that vowel formants from the latter speaker group would show larger deviations from native pronunciation than those from the French.

Table 1: Phonological classification of the vowels selected for this study. centr= central; rd= rounded.

	long			short		
	front		centr	front		centr
	-rd	+rd	+rd	-rd	+rd	+rd
close	iː	yː	ʉː	i	y	ʉ
close-mid	eː	øː		ɛ	œ	
open-mid	æː			æ		

2. METHOD

2.1. Speech material and subjects

The speech material for the present investigation was taken from existing recordings made for a larger project. These recordings were made in a sound-treated studio using high-quality equipment and were stored with a sampling frequency of 44.1 kHz. For the present purposes, a number of read sentences were selected containing words with the vowels presented in Table 1.

The two selected groups of L2 speakers comprised six subjects (four males, two females) with a French and four (two males, two females) with a Russian native language background. Six native speakers of Norwegian served as a control group, three of them having a dialect from the Trøndelag area (one male and two females) and three with a South-East Norwegian dialect (two males and one female).

2.2. Formant measurements

Using Praat [3], the frequency values of the first three formants of the vowels were measured at the

approximate temporal midpoint. Subsequently, for each of the three formants three different measurements were carried out. These involved formant frequency as (a) judged by visual inspection of the spectrogram, (b) judged by inspection of a FFT spectrum of a 40ms window around the temporal midpoint, and (c) the frequency value given by the Praat program. The three values thus obtained were compared pairwise. If none of the differences exceeded 15% of the mean of a pair, the average of the three measurements was taken as the formant value. If one of the differences was larger than 15%, the measurements were checked and a final decision as to the most appropriate formant value was taken.

2.3. Data treatment

In order to reduce gender-related variation in the data, a vowel normalization procedure was carried out as proposed by Lobanov [8]:

$$(1) \qquad F_{ti}^{N} = (F_{ti} - M_{ti}) / \sigma_{ti}$$

In (1) F_{ti} is the *i*-th formant for talker *t*, M_{ti} is the mean value of F_i across all vowels analyzed for this talker and σ_{ti} the standard deviation belonging to the mean value. As was shown by Adank, Smits and van Hout [1] this procedure reduces anatomical/physiological variation effectively while preserving phonemic and linguistic (here: L2 specific) variation. For the present study normalized formant data were used as input for statistical evaluation. Since the interpretation of such normalized values in acoustic and articulatory terms is difficult, figures present formant values transformed to bark [10].

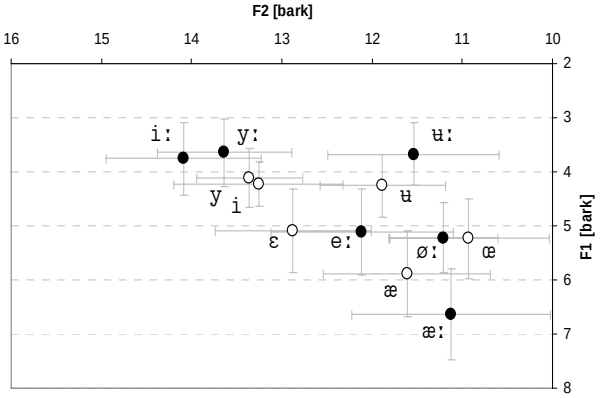
3. RESULTS

3.1. Norwegian reference vowels

3.1.1. Short vs long vowels

The first question investigated concerned the phonetic quality of the short *vs* long vowels as spoken by the native reference group. From the F1/F2 plot of the data presented in Figure 1 it can be seen that the close short vowels /i, y, ʉ/ have a somewhat larger degree of opening than their long counterparts. According to a multivariate ANOVA with vowel length and roundedness as factors mean F1 is significantly lower for the latter (0.51 bark; F(1, 68)= 24.762; p< .001). The short *vs* long vowels differ also in the F2 and F3 dimensions (F(1, 68)= 4.242; p= .043 and F(1, 68)= 3.967; p= .050), but not systematically so.

Figure 1: F1 and F2 of long (closed symbols) and short (open symbols) vowels spoken by six Norwegian speakers. Bars indicate standard deviations.



In contrast to the close vowels, the degree of opening of the close-mid vowels /e:, ø:/ *vs* /ɛ, œ/ appears to be independent of length (F(1, 50)< 1). F2 and F3 values, however, vary as a function of vowel length (F(1, 50)= 7.174; p= .010 and F(1, 50)= 7.4644; p= .009).

The open-mid pair /æ:/ *vs* /æ/ differs with respect to F1 (mean difference of 0.75 bark; F(1, 22)= 8.194; p= .009) and F2 (0.49 bark; F(1, 22)= 5.026; p= .035) but not F3.

3.1.2. Roundedness

In this section we will investigate how the values of F1, F2 and F3 vary as a function of the feature [±rounded]. For the group of close vowels an ANOVA showed that roundedness affected F2 and F3 (F(1, 68)= 22.415; p< .001 and F(1, 68)= 51.228; p< .001) but not F1. According to impressionistic observation, the vowel /y(:)/ is outrounded and perceptually rather close to /i(:)/. This in contrast to the vowel /ʉ(:)/ that is often described as central and as having a more audible lip rounding. Groupwise comparison of /i:, i/ with their rounded counterparts /y:, y/ revealed non-significant differences for F1 and F2, and only a significant effect for F3 (0.50 bark lower for the rounded vowels; F(1, 44)= 21.109, p< .001). Stronger effects were found for the qualitative differences between /i:, i/ and /ʉ:, ʉ/: for F2 (1.96 bark lower for the latter pair; F(1, 44)=

122.037; p< .001) and for F3 (1.50 bark lower; F(1, 44)= 145.667; p< .001), the difference for F1 being non-significant.

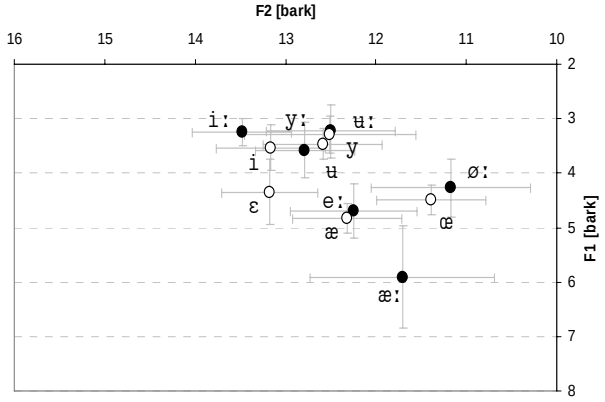
Also for the close-mid vowels /eː, ɛ/ *vs* /øː, œ/ significant effects of the feature liprounding on F2 and F3 were found (1.40 bark; F(1, 50)= 150.572; p< .001, and 0.32 bark; F(1, 50)= 11.443; p= .001).

3.2. Norwegian vowels by French speakers

3.2.1. Short vs long vowels

An illustration of the Norwegian vowels produced by the French speakers is given in Figure 2. With respect to the degree of opening of the close vowels the group of French subjects appears to deviate from the Norwegian native speakers. Their mean F1 value for /iː, yː, ʉː/ is not significantly different from that for the short counterparts. As far as the other dimensions are concerned, only mean F3 is lower for the latter (0.17 bark; F(1, 68)= 5.101; p= .027). This result is caused by the difference of 0.58 bark measured for F3 in /iː/ *vs* /i/ (t(22)= 3.210; p= .004).

Figure 2: F1 and F2 of long (closed symbols) and short (open symbols) vowels spoken by six French speakers. Bars indicate standard deviations.



Vowel length appeared to have no systematic effect on the degree of opening of the close-mid vowels. Whereas /ɛ/ was produced with a higher F1 than /eː/ (0.35 bark; marginally significant with t(22)= 2.062; p= .051), the opposite was found for /øː/ *vs* /œ/ (0.22 bark lower; n.s.). The pattern for F2 and F3 in the vowel pair /eː/ *vs* /ɛ/ was similar to that found for the natives (t(22)= -4.370; p< .001 and t(22)= -3.447; p= .002).

The open-mid vowels /æː/ *vs* /æ/ were produced in much the same way as by the natives, F1 being significantly lower for the short vowel (1.08 bark; F(1, 22)= 22.170; p< .001). The effect for F2 is in the same direction as for the Norwegian, however, without reaching significance.

3.2.2. Roundedness

The group of French subjects produced clear differences between the close rounded *vs* unrounded vowels. Both mean F2 and F3 were significantly lower for the former (0.73 bark; F(1, 68= 28.241; p< .001 and 0.94 bark; F(1, 68)= 50.534; p< .001). As was the case for the Norwegian reference group, the opposition /iː, i/ *vs* /yː, y/ was realized by lower F3 values. Beyond that, the mean F2 difference was significant (0.68 bark; F(1, 44)= 18.135; p< .001). Remember that there was no such significant difference for the Norwegian reference.

Also for the close-mid vowel pairs a considerable effect of lip rounding was found. Mean F2 is 1.45 bark and F3 0.38 bark lower (F(1, 50= 100.151; p< .001; F(1, 50)= 17.407; p< .001).

3.3. Norwegian vowels by Russian speakers

3.3.1. Short vs long vowels

Figure 3 presents a formant plot of the vowels spoken by the Russian subjects. Statistical analysis showed that the long vowels /iː, yː, ʉː/ as a group do not differ from short /i, y, ʉ/ in the F1 dimension. While F2 does not vary systematically with vowel length (especially for /ʉː/ and /ʉ/ there is a large scatter across all four speakers), mean F3 was 0.50 bark lower for short /i, y, ʉ/ (F(1, 43)= 7.540; p= .009). For the single vowel pair /ʉː/ vs /ʉ/, however, F1 is significantly higher for the latter (0.47 bark; t(13)= -2.510; p= .026).

The degree of opening of the long close-mid vowels /eː, øː/ is not different from their short counterparts. Furthermore, these vowel pairs do not differ with respect to F2 and F3.

Like the native reference group, the Russian speakers' /æː/ has a considerably higher F1 than /æ/ (1.18 bark; F(1, 14)= 8.194; p= .013). Due to large inter-speaker scatter the vowels do not differ as to the F2 and the F3 dimensions.

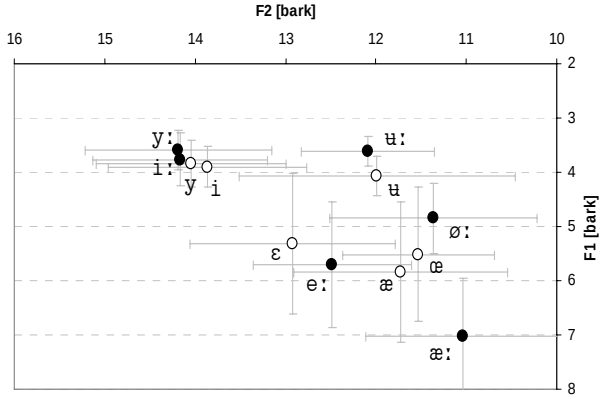
3.3.2. Roundedness

For the Russian subjects, F1 in the close vowels /iː, i/ vs /yː, y, ʉː, ʉ/ does not vary as a function of roundedness. Comparing /iː, i/ vs /yː, y, ʉː, ʉ/

showed that none of the three formant values differs significantly. For /ʉː, ʉ/ *vs* /iː, i/, however, F2 and F3 are lower with values of 1.98 bark and 1.02 bark, respectively ($F(1, 27)= 92.090$; $p< .001$ and $F(1, 27)= 81.637$; $p< .001$).

Like for the natives, the close-mid vowel pairs /eː, ɛ/ *vs* /øː, œ/ differ in both the F2 and the F3 dimension due to the factor roundedness. The differences amount to 1.27 bark and 0.41 bark, respectively ($F(1, 32)= 31.117$; $p< .001$ and $F(1, 32)= 10.861$; $p= .002$).

Figure 3: F1 and F2 of long (closed symbols) and short (open symbols) vowels spoken by four Russian speakers. Bars indicate standard deviations.



4. DISCUSSION

Through the present study we have obtained some information about the acoustic parameters of some Norwegian vowels. One of the very few previous publications containing pertinent data is the investigation of vowels spoken by two Norwegian speakers by Ophaug [9]. Her data confirm the present finding of the relatively similar spectral quality of /yː, y/ vs /iː, i/ and the importance of F3 for this distinction.

On the whole, our results are in line with the expectations in that the vowel formant patterns of the French speakers were closer to the Norwegian reference than those from the Russians. In particular, this is true for the production of the rounded vowels. The opening effect of short *vs* long close vowels as found for the Norwegian natives, however, was absent for the French subjects. At the same time, the French speakers' vowel space was small in comparison with the native reference. This might be due to the lack of an appropriate duration distinction between long and short vowels, a question that remains to be investigated.

The same lack of a quantity effect as for the French could be observed in the vowels spoken by the Russian subjects. The most salient deviation from the Norwegian pattern was their lack of distinction between the close front rounded *vs* unrounded vowels. Furthermore, it could be noted that there was a considerable scatter in the Russian speakers' productions.

It would require a longer discussion to relate the present results to existing models on L2 acquisition [2, 4, 7; see also Kingston's results and discussion in 5]. For example, Flege's Speech Learning Model [4] could explain the Russians' appropriate realization of /ʉ(ː)/ as a new phonetic category for these speakers. The reason why they had not acquired the /i(ː)/ *vs* /y(ː)/ distinction may be that the perceptual target for both vowels is close to the Russian /i/ target.

5. REFERENCES

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