

## ON THE PHONOLOGICAL OPERATIONS ENSURING SPEECH COMMUNICATION

L.V. Bondarko, Department of Phonetics, University of Leningrad,  
USSR

Conveying information through articulate speech presupposes the ability of the native speaker to analyse quickly and effectively heterogeneous sounds. This ability is developed by man because sound differences are used for discriminating meaningful units, i.e. words. Taking this function of speech sounds into consideration, we can understand why the native speaker does very well in the process of perception in spite of a number of variations of sound properties. From the linguistic point of view it can be assumed that there exist a number of levels ensuring optimum processing of sound signals. The first one consists in the ability of man to generate and perceive articulate sounds. Though this ability is universal by itself, it cannot be observed directly because it is realized on the basis of a certain concrete language. However, some of the phonetic universals (Greenberg, 1966) deduced on the basis of comparing various languages, can be also related to the peculiar properties of man's verbal behaviour. The second level is concerned with the system of phonemes in a given language. The native speaker disposes of the information of the system of phonemes which he acquires in the process of learning his native language. The main points of this information are as follows: the inventory of the phonemes in the language, the ways the distinctive features of the phonemes are realized, the rules of usage which include the probability of the occurrence of phonemes within the minimal meaningful unit - within a word.<sup>1</sup>

The third level deals with the information of the rules about possible sound combinations in shaping the words. One can assume that the perception of the word is the recognition of its phonemic composition. Evidently a clear-cut differentiation of all the three levels is impossible, because practically they overlap to a great extent. But one may hope that the systematic research on the process of perception will enable the scientists to describe these levels in a more detailed way.

---

(1) It is possible that in a number of cases a morpheme may be treated as this minimal unit. This may take place in languages where phonemic alternations are regular and are governed by the existing rules, Russian being an example.

Let us consider some facts dealing with each of these levels which testify to the reality of the language consciousness of the speakers. The opposition of consonants with regard to "absence - presence of voice" is one of the most widespread (Zhivov, 1976). In fact, it can be connected not only with the function of the vocal cords alone, but also with properties like tenseness - laxness, delay in the onset of voice after the opening of the occlusion, the duration of the preceding vowel, and so on. One may assume that "absence - presence of voice" can be treated as a universal feature. For the native speaker of the Russian language, where the correlation "presence versus absence of voice" is one of the characteristic features, each consonant he hears must be described either as a voiceless or as a voiced one. But the consonants /c/, /č/, /x/ do not have voiced correlates, i.e., the opposition of voiceless consonants to voiced ones is not possible for them in the positions before vowels and consonants. Compare [tu'goj] - [du'goj], [sɪpɪtʃ] - [gɪbɪtʃ] and [tsex], [tʃaj], [xot], and so on. However, in accordance with the rules of alternations which are known to be regular in the Russian language, in the combination of words ending in the consonants /c/, /č/, /x/ ([ts, tʃ, x]) with words in which initial consonants are voiced obstruents, there appear voiced allophones of these voiceless consonants: [kan'nedz zɪ'mɪ], [zedz drɪvɪ], [moɣ ga'ʃit], phonologically: /kan'éc z'i'mɪ/, /žeč drɪvɪ/, /moɣ gar'ít/.

The voiced character of these phonologically voiceless consonants can be treated in various ways from the linguistic point of view. We are especially interested in how the voiced character is treated by the Russian native speaker who is expected to discriminate between voiceless and voiced consonants and who does not have at his disposal the voiced correlates of phonemes which possess the same properties as /c/, /č/, /x/.

Russian subjects when presented with the consonants from phrases of the type /kan'éc z'i'mɪ/, /žeč drɪvɪ/, /moɣ gar'ít/, cut out from the magnetic tape, recognized these consonants as voiced ones; other properties of the consonants could be perceived incorrectly in this case. If the phonetic context is enlarged and the subjects are presented with combinations - 1: including the following consonant (CC), 2: including also the preceding vowel (VCC), 3: including the vowel in the succeeding syllable as well, - the

recognition of the consonants under consideration as voiced ones occurs less frequently, though in these cases the consonants /c/, /č/ and /x/ are not interpreted 100% correctly.

Figure 1 presents data on how separate properties of the consonants /c/, /č/ and /x/ are perceived if they are presented in various contexts, such as C, CC, VCC and VCCV. The influence of the phonetic features proper increases with the narrowing of the phonetic context, although even if there is a complete phonetic context - the following consonant bringing about voicing, or vowels, ensuring as a rule good recognition of the neighbouring consonant - this is not sufficient for the recognition of such phonemes as /c/, /č/ or /x/. The sounds may be perceived as /c/, /č/ or /x/ only if the native speaker hears the whole phrase, i.e. if he makes use of both the phonetic and the semantic contexts (Bondarko, 1975). This means that the predominant influence of the first, universally phonetic level is removed only if both the second level including rules of alternations, and the third level concerned with the

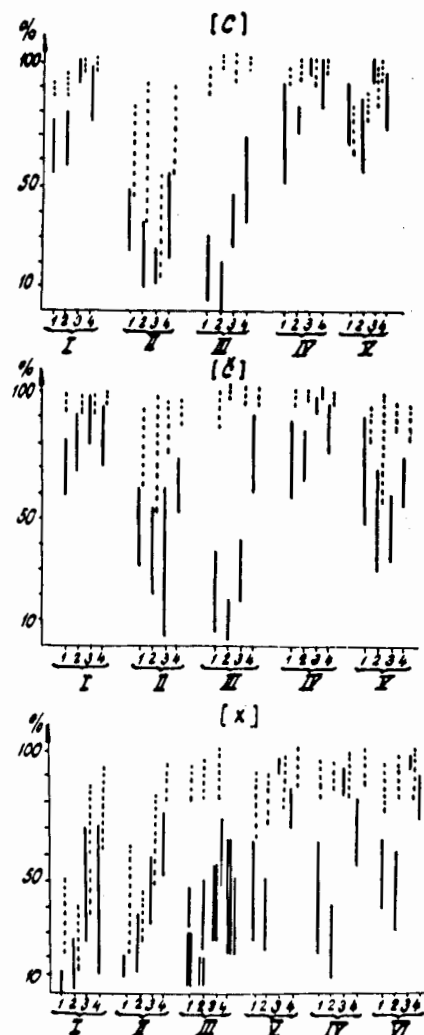


Figure 1

The perception of the properties of the voiced (—) and voiceless (---) allophones of the consonants /c/, /č/ and /x/. The phonetic context: (1) -C, (2) -CC, (3) -CCV, (4) -VCCV. Properties: I the active organ of speech II the manner of production III absence - presence of voice IV noise - sonorous character V hardness - softness VI vowel-consonant character

analysis of the phonemic composition of words can be made use of.

The second level of analysing speech, as has already been mentioned, includes information about the inventory of phonemes in the given language, the ways in which the distinctive features are realized, and the rules of usage. It is this level that ensures the transition from the phonetic variations of real sounds to economic phonological interpretations. Let us consider this level of perception using the examples concerning the perception of vowels by Russian native speakers.

It is known that the system of vowels in the Russian language is comparatively poor. There are three degrees of height and two series. Vowels of the back series (with the exception of the lowest vowel /a/ are necessarily rounded, whereas this connection does not exist in the case of the front vowels. The six vowels /a/, /o/, /u/, /e/, /i/, /i<sup>2</sup>/ are realized differently in the stream of speech, depending on their stressed or unstressed character, the quality of the neighbouring consonants, and so on.

As was shown in an experiment (Bondarko et al., 1966), the i-like transition, appearing in the vowel under the influence of the soft neighbouring consonant, serves as a useful indication which enables a person to differentiate hard and soft consonants. The i-like transition (phonetically pushing forward the vowel into the front zone) is perceived by all Russian native speakers as a cue of the consonant. Nevertheless, the phonetic property itself is realized in the vowel, and Russian native speakers discriminate a greater number of vowels than could have been expected on the basis of the inventory of vowel phonemes in the language.

We can assume that it is this peculiarity in the realization of the feature of softness in consonants that enables Russian speakers to describe vowels of the type [y], [ø], [œ] at a universal, phonetic level. These are integrated in the inventory of vowels in the same way as is done by speakers of those languages in which these vowels represent phonemes (Slepokurova, 1971). Things are different in the situation where vowels adjacent to nasal sounds are presented. In this phonetic position, Russian

vowels are considerably nasalized and it could be expected that Russian speakers would use such changes in vowels by analogy with those that are observed in the position with the neighbouring soft consonants. But in reality, the results are quite different.

In a special investigation (Belyakova, 1977) dealing with the perception of nasal vowels of the French language and nasalized Russian vowels by Russian and French subjects, it was shown that French people recognize nasal vowels of their own language much better than Russians do theirs, but that they are less sensitive in the perception of Russian nasalized vowels. They perceive Russian nasalized vowels as non-nasalized. A comparatively low degree of the recognition of the Russian vowels a and e by French listeners can be accounted for not by the influence of nasalisation but by the influence of the neighbouring soft consonant, which leads to the perception of this vowel as more front and less open, i.e. a as e, e as i. It is typical of Russians to make a lot of mistakes in the recognition of the nasalized vowels (Fig. 2).

Finally, it is on the third level, dealing with the rules of the formation of the sound shape of the word, that a phonological interpretation of sounds is given, which has no unique phonetic correlate. For example, the recognition of the unstressed vowel

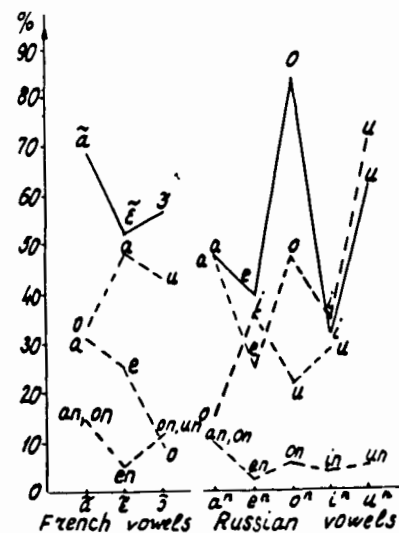


Figure 2

The perception of French nasal and Russian nasalized vowels. French listeners ——— Russian listeners ----- For all the subjects, various identifications of the vowels are shown: as the corresponding nasal vowel, as non-nasal but having different quality, and as a combination of a non-nasal vowel with a nasal consonant. Such identification is indicated in the figure by: an, en, and so on, even in those cases where the subjects wrote down the sounds an, am, etc.

(2) We do not consider here the question of the phonemic relevancy of the opposition of /i/ - /i<sup>2</sup>/, because it is widely discussed from the linguistic point of view, and, practically, because in the linguistic analysis it is not treated from the point of view of the phonology of the native speaker, for whom these are different vowels, and not on the lowest level alone.

in the words [sʌ'rok], [dʌ'ma] and so on, as /a/ is connected with the rules of reduction in the Russian word; the recognition of the voiced affricate as a voiceless one in the phrase "otec bolen" ([ʌ'tɛdz 'boʎɪn]) is connected with the rules of alternating voiceless and voiced consonants.

The recognition of morphologically loaded sounds or sound combinations represents a special case, particularly for such a language as Russian (Bondarko et al., 1966). In these cases the phonetic information about the sound is often insufficient, although the use of the rules of alternation and the use of semantic redundancy of the context enable the subject to correctly interpret the phonemic composition of the word (compare the realization of the phoneme /s/ in the combination "brosj ŝumetj" ([broʂ ʃu'mɛtʃ]) with a considerable assimilation of /s/ to the following /ʂ/ and the realization of the phoneme /a/ in posttonic inflections after the soft consonant "njanja" ([ 'nʲaŋʲɪ]), and so on.

All this proves that in oral communication, a person performs rather complicated operations the total of which can be called the phonology of the native speaker.

The reality of other purely linguistic phonological descriptions is proven by the extent to which this description is in accordance with these operations. The description of the phonology of the native speaker, based upon the description of different levels determining his verbal behaviour and upon the comparison with the linguistic phonology set up in linguistic descriptions, can be considered the main task in the experimental phonetic investigations dealing with speech perception.

#### References

- Belyakova, G.A. (1977): "The nasalization of vowels and its perception (on the basis of French and Russian languages)", Vestnik L.G.U., No. 8.
- Bondarko, L.V. (1969): "The syllable structure of speech and distinctive features of phonemes", Phonetica 20.
- Bondarko, L.V. (1975): "The phonemic description of the utterance - the condition and the result of understanding context", The minutes of the Fifth All-Union Congress of Psycholinguistics and the Theory of Communication, Moscow.
- Bondarko, L.V., L.A. Verbitskaya, L.R. Zinder and L.P. Pavlova (1966): "The sound units that can be distinguished in Russian speech", in The Mechanism of Speech-Production and Speech-Perception of Complex Sounds, Nauka, M.L.

- Bondarko, L.V. and L.A. Verbitskaya (1975): "Factors underlying phonemic interpretation of phonetically non-defined sounds", in Auditory Analysis and Perception of Speech, London: Academic Press.
- Greenberg, J. (1966): "Synchronic and diachronic universals in phonology", Language 42, No. 2.
- Slepokurova, N.A. (1971): "On the position of the phonemic boundary between synthetic vowels", in The Analysis of Speech Signals by Man, Leningrad.
- Zhivov, V.M. (1976): "The universals of syntagmatic functioning of the feature of voiceness", The Institute of the Russian Language of the Academy of Sciences of the U.S.S.R., A Study Group dealing with experimental and applied linguistics, preliminary publications, Issue 89, Moscow.