

USE OF CLINICAL DIAGNOSIS IN AUDITORY THEORY

Ira J. Hirsh

In the previous paper by Davis, we have seen how a model of the auditory system can be built from information in anatomy and physiology. When a physiologist proposes such a model, he has an interest in ascribing to the various parts and functions the different processes that have been detailed in psycho-acoustics. Davis' particular interests have focused on the localization and periodicity hypotheses for pitch and also the shape of the loudness function.

One of the deductions to be made from such a model is that a lesion or pathological process involving particular parts of the model should result in a deterioration or malfunction of particular psycho-acoustic processes. A test of such a deduction should be available when patients with different kinds of hearing loss demonstrate on the one hand particular results in psycho-acoustic tests and, on the other hand, particular identifiable lesions or pathology. It will be my conclusion that although various combinations of psycho-acoustic tests may result in diagnoses that are of some use to the clinician in treating hearing loss, these diagnostic labels are so general and untied to anatomical or physiological data as to be not very useful for the testing of such a physiological model.

In audiology we have about four broad categories of tests: (1) pure-tone audiogram, for both air and bone conduction; (2) hearing for speech, especially speech discrimination; (3) loudness tests of various kinds, especially oriented toward determination of recruitment; and (4) other kinds of psycho-acoustic tests involving the perception of tones or complex signals at levels above threshold.

The pure-tone audiogram gives a large amount of information. The total amount of hearing loss indicates crudely certain sites of lesion. The shape of the audiogram tells us something about the transmission characteristic of the auditory system and is also useful in eliminating certain pathological possibilities. Finally the discrepancy between the results for air conduction and those for bone conduction helps still further in selecting the most probable site of lesion. In general, it appears that purely conductive impairments can be identified with pure-tone audiometric results, especially when there is a great gap between air and bone conduction. The shape of the audiogram is less informative unless it is coupled with these results on bone conduction.

When we pass beyond the stapes footplate, things become very complicated from a diagnostic point of view. One of the major distinctions that has been advanced in recent years is that between cochlear and retrocochlear lesions.

When the audiograms of such patients show only mild hearing losses, the results for speech discrimination are ambiguous. Many of these patients in either category show rather good speech discrimination unless the hearing loss has become severe. On the other hand, results from loudness-balance tests appear to indicate that the phenomenon of recruitment is associated with pathology in the cochlea, while the absence of recruitment in cases that are otherwise similar indicates retrocochlear lesions. Can we, on the basis of such a relation, assign the loudness growth function to the cochlea? This would be a dangerous thing to do, it seems to me, especially since we do not know from an anatomical or physiological point of view what a cochlear lesion is. The two best known kinds of cochlear pathology are Menière's disease and industrial hearing loss. In the latter case, we infer something about the human auditory system on the basis of what we know from anatomical reconstructions of the cochleae of animals who have been exposed to intense noise. Even here, however, the evidence is not clear because the traumatic results in which structures associated with the organ of Corti are actually ruptured or degenerated must be distinguished from the kind of permanent hearing loss that may ensue after prolonged exposure to moderate intensities where there is no clear anatomical damage but yet clear physiological dysfunction.

Menière's disease is even more complicated. It is certainly clear that recruitment is almost always found in Menière's patients but it is certainly not clear what aspect of the pathology can be related to this abnormal loudness function. Are there changes in the mode or rate of metabolism in cochlear structures? Is there not a new cochlear mechanical system in which the cochlear duct is enlarged and probably also stiffer? Are there missing or diseased receptor cells? Do the inner and outer hair cells operate at different levels? If all of these possibilities exist without direct anatomical or physiological knowledge of the disease, then it would be very difficult indeed to ascribe recruitment to any one of them.

The first main point here is that a diagnostic label like "industrial hearing loss" or "Menière's disease" may be useful for an otologist who is trying to prescribe a treatment or for the audiologist who wishes to know what kind of case he is working with. But these labels are not very useful for a person who is building a model of the auditory system because they do not say very much about the particular structural elements in the system that are involved in the disease. Another way of stating this first point is that a diagnosis, as it appears to be given in otology today, is not an anatomical or physiological statement. It is, rather, a judgment based upon a collection of items from history, physical examination, and audiological tests. In fact, there is a certain amount of circularity to be observed in the audiological and otological literature because a diagnosis seems to imply an anatomical statement which then can be related to an audiological finding, but on close examination the diagnosis turns out to be merely a restatement of the audiological findings.

The cochlea is actually the most difficult part of this business. Lesions of the external or middle ear and also lesions of the central nervous system in human patients can often be confirmed at the time of surgery. Thus it is that we may have very specific information on the part of the auditory system

that is affected by a tumor but this leads to a frustrating result also, because here the audiological findings are rather diffuse. Patients with acoustic tumors confirmed by surgery can sometimes show great hearing loss for tones and poor speech discrimination, or sometimes very mild hearing loss for tones but poor speech discrimination, or sometimes only mild or non-existent auditory symptoms of any kind. One observation that has been made on only a few patients may stand up over time and that is the abnormal decrement in sensation that accompanies prolonged stimulation. This is one observation that is consistent with some of Davis' suggestions about transmission in the auditory nerve.

Very few of the predictions made by Davis about what changes in hearing should accompany certain changes in the structures of his model are contradicted by facts. The difficulty lies in the lack of supporting evidence on the physiological or anatomical side.

INTERET THEORIQUE DU DIAGNOSTIC CLINIQUE AUDIOLOGIQUE

H. Davis a proposé des interprétations physiologiques de différents syndromes audiolgiques. Est-il possible, inversement, d'établir des relations entre les caractéristiques psycho-acoustiques et les modifications anatomo-physiologiques?

Une preuve de l'existence de ces relations est évidemment la présence simultanée d'un déficit auditif et d'une lésion déterminée.

De nombreux tests audiolgiques permettent de préciser les déficits auditifs, mais il est difficile d'y faire correspondre des modifications pathologiques particulières. On utilise couramment des termes cliniques tels que syndrome de Ménière, surdité professionnelle, lésion rétrocochléaire, qui ne peuvent être traduits avec précision en termes anatomiques. Ces définitions cliniques sont d'une grande utilité pour la pratique, mais elles n'apportent pas beaucoup de lumière sur le plan anatomo-physiologique.

Les résultats des investigations cliniques sont en définitive d'une faible utilité pour l'interprétation théorique des phénomènes.

Ira J. Hirsh, Ph. D.,
Central Institute for the Deaf,
818 South Kingshighway,
St. Louis 10, Mo., U.S.A.

DISCUSSION:

Chocholle:

Les difficultés évoquées par le Dr Hirsh se compliquent du fait que nous n'avons pas d'autre moyen de communication que des mots, en nombre toujours limité, et toujours conventionnels, symboliques; même après explications, ils ne peuvent rendre compte que fort imparfaitement du fond même de la pensée de chacun, extrêmement subtile; comme la sensation, la perception, la façon de penser, de comprendre, d'interpréter, etc, sont purement personnelles et varient d'un individu à un autre, on ne sait jamais si le sujet a bien compris, à quoi il répond, etc; il faut donc être très vigilant dans l'interprétation des résultats.