

THEORETICAL

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PHONETICS

ТЕОРЕТИЧЕСКАЯ ФОНЕТИКА АНГЛИЙСКОГО ЯЗЫКА

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Р е ц е н з е н т ы: кафедра романо-германской филологии Азербайджанского педагогического института иностранных языков и кандидат филологических наук *Пилипенко О.Ф.*

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В пособии рассматриваются основные проблемы современной фонетики английского языка: фонологический анализ звуков, слогообразование и слоговое деление, фонетическая природа и характерные особенности английского словесного ударения, интонация, вариативность произносительной нормы английского языка. Введены разделы, описывающие принципы акустической классификации звуков, фоностилистические особенности английской речи, вопросы фонетической интерференции при двуязычии, а также способы графического изображения интонации.

Предназначается студентам факультетов английского языка.

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FOREWORD

The book is designed for students of English who have undertaken the study of a theoretical course in English phonetics at Pedagogical Institutes and Faculties of Foreign Languages.

The authors of the book had two objects in view: firstly, to give the prospective teachers of English necessary information on theoretical problems of English phonetics and, secondly, to acquaint them with some of the diverse views of Soviet and foreign linguists. The authors have put forward the opinions of the foremost linguists on the points at issue and expressed their own attitude to them. An endeavour has been made to treat the main problems of theoretical and experimental phonetics with due reference to the latest findings in this field, and to draw the readers' attention to phonetic phenomena which are in the forefront of modern linguistics, such as phonetic styles and prosodic interference. An attempt has also been made to show the relevance of theoretical studies in solving practical problems connected with language teaching.

Every chapter is followed by exercises. Their purpose is not so much to control understanding as to encourage further reading. The exercises contain questions which stimulate independent decisions, controversial views which are to be refuted or supported, and assignments which require reference to pronouncing dictionaries and analysis of the phonetic features of speech.

Although this book is intended primarily for students, it may be of interest to teachers and to all those concerned with English phonetics.

The authors make grateful acknowledgement to Prof. V.V. Artyomov, Prof. V.A. Vassilyev and the late Prof. K.K.Ba-ryshnicova who have inspired and encouraged this work.

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CHAPTER 1. THE ROLE OF SOUND PHENOMENA IN COMMUNICATION

THE PHONETIC SYSTEM OF A LANGUAGE

Language — "the immediate actuality of thought" [46] and "the most important means of human intercourse" [47] exists in two main speech forms: oral and written. Speech is a manifestation of language. It is a process of communication by means of language. Both the oral and written speech forms have a material substance. In oral speech the substance is phonic*, it is the sound substance or the sound matter. In written speech the substance is graphic.

A substance is not in itself language, but it is what forms patterns of language. The sound substance gives shape to a spoken message in communication, it forms units of the phonetic system of a concrete language.

The phonetic system of a language is a set of phonetic units arranged in an orderly way to replace each other in a given framework. In fact it contains two systems (or levels) — segmental and suprasegmental, or prosodic, each of which is a specially organized language system with a certain number of its units. Segmental units are elementary sounds, vowels and consonants which form the vocalic and the consonantal subsystems. Prosodic units are syllables, accentual (rhythmic) units, intonation groups, utterances, which form the subsystems of pitch, stress, rhythm, tempo, pauses.

The sound substance is a medium in which the whole system of language is embodied. Segmental and prosodic units serve to form and differentiate units of other subsystems of language, the lexical and grammatical units. The modifications of words and their combination into utterances (sentences) are first of all sound phenomena. The grammatical form of a verb or a noun can be changed only by changing the sounds which compose them. By changing the prosodic structure (intonation) of an utterance one changes the meaning of the utterance. It is clearly seen from the utterances of identical lexical and grammatical structures. For example, "Well done?" pronounced with the rising tone, is a question, expressing the speaker's uncertainty and desire to get further information. "Well done!", pronounced with the falling tone, wide pitch range and greater loudness, is an exclamation, expressing the speaker's evaluation. The rising-falling tone in the utterance "Well done" may express a challenging or quizzical attitude on the part of the speaker.

*The terms "phonic", "phonetic", "phonetics" come from the Greek word *φωνη* (fo:ne:) — sound.

To underline the importance of the sound medium of language H. Gleason notes that to speak any language a person must know nearly all the 100% of its phonetics, while only 50–90% of its grammar and 1% of the vocabulary may be sufficient [24].

ASPECTS OF SOUND PHENOMENA

The ability to form language units is not the only property of the sound medium. In addition to it, the sound medium has its own independent properties as a physical phenomenon. Moreover, it is a product of human activity. Being created by the speaker, the sound medium indicates the speaker's personality (sex, age, individual features) and reveals his physiological and emotional state, geographical origin, education, social status and so on.

Every act of speech presupposes the presence of a person who speaks and a person who listens. The speaker produces sounds, the sounds travel through the air to the listener in the form of complex combinations of sound waves, the listener hears and interprets them. Communication is possible only because the speaker and the listener interpret the sounds as units of the same language.

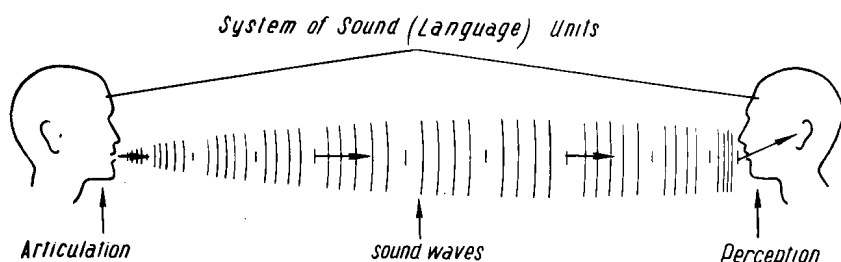


Fig. 1. Stages in the passing of a spoken message.

Consequently, sound phenomena have different aspects, which are closely interconnected: the articulatory aspect, the acoustic, the auditory and the linguistic aspect.

The articulatory (sound–production) aspect. Speech sounds are products of human organs of speech. They result from the activities of the diaphragm, the lungs, the bronchi, the trachea, the larynx with the vocal cords in it, the pharynx, the mouth cavity with the speech organs situated in it and the nasal cavity.

Sound production is impossible without respiration, which consists of two alternating phases – inspiration and expiration. Speech sounds are based chiefly on expiration, though in some African languages there are sounds produced by inspiration.

Expiration, during which speech sounds are produced is called phonic expiration as distinct from quiet breathing. In phonic expiration the air co–

mes from the lungs not freely but in spurts, because during speech the air—passage is periodically blocked by the speech organs. Therefore in speech, ex—piration lasts much longer than inspiration, whereas in quiet breathing inspi—ration and expiration each take about the same period of time.

The lungs supply the necessary air—pressure and regulate its force, thus producing variations in the intensity of speech sounds. For example, the air pressure is greater on the peak of the syllable and it is less on its margins.

Sound production actually takes place in the larynx, the pharynx and the oral and nasal cavities. The air—stream coming from the lungs undergoes im—portant modifications in them.

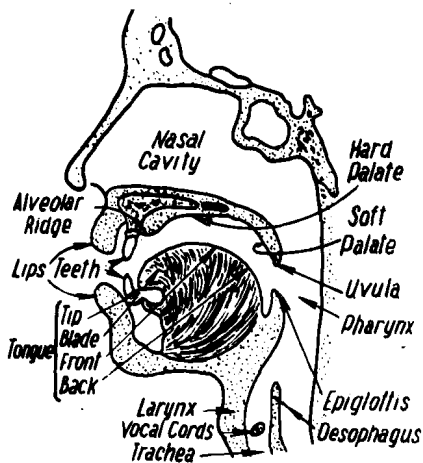


Fig. 2. Organs of speech.

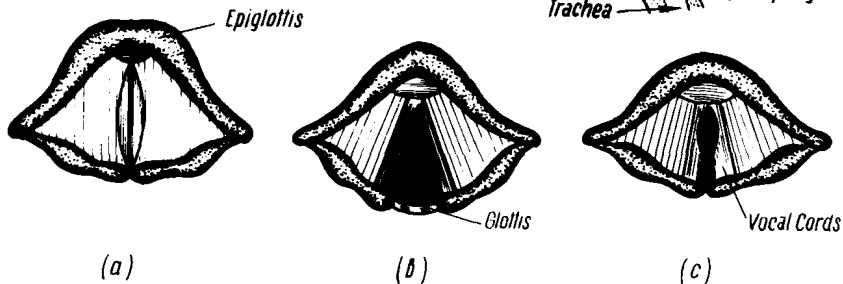


Fig. 3. Diagrams of the vocal cords: (a) tightly closed as for [ʔ]; (b) wide open as for breath; (c) loosely together and vibrating as for voice.

One part of sound production is phonation, or voice—production.

When the vocal cords, situated in the larynx, are tensed and brought loosely together, the air—pressure below the vocal cords becomes very high and the air comes from the lungs in regular puffs making the vocal cords vibrate. Their vibrations are complex, though mainly regular or periodic. The regular vibrations of the vocal cords are transmitted to the air—stream and the acoustic effect perceived by the human ear is that of a vocal tone. This is what we call voice.

The other part of sound—production is articulation which comprises all the movements and positions of the speech organs necessary to pronounce a speech sound. The movements of speech organs modify the shape, size and volume of the supralaryngeal cavities (the pharynx, the mouth and the nasal cavity) thus modifying the voice which comes from the lungs. As a result, a vowel sound of a certain quality is produced.

When in the supralaryngeal cavities there is an obstruction to the air-stream, a noise is produced. The character of the noise (friction or plosion), depends on the type of obstruction (a constriction or a complete closure) and determines the particular quality of a consonant. When an obstruction is created and the vocal cords vibrate, a voiced consonant is produced. When the vocal cords do not vibrate, the result is a voiceless consonant.

Thus there are two main sources of vibration in the production of speech sounds — the vocal cords and various kinds of obstruction.

The acoustic aspect. Like any other sound of nature speech sounds exist in the form of sound waves and have the same physical properties — frequency, intensity, duration and spectrum.

A sound wave is created by a vibration which may be periodic or non-periodic, simple or complex.

The vocal cords vibrate in such a way that they produce various kinds of waves simultaneously. The basic vibrations of the vocal cords over their whole length produce the fundamental tone of voice. The simultaneous vibrations of each part of the vocal cords produce partial tones (overtones or harmonics).

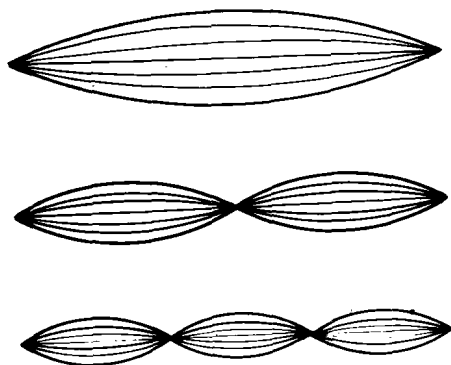


Fig. 4. Vibrations (a) of entire cord; (b) of its parts.

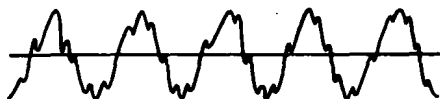


Fig. 5. Complex vibrations.

The number of vibrations per second is called frequency. Frequency is measured in hertz or cycles per second (c/s). Frequency of the basic vibrations of the vocal cords is the fundamental frequency (marked by F_0). The fundamental frequency determines the pitch of the voice and forms an acoustic

basis of speech melody. It is relatively low, about 40–400 c/s in the total range of voice. The frequencies of the overtones are much higher.*

The superposition of the fundamental and partial vibrations results in a complex tone.

The complex tone is modified in the oral and nasal resonators. Due to the particular changes in their shape, size and volume the oral and nasal cavities function as an acoustic filter: they intensify certain frequencies contained in the complex tone and weaken the others. Thus the specific qualities of vowel sounds are achieved.

The complex range of intensified frequencies which form the quality of a sound is called the acoustic spectrum of the sound. The intensified frequencies in the spectrum which characterize the quality of a sound and distinguish it from other sounds of different quality are called formants.

Vowel sounds have at least two formants marked by F_1 and F_2 , which are together responsible for the particular quality of each vowel type. F_1 is characterized by lower frequencies, F_2 – by higher frequencies. Thus, F_1 of the vowel /a:/ is equal to 800 Hz and F_2 – to 1100 Hz. The formants of /i:/ are equal to 380 Hz and 2500 Hz, respectively.

The formant of the fundamental tone (F_0) is irrelevant to vowel differentiation. F_0 is present in the spectra of vowels, sonants and voiced consonants because these sounds are formed with voice and it is absent in the spectra of voiceless consonants.

Intensity of speech sounds depends on the amplitude of vibration. Changes in intensity are associated with stress in those languages which have dynamic stress. Intensity is measured in decibels (dB**).

Like any other form of matter, sound exists and moves in time. Any sound has a certain duration. The duration of a sound is the quantity of time during which the same vibrations continue. For this reason the duration of a sound is often referred to as its quantity. The duration of sounds is measured in milliseconds (ms).

The auditory (sound–perception) aspect. Speech sounds may also be analysed from the point of view of perception. The perception of speech sounds involves the activity of our hearing mechanism, which can be viewed in two ways.

*Each half of the cord vibrates at a frequency twice as great as that of the cord as a whole. Each third vibrates three times faster, each quarter – four times faster, and so on.

**The decibel is one tenth of a bel. The bel is so named after Alexander Graham Bell (1847–1922), inventor of the magnetic telephone.

On the one hand, it is a physiological mechanism which reacts to acoustic stimuli: the human ear transforms mechanical vibrations of the air into nervous stimuli and transmits them to the brain. The listener hears the acoustic features of fundamental frequency, formant frequency, intensity and duration in terms of four perceptible categories of pitch, quality, loudness and length.

On the other hand, it is also a psychological mechanism which selects from the great amount of acoustic information only that which is linguistically significant. The human brain interprets acoustic phenomena in terms of a given language system. In this way, different acoustic stimuli may be interpreted as being the same sound unit. Thus for a Russian the open / ϵ / as in "шэст" and the mid-open / e / as in "дети" are one and the same sound unit, as the difference between them is not significant in distinguishing words or grammatical forms in Russian. An Englishman would consider these sounds as different sound units since in the English language the former resembles the open / æ / as in "had" and the latter is very much like the mid-open / e / as in "head" which serve to differentiate words. So a listener's reactions are conditioned by his experience of handling his own language.

Our physiological capabilities in perception are limited. The human ear does not perceive all the acoustic features present in a sound wave. Thus, the lower limit of frequency which we can perceive is 16 Hz, the higher limit is 20 000 Hz. In ideal conditions we can perceive even a difference in 3 Hz, but such small distinctions are not usable in speech.

It should be remembered that perceptible features of sounds are not fully conditioned by the related articulatory and acoustic ones. Our perception of the pitch of the voice depends largely (but not solely) on the fundamental frequency generated by vocal cord vibration. The greater is the frequency, the higher is the pitch of the voice and vice versa. But the perceived pitch variation may also be affected by variations of intensity on the same frequency. By reducing the intensity of a sound we can achieve a high pitch in perception.

Changes in intensity are perceived by our ear as variations in the loudness of a sound. The greater is the intensity of a sound, the louder is the sound. But our perception of loudness does not depend on intensity alone. A sound or a syllable may be perceived as louder, in comparison with neighbouring sounds or syllables, because of a marked pitch change on it or because it is longer than the others.

Moreover, some sounds, owing to their nature, are louder or more sonorous than others. Thus / a :/ is more powerful than / i :/, and vowels generally have more carrying power than consonants.

Our judgements relating to loudness are not as fine as those relating to either quality or pitch.

Different duration of speech sounds is perceived as a difference in their length. But our perception of length does not always correspond to the actual duration of speech sounds or other units. For example, the length of rhythmic units in an English utterance is considered to be approximately the same since it is a characteristic feature of English rhythm that stressed syllables occur at more or less equal intervals of time. But the actual duration of rhythmic units is far from being equal. This is an example of how our brain interprets from the acoustic material only that which is linguistically significant.

Our hearing mechanism acts as a monitor of what we ourselves are saying. The process of communication would be impossible if the speaker himself did not hear the sounds he pronounces. If the link between listening and pronouncing is disturbed, disturbances in the production of speech sounds are likely to appear. The better we hear the differences between the sounds, the better we pronounce them. Therefore in learning to pronounce the sounds of a foreign language one should bear in mind the importance of ear-training.

The linguistic aspect. Segmental sounds and prosodic features are linguistic phenomena. Representing language units in actual speech, they perform certain linguistic functions. They constitute meaningful units — morphemes, words, word-forms, utterances. All the words of a language consist of speech sounds which are grouped and arranged in the way specific for the language and which are unified by stress. All the utterances consist of words, and, consequently, of sounds; they are characterized by certain pitch-and-stress patterns, temporal features, rhythm.

Most of the meaningful distinctions of the language are based on distinctions in sound.

Sounds and prosodic features serve to differentiate the units they form since communication by means of language is possible only because sound phenomena can be opposed to one another for purposes of differentiating words, word-forms and utterances.

Simultaneously, the sound phenomena enable the listener to identify them as concrete words, word-forms or utterances.

Thus, segmental sounds and prosodic features of speech perform constitutive, distinctive and identificatory functions.

The linguistic aspect of speech sounds is also called the functional or social aspect, because of the role which sound matter plays in the functioning of language as a social phenomenon.

The relations between the articulatory, acoustic, auditory and linguistic aspects of speech sounds can be presented roughly in the following way:

Articulatory characteristics	Acoustic properties	Auditory (perceptible) qualities	Linguistic phenomena
vibrations of the vocal cords	fundamental frequency	pitch	prosody (melody, stress)
different positions and movements of speech organs	formant frequencies	quality (timbre)	phoneme, prosody (stress)
the amplitude of vibrations	intensity	loudness	prosody (stress)
the quantity of time during which the sound is pronounced	duration	length	prosody (tempo, rhythm)

PHONETICS AS A SCIENCE

The study of the sound phenomena of language, in all their aspects and varieties, constitutes the subject of the phonetic science.

Phonetics as a branch of linguistics studies sounds in the broad sense, comprising segmental sounds (vowels and consonants) and prosodic phenomena (pitch, stress, tempo, rhythm, pauses). Phonetics occupies itself with the study of the ways in which the sounds are organized into a system of units and the variation of the units in all types and styles of spoken language. It also studies the acoustic properties of sounds, the physiological basis of sound production and the sound phenomena that reveal the individual peculiarities of the speaker.

Thus the sound medium has a special science all to itself because of the exclusive importance of oral speech as compared with written speech. Oral speech is primary, whereas written speech is secondary (it is constructed on the basis of oral speech). The sound medium needs special attention also because of the complex character of its production and perception. Besides, further development of such technical means of sound transmission as the telephone, the radio, recording and speaking machines, speech recognizers, deaf aids raises a great number of primarily phonetic problems.

Phonetics as a science is a branch of linguistics. Being a science in its own right, it is at the same time closely connected with other linguistic sciences —

grammar, lexicology, stylistics and the history of the language, since the phonetic system of a language, its vocabulary and grammar constitute one indivisible whole. It is also closely interconnected with physiology, biology, physics, pedagogy, psychology, mathematics, cybernetics.

Phonetics has a long history. It was known to the ancient Greeks and Hindus. But as a science in its own right it began to develop in Russia and in Western Europe only in the second half of the 19th century.

BRANCHES OF PHONETICS

Depending on which of sound phenomena is studied, phonetics is subdivided into four main branches.

Articulatory phonetics is concerned with the study of sound as a result of the activities of speech organs. It deals with our voice-producing mechanism and the way we produce sounds, and prosodic phenomena. It studies respiration, phonation (voice-production), articulation and also the mental processes necessary for the mastery of a phonetic system.

Methods employed in articulatory phonetics are experimental. They involve palatography, laryngoscopy, photography, cinematography, X-ray photography, X-ray cinematography, electromyography, and various kinds of technique to study sound-perception.

Besides these objective methods articulatory phonetics uses its oldest, subjective method – the method of direct observation. This method involves observation of the movements of speech organs when pronouncing sounds and analysis of one's muscular sensations during the articulation of speech sounds.

Perceptual (auditory) phonetics occupies itself with the study of man's perception of segmental sounds, pitch variation, loudness and duration. It studies the ways in which sound perception is determined by the phonetic system of a language.

The methods used in perceptual phonetics are also experimental. They include various kinds of auditory tests.

Since sound production and sound perception are physiological processes, articulatory and perceptual phonetics are generally termed physiological phonetics.

Acoustic phonetics is concerned with the acoustic aspect of speech sounds. It studies speech sounds with the help of experimental (instrumental) methods. Various kinds of apparatus are applied for analysing the acoustic structure of segmental sounds and prosodic phenomena. For example, we use a spectrograph to analyse the acoustic spectra of sounds, an oscillograph and an intonograph to analyse frequency, intensity and duration. With the help of an electro-acoustic synthesizer synthetic speech is produced which is a good means of testing the results of the electro-acoustic analysis.

Phonology, or functional phonetics is a purely linguistic branch of phonetics. It deals with the functional aspect of sound phenomena. Phonology sets out to discover those segmental and prosodic features that have a differential value in a language, and it establishes the system of phonemes and prosodemes. It also sets out to determine the frequency of occurrence of these units in syllables, words, rhythmic units and other sequences which form the utterance. The distribution and grouping of phonemes in syllables and words in a particular language are dealt with in an area of phonology which is called phonotactics.

The basis of phonology is the phoneme theory, created in Russia by I. Baudouin de Courtenay and developed by his pupils and followers L. Shcherba, N. Krushevsky and, later, by other Soviet and foreign linguists. Phonology was founded in Prague by a group of linguists (N. Trubetzkoy, R. Jakobson and others).

Phonology of segmental units is often called phonemics, whereas phonology of intonation (prosody) is termed intonology (or prosodemics).

The methods employed by phonology are linguistic.

All the above branches of phonetics are closely connected since the object of their study—speech sounds—is a close unity of acoustic, articulatory, auditory and linguistic aspects. But not all linguists are of the opinion that phonology is an integral part of phonetics.

N. Trubetzkoy [40] claims that phonology should be separated from phonetics. According to the Prague School, established by him, phonetics and phonology are independent sciences: phonetics is a biological science and is concerned with physical and physiological characteristics of speech sounds, phonology is a linguistic science and is concerned with the social function of phonetic phenomena. This point of view is supported by the Danish linguist L. Hjelmslev who advocated total separation between phonetics and phonology. But the vast majority of Soviet phoneticians do not consider it logical to separate function from form and to exclude phonetics from the linguistic sciences [80]. A great number of phoneticians abroad adhere to the same point of view. For instance, B. Malmberg, a Swedish phonetician, writes as follows: "It was a grave error on the part of the Prague School to want to establish a strict separation between phonetics and phonology... The two types of studies are interdependent and condition each other. Consequently it seems preferable to group them together under the traditional general heading of phonetics" [97, p. 97].

Besides the four branches given above, there are other branches of phonetics, such as special, general, historical, descriptive, comparative, applied.

Special phonetics is concerned with the study of the phonetic system of a concrete language. When the phonetic system is studied in its static form at a particular period (synchronically), we deal with

descriptive phonetics. When the system is studied in its historical development (diachronically) we speak about historical, or evolutionary phonetics. Historical phonetics uses the philological method of investigation. It studies written documents and compares the spelling and pronunciation of one and the same word in different periods of the history of the language.

General phonetics is concerned with the study of man's sound-producing possibilities and the functioning of his speech mechanism. It establishes the types of speech sounds which exist in various languages, the way they are produced and the role they play when forming and expressing thoughts. General phonetics is based on the extensive material which is provided by the special phonetics of a number of languages and on the material of other sciences. As a result of this, general phonetics has been able to make a number of general conclusions concerning the complex nature of speech sounds and to formulate a number of theories: the phoneme theory, the theory of syllable formation, theories of stress, intonation, etc.

Theoretical phonetics of a particular language applies those theories to the language it analyses.

Comparative phonetics is concerned with the comparative study of the phonetic systems of two or more languages, especially kindred ones.

By practical, or applied phonetics we mean all the practical applications of phonetics. Phonetics is of considerable importance for other fields of language study, which have made use of the approaches and the linguistic methods worked out by phonetics.

All the branches of phonetics are of great use and importance in teaching the pronunciation of foreign languages. Phonetic data is also made use of in teaching children to read and write their mother tongue; in creating orthographies for unwritten languages.

Phonetics is of great practical importance in the teaching of diction to actors, singers, radio-announcers and other public speakers. In order to speak well and to teach others the proper way of speaking one must understand the mechanism of articulation and the mechanism of phonation. Young teachers should bear it in mind that to teach efficiently they must learn to speak efficiently.

Phonetics is applied in logopedics, i.e. in correcting speech defects and in curing pathological phenomena of speech, such as aphasia. To correct deviations from the pronunciation norm, one must have a good knowledge of normal phonetics.

Phonetics is of great importance in surdo-pedagogics, i.e. teaching normal oral speech to deaf-mutes. The deaf people can, in most cases, use only muscular sensation to control and guide their articulation. Therefore, to teach to speak one must know thoroughly the articulatory aspect of speech sounds.

Phonetics is widely used in the field of sound transmission: in telephony, broadcasting, speech recognition. To build a microphone, a tape recorder, a

spectrograph, a speech synthesizer or any other apparatus capable of transmitting the spoken language, the sound engineer must know acoustic phonetics and, very often, solve the same problems as the linguist does.

Close interaction and collaboration between phonetics and other sciences has given birth to new scientific branches such as technical acoustics, psychophonetics and other phonetic sciences which contributed considerably to the formation of speechology — the science of speech.

EXERCISES

A. Think about the following questions for class discussion:

1. What are the relations between language and speech?
2. Define the phonetic system of a language. What units does it include?
3. What are the two main sources of sound?
4. How does the frequency of the vocal cord vibrations change in the production of the falling tone? (the rising tone?)
5. Why do the sounds of the violin, the guitar and other musical instruments differ? What affects their specific qualities? Is there any analogy in the production of speech sounds?
6. In what way does the listener perceive the acoustic properties of speech sounds? What does perception of pitch and loudness depend on?
7. How would you explain the difference between the physiological and psychological aspects of our hearing mechanism? Which of them is responsible for "hearing the message"? Which is responsible for "understanding the message"? Which of them is involved when we listen to a foreign language that we don't know?
8. Why is it important to train one's hearing abilities in foreign language learning?
9. Why is phonetics placed among linguistic sciences and not among physiological or physical?

B. Select some examples:

- 1) to illustrate articulatory and functional distinctions between English and Russian (or Byelorussian) sounds;
- 2) to illustrate the distinctions in sounds which express distinctions in meaning;
- 3) to illustrate that an utterance, an act of oral speech, is a concrete manifestation of the whole system of language at work.