ON UNIVERSAL AND SPECIFIC FEATURES IN VOWEL PERCEPTION

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ABSTRACT

The results of a cross-language study of the perception of a set of synthetic steady-state vocalic stimuli using mimicking and identification methods are reported. The subjects were native speakers of Russian,French and Georgian. The results show the influence of the vocalic system of the mother tongue on vowel perception. A close correlate to the given stimulus occuring in the native vowel system induces significant changes in mimicking and identification responses. This influence may be manifest even in cases where this correlate is a context-bound allophone. A superficial aquaintance with the vocalic system of a second language changes the identification results,which has implications for the analysis of experimental perceptual data.

INTRODUCTION

The present paper attempts to establish, to what extent vowel perception of different language speakers is determined by the vowel system of their mother tongue, and to what extent - by the universal perceptual abilities of human listeners.

A number of researchers have maintained that speakers of different languages are able to identify more vowels than the number of vowel phonemes in the language they are speaking. However, neither a finite inventory of such perceptual vowel units, nor their relation to linguistic phonemes has as yet been established for any language.

Two possible solutions have been suggested for native speakers of Russian: I) this set of internal vowel representations might correspond to context-bound allophones in Russian vowels /3,2/; 2) it might conform to cardinal vowels /I/. But these solutions are not fully supported by the actual experimental data in different perceptual tests.

A combination of mimicking and identification was used. There is evidence to believe that the transformations of the initial signal in mimicking and identification coincide up to the phonetic feature level.In mimicking, transformation of the phonetic representation into motor commands then takes place. Identification requires the phonetic labelling step. Mimicking does not seem to imply a necessary phonemic classification, and when it is difficult, no decision in terms of phonological categories is made. The comparison of mimicking and identification results makes it possible to isolate motor and labelling factors.

It is important to realize that in analysing mimicking data purely in terms of FI and F2 values we lose a great deal of information about the phonetic quality of vowel responses.

PROCEDURE

Three groups of I0 male adult subjects, native speakers of Russian, French and Georgian, took part in the experiments. A set of 8 synthetic steady-state vocalic stimuli with Fo increasing from I00 Hz to I25 Hz was used (phonetic symbols with a letter "s" are assigned to each stimulus).

Formant frequencies of synthetic vocalic stimuli

Stimuli	FI	F2	F3	F4
i_S	260	2760	2930	3500
y_S	240	I880	2660	3500
ϕ_S	350	I560	2200	3250
$æ_S$	840	I7I0	2200	3250
u_S	240	660	2420	3250
o_S*	290	600	2420	3250
$ɔ_S$	570	800	2420	3250
a_S	760	I060	3220	4000

The stimuli were recorded in random order at 5 ms interval, each stimulus was repeated 5 times.

There are eleven oral vowels in French: /$i, e, ɛ, a, y, \phi, œ, u, o, ɔ, a$ /; six in Russian /$i, e, ɤ, u, o, a$ /; five in Georgian: /i, e, a, u, o/. The Russian and the Georgian vowel systems are considerably poorer than the French one. On

*o_S-closer quality, $ɔ_S$-more open quality.

the other hand, large allophonic variations occur in Russian, unlike French and Georgian. Vowels differ in quality according to stress position and to the phonological palatalization of adjacent consonants (i-glides and an advanced vowel articulation)..
The stimuli i_S, a_S, u_S have correlates in all three languages; y_S and ϕ_S - front labial vowels - occur only in French. The stimuli $æ_S$, $ɔ_S$, o_S have no close correlates in any of the three languages. However, $æ_S$ is phonetically nearer to the French /a/ and /ɛ/, $ɔ_S$ - to /ɔ/, o_S - to /o/, than to Russian or Georgian vowels.

MIMICKING TEST

All the subjects were instructed to repeat as closely as possible the stimuli that they thought to be natural. Each subject went through the mimicking test twice and gave I0 responses to each stimulus, which were recorded onto tape. Before mimicking, subjects pronounced vowels in their own language.
The FI and F2 values of the response vowels were measured from spectrograms and plotted as dots on the FI/F2 plane. The accumulations of such dots formed the response areas for each stimulus by each group (see Fig.I a,b,c).
All the vowel responses were classified using phonetic symbols and signs for finer phonetic details by a trained phonetician (see Table I for the results).
The response areas to different vocalic stimuli partly overlap, less in the case of French speakers and most of all in the case of Georgian speakers.
All the subjects responded to i_S, a_S, u_S stimuli with their own corresponding vowels.
Only French subjects were successful in mimicking y_S and ϕ_S. Russian subjects showed much poorer results and those of Georgian subjects were on the whole inadequate.
French and Russian subjects gave similar responses to $æ_S$; the Georgians responded by an /a/, often pharyngalized.
Russian and Georgian subjects tended to substitute their own vowels for $ɔ_S$ and o_S stimuli. French subjects' responses were sometimes phonetically rather close to $ɔ_S$ and o_S.
Thus, mimicking results were strongly determined by the linguistic experience of the subjects: mimicking is more accurate when the stimulus has a correlate in the vocalic system of the mother tongue. It was therefore to be expected that the mimicking of French subjects would be most accurate.
But a vowel without correlates in the subjects' native language can also be accurately responded to. The better mimicking results of Russian subjects in comparison with Georgian ones seem to be due to the advanced articulation of the

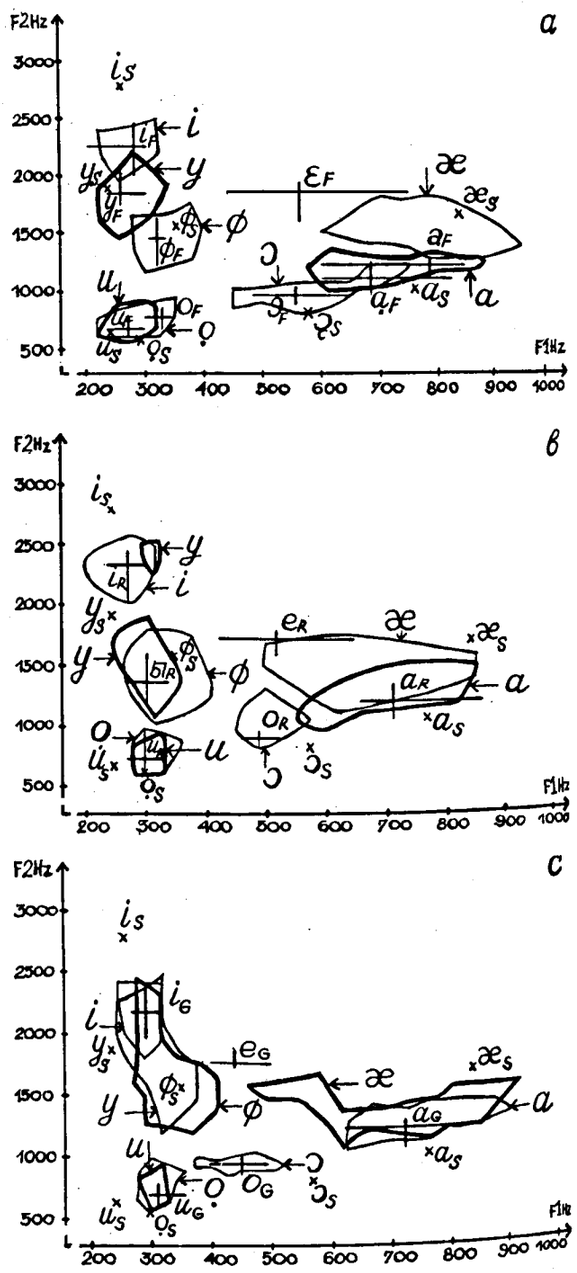

Fig.I a,b,c. Mimicking response areas in the FI/F2 plane of French (a), Russian (b) and Georgian (c) subjects. Dots with symbols a_F, a_F etc. show the locations of French vowels, a_R, i_R etc.- Russian and a_G, i_G - Georgian vowels (the mean of 20 measurements, mini and maxi FI and F2 values are also shown).

Russian / u, o, a/ adjacent to the palatalized consonants. The perceptual independence of such allophones is reinforced by the existence of special letters for them in the Russian alphabet.

		i_S	y_S	ϕ_S	$æ_S$	a_S	$ɔ_S$	o_S	u_S
i	I	I00						I	2
	2	60							
	3	67	36	I5					
$i/ɪ$	I								
	2	34	9						
	3	29	3I	20					
$ɪ$	I		I						I
	2	5	I6	25					
	3	3	8	26					
$ʊ$	I								
	2		35	24					
	3		I2	I6					
y	I		97						
	2		28	5					I
	3	I	I3	I2					
ϕ	I		2	I00					
	2		7	7					I
	3			7					
$æ$	I								
	2	I	4	22			2		
	3						7		
$ə$	I								
	2			I7	I				I
	3			I	2			I	
$ɛ$	I				29				
	2				37				
	3			3	6	I			
$æ$	I				I9				
	2				I4				
	3								
a	I				47	8			
	2				33	28			
	3				4I	I4			
a/a	I					2I			
	2				I0	26	I		
	3				II	24			
$ɒ$	I				5	7I	28		
	2				5	46	8		
	3				40	6I			
$ɔ$	I						49		
	2						I4		
	3								
o	I						2I		
	2						36		
	3						I2		
o/u	I						34	8	
	2		I				88		
	3							36	I9
u	I							3I	22
	2							32	20
	3							55	78
								69	75
								67	80

Table I. Mimicking responses to synthetic vowels by groups of French /I/, Russian /2/ and Georgian /3/ speakers.

Russian, and only rarely Georgian speakers responded to y_S and ϕ_S with the unrounded vowels: a central /ɐ/ or a retracted /ɪ/, realizing the same low values of F2 owing to vowel retraction and not to vowel rounding.

IDENTIFICATION TEST

The same subjects after a delay of several days were instructed to provide a possibly exact graphical representation of the same set of stimuli as in the mimicking test. See the results of the classification of the diverse responses in Table 2.
Identification and mimicking responses to each stimulus by the three groups of subjects have much in common: the best results in the three groups were for i_S, a_S, u_S vowels; the most adequate responses were from French subjects; there were better responses from Russian than from Georgian subjects to y_S, ϕ_S, $æ_S$ stimuli eto. It should be specially noted, that a Russian subject identified $æ_S$ as /'a/ - after a palatalized consonant, while a Georgian one - as /h/, that is, he perceived pharyngalization and considered it to be the most prominent feature.
A supplementary test was conceived to verify our assumption that even a superficial aquaintance with the vocalic system of a second language may influence the perception of vowels that do not occur in the mother tongue as context-free allophones. The identification of the same set of vocalic stimuli was tested with a group of native speakers of Georgian, all - first year students in physics at Tbilisi University. Of the total of 38 subjects - I6 had studied English as a foreign language at school and 22 - French and German. It was found that those who had studied English did not respond to y_S with rounded vowels at all and gave almost no responses to ϕ_S with a front rounded vowel. Those who had studied French and German identified y_S as a rounded vowel and ϕ_S - as a front rounded vowel in I/3 of their responses.
Thus, the results of mimicking and of identification of vocalic stimuli proved to be similar, but mimicking was still more accurate: the subjects responded with similar vowel types in both tests. In general, this is also true for each individual subject. Sometimes, however, subjects answered with different vowels from test to test: for example, mimicking responses to $ɔ_S$ as /a/ and identification responses as /ɔ/ of a French subject.
If mimicking responses were influenced by individual articulation skill, the identification responses even in a free-choice experimental situation were to a great extent determined by the subjects' resourcefulness in choosing an appropriate symbol. (For example, a Georgian identified y_S as "fi" - the consonant

	i_S	y_S	ϕ_S	$æ_S$	a_S	$ɔ_S$	o_S	u_S
i	I00 98 92	4 72	56					
$i/ɒ$		I0	I2 6					
$ɒ$	2	30 I0	28 I8					
y		I00 50 I0	2 I0					
ϕ			78 48					
$œ$			22					
$ə$	6	8	4	2				
e/ɛ			I0 4	30 I4 20				
a/ɛ				28 40 2				
$ɦ$			2	I0				
$'a$				8				
$ɑ$				36	60			
a/a				6 34 68	6 I00 I00			
a					34	I0		
$ɔ/a$						I8		
$ɔ/ə$				2		72 I6 I0		
o						84 90	8	
u/o							I8 8	2
u	2	6					74 92 I00	98 I00 I00

Table 2. Identification responses to synthetic vowels by groups of French (top figure for each classification unit), Russian (middle figure) and Georgian (bottom figure) speakers.

seemingly carried the feature of "lip articulation", i.e. "rounded").

CONCLUSION

The results reported above suggest the influence of the vocalic system of the mother tongue on vowel perception. The set of synthetic vowels was most compatible with the linguistic experience of the French subjects, and they had the best results in identification.

But this influence is more complex than the presence of a close corresponding vowel to the stimulus in the vocalic system. We may assume a certain role of acoustical properties of the native vowels involved as references in the perceptual process.

Furthermore, we may speculate that not only the phonetic properties of the context-free allophones, but also of the most perceptually distinct context-bound allophones of the native vowels exert a certain influence on vowel perception.

The better results in mimicking and identification of y_S, ϕ_S, $æ_S$ achieved by native speakers of Russian than by the Georgians seem to be due to the actual advancement of the Russian /u, o, a/ allophones adjacent to palatalized consonants.

On the contrary, large allophonic variations do not occur in the Georgian language and Georgian subjects tend to give more "categorical" responses.

The obtained results cannot be explained only by the influence of the phonological system of the mother tongue, but also reflect the universal perceptual abilities of different language users.

And finally, it is suggested that even a superficial aquaintance with the vowel system of a second language has an effect on vowel perception which should be borne in mind when interpreting the results of perceptual experiments.

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