
ARTIFICIAL DISTORTION OF WORDS

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Hearing is a phenomenon which is composed of different elements, anatomical, biochemical, elektroneurophysiological, linguistic, phonetic and statistical. Therefore one can study hearing as a process either from a medico-audiological, psychological, or linguistic standpoint, which means, that the results from these rather different groups of sciences must be somewhat different, or, at least they cannot be identical. Medical audiology has developed tonal liminar audiometry, tonal supraliminar audiometry and with all these techniques and tests one can obtain precise results about the lesions of hearing from the outer part of the ear up to the cochlea with all its structures.

The attempts to draw out with supraliminar tonal audiometrical tests pure neural, or even central lesions of hearing, in spite of many elaborate tests could not find broader application in the audiological diagnosis.

In such a situation the audiologists turned to speech audiometry with the task of elaborating tests for the ascertainment of central disorders and lesions of hearing. In the last 10 years many distorted speech audiometrical tests have been elaborated. With the distortions of speech elements (the distortion was performed in different ways and principles) on the ground of full or lessened discrimination effect one should reach the diagnosis of the central lesions of hearing.

All these tests in spite of the fact, that they were theoretically ingeniously elaborated, have too many uncertain elements to be applicable in routine audiological examination. The main reason lies in the complex structure of the phenomenon of hearing. Human communication takes place with speech. But, what is speech?

Into the ear of the person who is listening do not enter either sentences and words or syllables, from which every single word is made up. Into the ear during communication enter only sequences of air vibrations or sequences of variations in the air-pressure. From the phonatory organ of the person come not sentences or words, but sequences of variations in the air-pressure. In the cochlea take place the transformation of the mechanical movements into electrical potentials, and a detailed and definitive frequency and amplitude analysis. The sequences of the impulses of the equivalent pass through the filaments of the acoustic nerve to the brain, where the definitive stage of the hearing phenomenon, the decoding will take place. The decoding is the linguistic and statistic process for the ascertainment and identification of the

corresponding acoustic picture which as an engram lies as a deposit in the "memory". In the same time interval take place the confrontation and identification of the sequences which arrive, with the adequate and corresponding acoustic engrams. But these sequences consist only of the series of impulses which flow through the acoustic nerve. As yet we know neither the total number of informations for a certain acoustic engram, nor the minimal quantity of informations on the ground of which an adequate identification will take place in the process of decoding. This minimal number of informations depends on the presence of many factors which are superimposed in this process such as noise etc.

Every distorted word, from the theoretical standpoint, should have its frequency composition (and in some tests also the time factor) so much distorted that the sequences of informations which reach the decoding process will not correspond well to the adequate normal engram.

It is obvious that during the presentation of such distorted words the whole linguistic and statistic procedure must be activated under extremely unfavourable conditions in order to reach the adequate engram in the process of decoding. Therefore the whole diagnostic procedure in the audiological examination of the lesion of hearing of presumably central origin takes place in the area of psychological, linguistic, phonetic and statistic elaboration and in a very small part in the medico-audiological ascertaining of the nature and the degree of the lesion of hearing.

The application of speech audiometrical tests for the topical examination of the lesion of hearing especially in the area of the cochlea has so far been only partly elaborated and has not shown clear results. Lafon in his phonetical testing and measuring, of hearing besides tests intended only for the diagnostical procedure for the ascertainment of the central types of lesion of hearing, elaborated also a test for the ascertainment of lesions of hearing located in the cochlea. In this test he uses the same linguistic and mathematical procedure as in the test for central lesions of hearing, and that cannot be the right way for this task.

It is a fact that with tonal audiometrical tests and methods it is impossible to ascertain the finer differentiation of the perceptive lesions of hearing of the sensory type. It is evident that all perceptive lesions of hearing of the sensory type cannot have the same pathological origin and the same anatomical background. Owing to the complex mechanism of the frequency and amplitude analysis which takes place in all the structures of the cochlea and not only in the sensory cells of the Organ of Corti, one should try to divide the broad group of sensory lesions of hearing into some special types and audiological forms, but during this procedure one should take maximum care not to disturb the final stage of the phenomenon of hearing. Only under such circumstances could one be sure that the phenomenon of hearing as a whole will take place under normal and not artificially aggravated conditions. All tests with distorted speech elements are elaborated either with frequency distortions or with the superposition of a changed time factor. Therefore the process of the frequency and amplitude analysis of a quite new speech element takes place in

the cochlea, and sequences which very little resemble the original, undistorted word run to the brain. For this reason the decoding process will take place under ad maximum aggravated conditions of linguistic and statistical elaboration, and the final identification will take place with or without success, but we cannot state or measure

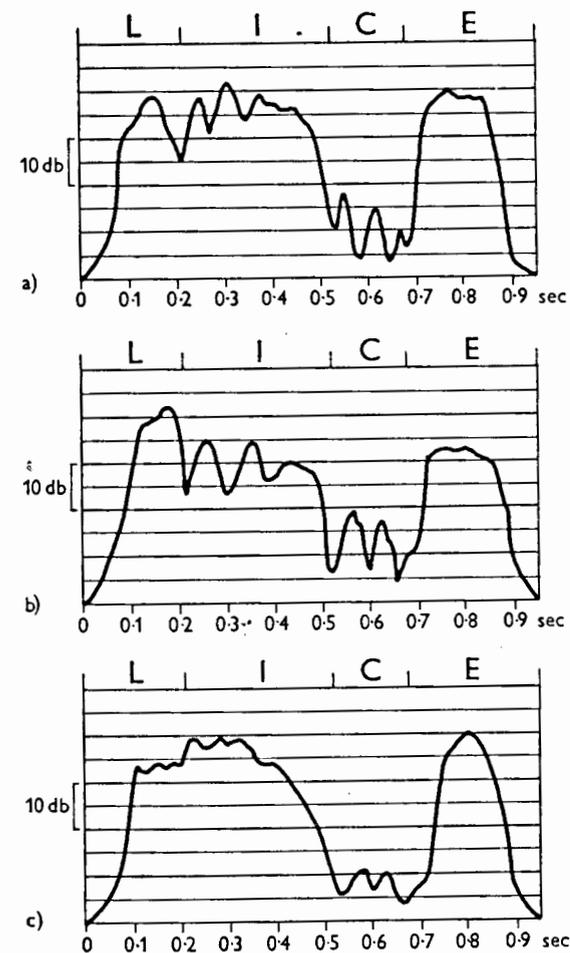


Fig. 1.

with non-objective methods all forces used in this final act of hearing. The examination of hearing with distorted speech elements with the aim of ascertaining finer forms in the group of sensory lesions of hearing can be successfully elaborated only if the distortion can be performed in a way which would attack only the analytical process in the cochlea but not the later stage of the decoding, which means that the distortion must be achieved in such a way that the sequences as a whole in passing from the cochlea to the brain must be ad maximum similar and adequate to the sequences of the normal presentation of the same speech elements. The frequency

distortion with filters changes too much the acoustic material which enters the cochlea. Therefore quite another process of analysis of this speech element must follow. It is obvious that every distortion of the frequency qualities of the speech elements at least for the purpose of studying the function of the cochlea must be without sufficient effect.

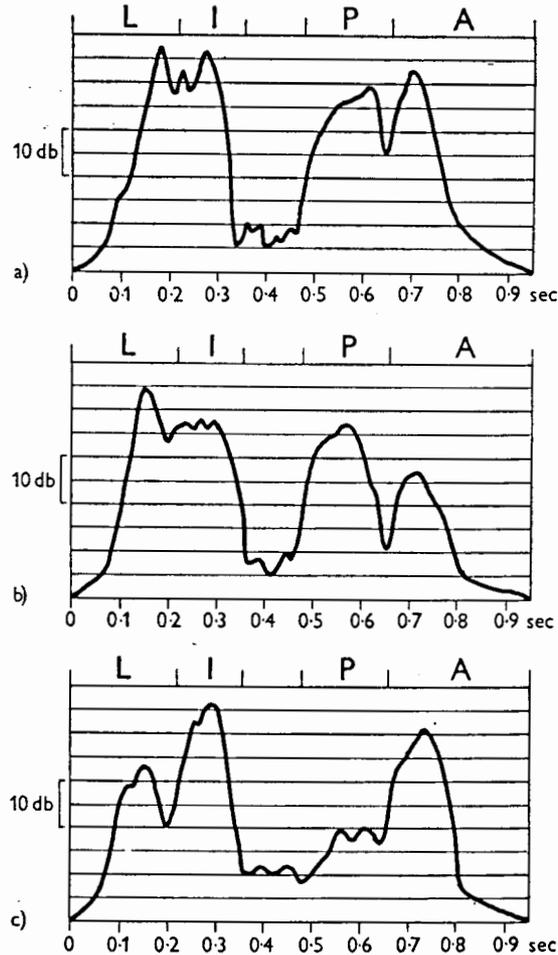


Fig. 2.

Another as yet not applied principle of distortion is, to perform the distortion only of amplitude elements and only of some of these which will be strictly selected in advance. If one can carry out this distortion precisely and measure it exactly, it should be possible to work with precise units of measurement such as the decibel.

I elaborated such a distortion test in which I lowered by 10 decibels the amplitude values of either vowels or consonants in the speech elements. With a special technique this procedure can be performed precisely, and the tape-recorder in the Brüel Kjaer logarithmic writer shows exactly if the procedure is performed successfully or not.

As one can see on the following figures 1, 2, 3, 4 and 5, every word has a certain envelope with frequency and amplitude elements for every phoneme. After a weakening either of vowels or of consonants the envelope shows that this weakening amounts to exactly 10 decibels either for consonants or for vowels. If we reproduce these

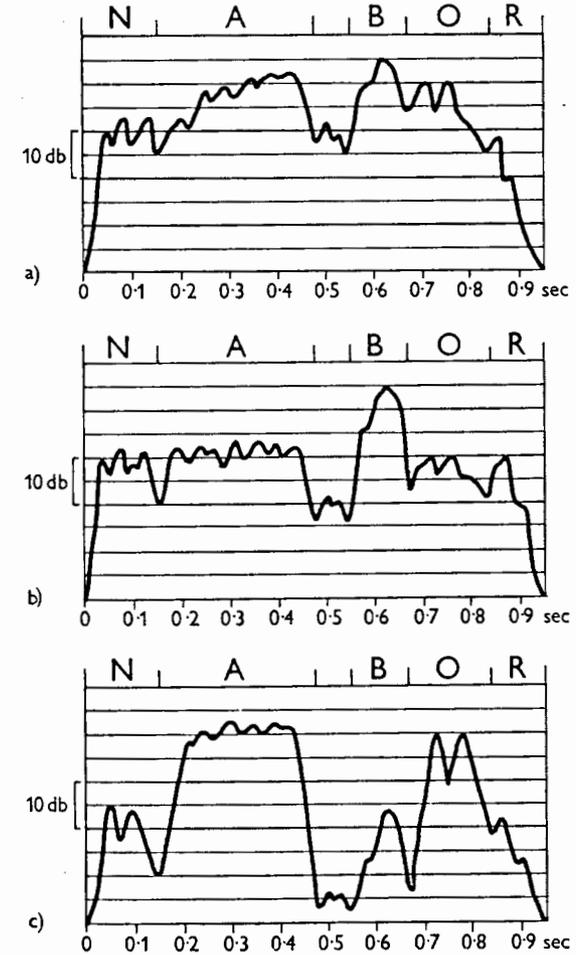


Fig. 3.

weakened words through a loud-speaker in the free field, the intelligibility of these artificially distorted words will be for the person with normal hearing only somewhat lessened. But, if we present these distorted words to patients with reduced hearing we shall see that there is an evident difference between conductive and perceptive losses of hearing. In all conductive cases the intelligibility of such distorted words with weakening either of vowels or of consonants presented at different supraliminal levels is the same as with persons of normal hearing. But with the patients with perceptive loss of hearing there are 2 different groups. In the one group the patients show mar-

edly lessened intelligibility of the distorted words at all higher supraliminal levels. In the other group the patients show the same intelligibility as the patients with

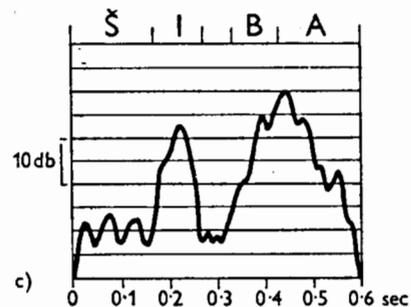
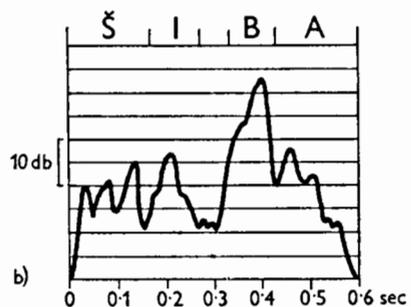
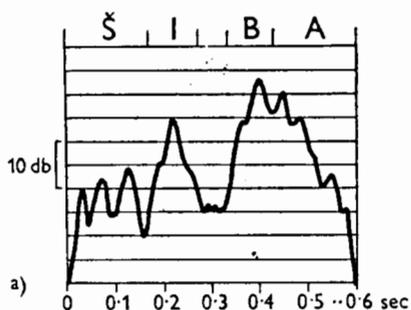


Fig. 4.

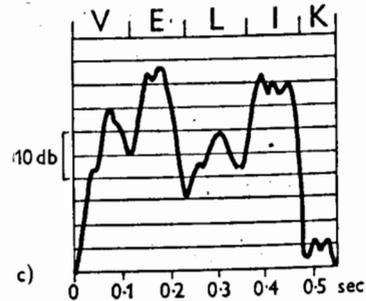
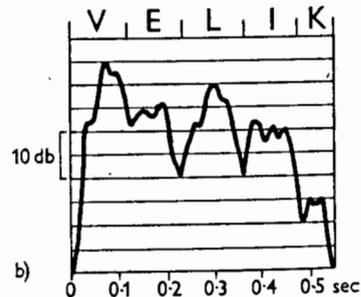
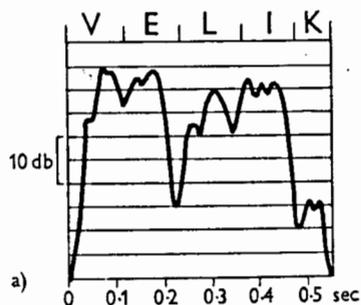


Fig. 5.

conductive loss of hearing. These results show that it is possible with the distortion test of weakening either of vowels or of consonants to obtain some new details on the audiological picture of perceptive losses of hearing.