Auditory analysis in some common hearing problems

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THE value of several of the modern tests of auditory function is becoming clearer, and it is now possible to perform a systematic, but essentially simple, auditory analysis of both middle-ear and neuro-sensory elements. This is of value in many problem cases.

Simple air and bone pure-tone audiometry while providing a measurement of hearing loss has done little by itself to assist diagnosis in such cases, and has often merely emphasized the difficulties inherent in recording true thresholds especially when there is a marked difference in the two ears. If any clinician still believes that a set of tuning forks and a Barany box are all that is necessary, he should be disillusioned. This may have been true up to 10 years ago, it is certainly no longer the case.

Of course we need an interview with the patient, and the tuning forks and the Barany box to obtain a proper history and to make a clinical estimation of the hearing problem involved. Indeed upon this estimation will depend the successful deployment of the technical team required in a modern otological unit. If this team is to be both efficient and economic it must be skilfully led, have the necessary equipment and understand the underlying purpose and significance of the individual tests to be applied. The relationship between management and labour must be excellent or team failure is inevitable. Autocratic demands on, and control of, technical personnel may produce hearing test results, which satisfy or even gladden the heart of the otologist but under these circumstances they are liable to be inaccurate and may reflect what the technician thinks is wanted rather than the true picture. Successful auditory analysis therefore is dependent upon team work of a high calibre. The clinician must be essentially humble and he must understand what he is trying to do. The technicians on the other hand must understand what they are doing and should be proud and happy as a result. I do not subscribe to the view that the clinician should be a better technician than the technician; by the nature of things the latter encouraged to think and to use his delicate equipment intelligently will always be ahead of the ordinary otologist who must spend the majority of his time on other aspects of his work.

I have laid some emphasis on this aspect as auditory analysis is

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essentially dependent upon human beings—clinician, technician and patient, and the results in any unit will mirror the skill, sympathy and dedication of those conducting the investigations. I do not believe it possible to produce accurate findings in this type of work by mass production or by the assumption that multiple test results can be squeezed out of a patient in a set time. Blood chemistry analysis with the Astrup machine may be suited to this approach; auditory analysis certainly is not. It is important therefore for the clinician to be clear as to what he is trying to do and not to waste the valuable technical time, and enthusiasm, which ought to be at his disposal.

The tests which we use in auditory analysis are familiar to most of you and the method of application is, we think, logical. Briefly measurements of acoustic impedance, middle-ear pressure and the elicitation of the stapedial muscle reflex are desirable in the differential diagnosis of conductive deafness; tests for recruitment are essential in cochlear deafness; and tests for tone decay and loss of speech discrimination are helpful in retrocochlear deafness, while skilful combinations of all these tests may be necessary in problem cases of both genuine and psychogenic deafness.

The following illustrations show our actual findings in several cases. On each is recorded an audiograph showing the air and bone pure-tone thresholds together with the loudness discomfort level (L.D.L.). Below this is a battery of relatively simple tests any or all of which may be useful in a particular case. For the sake of clarity the results of these tests are recorded in two columns, that on the right representing the findings which we believe to be of special significance in the particular case being studied. The conclusion resulting from these test results and the final diagnosis are recorded at the foot of each illustration.

The key to the tests used is shown below the first illustration.

It will be apparent that we should not make too hard and fast a distinction between neuro-sensory deafness on the one hand, and conductive deafness on the other. Not infrequently elements of both are present which need assessment.

Illustrations 1–3 show the value of acoustic impedance testing in conductive deafness, illustrations 4 and 5 show the two extremes in neuro-sensory deafness and illustrations 6–8 show the application of the system to mixed lesions.

While I agree with Tumarkin that eustachian tube obstruction can cause effects upon inner-ear function I believe that this only occurs in a small minority of cases and that this small group can and should be differentiated from the vast majority of inner-ear problems, in which middle-ear pressure and eustachian tube function are entirely normal. I can see no merit in artificially ventilating a middle ear which is already ventilating normally.

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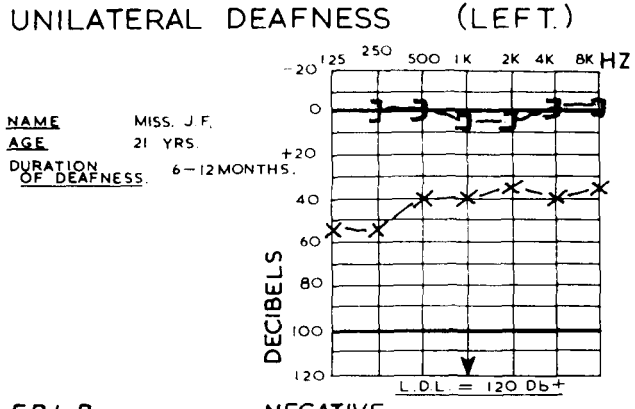


FIG. 1.

Significant findings here are the absent stapedius muscle reflex and increased rigidity of the tympanic membrane in a unilateral conductive deafness. This patient had normal hearing in the right ear.

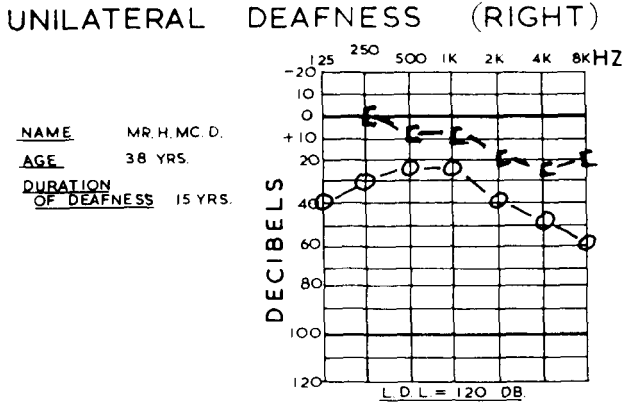


FIG. 2.

Here unilateral conductive deafness is again accompanied by absence of stapedial muscle reflex but there is no increase in M.T. rigidity and there is a history of head trauma at onset of deafness.

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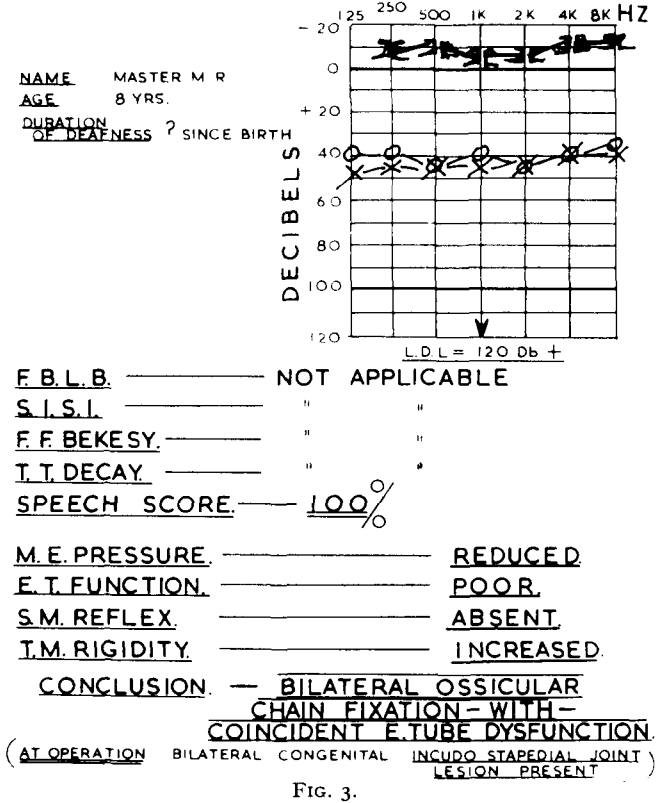


FIG. 3.

A young boy with bilateral conductive deafness possibly since birth. The findings of absent S.M. reflex and increased M.T. rigidity, although typical of otosclerosis involving stapedial footplates, are unusually symmetrical, and complicated by evidence of abnormal middle-ear and eustachian tube function. This child's mother and elder brother had similar findings in both ears.

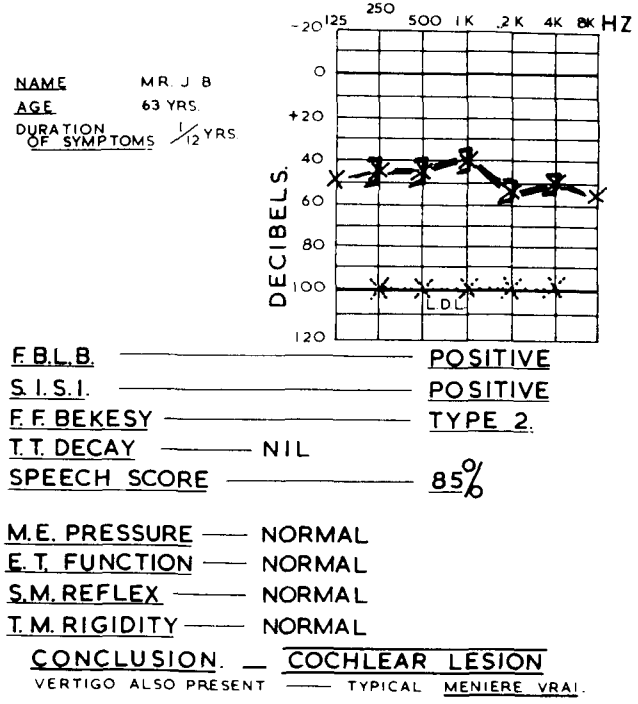


FIG. 4.

A typical history of Ménière's disease is accompanied by evidence of recruitment (1. Reduction of loudness discomfort level; 2. Positive loudness balance; 3. Positive S.I.S.I.; 4. Type 2 Békésy trace). This with a good speech score, is typical of a cochlear lesion.

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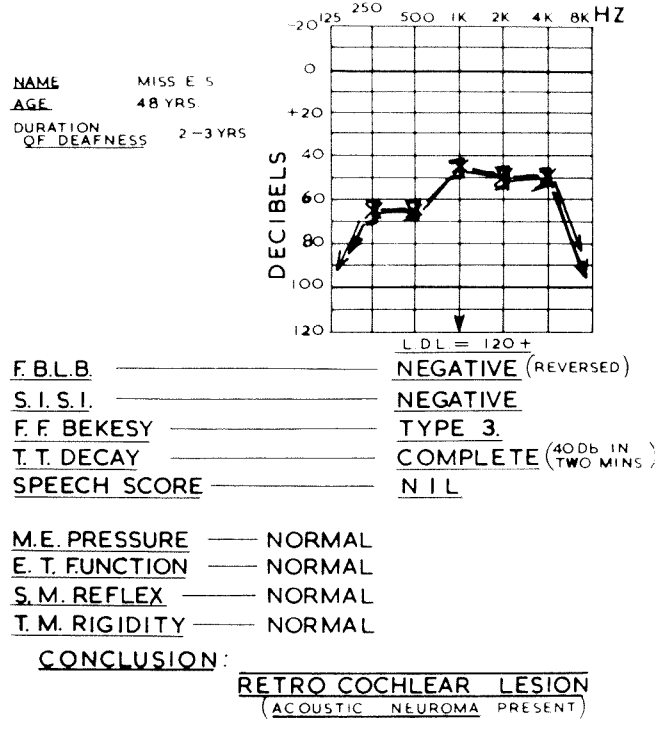


FIG. 5.
Coincident air and bone pure-tone thresholds are accompanied here by absence of recruitment, by strong evidence of tone decay (1. Type 3 Békésy trace; 2. Threshold tone decay test positive) and by a very poor speech score. All suggestive of a retro-cochlear lesion.

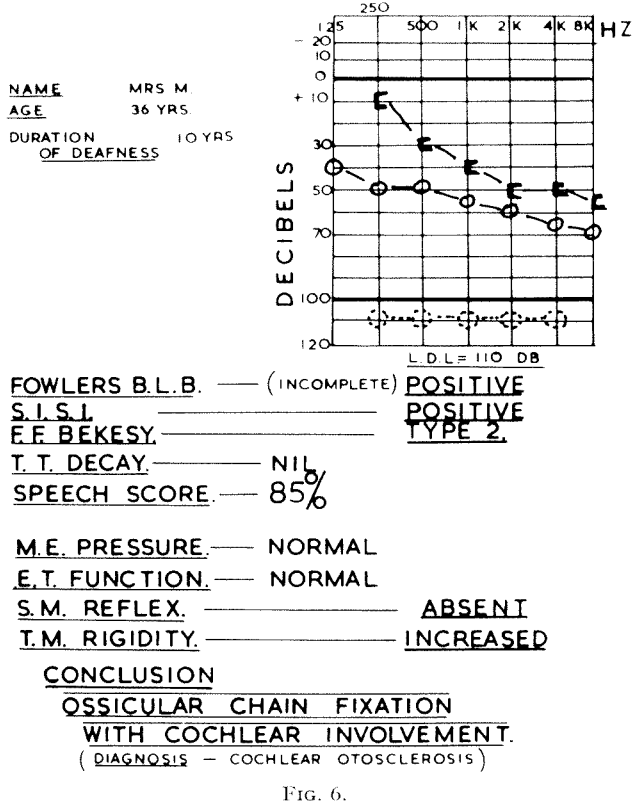


FIG. 6.
Here a conductive hearing loss shows some impairment of bone conduction with evidence of coincident recruitment suggesting cochlear involvement by an otosclerotic process.

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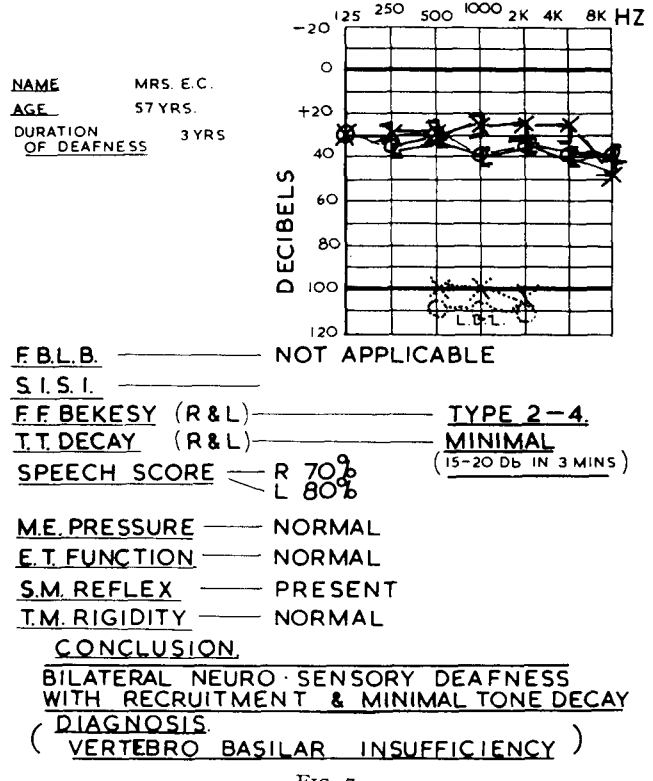


FIG. 7.

A middle-aged female with neuro-sensory loss shows reduced loudness discomfort and a type 2–4 Békésy together with some tone decay. These findings were present with episodes of imbalance and falling, with obesity and with marked cervical spondylosis.

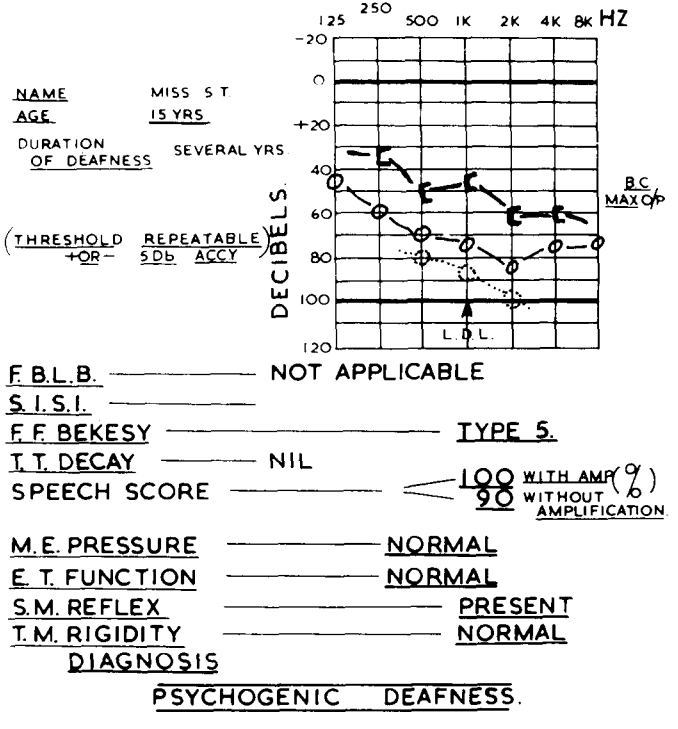


FIG. 8.

Here the appearance of a consistent conductive deafness in one ear was challenged when gross reduction of the loudness discomfort level was found. A typical type 5 Békésy trace, the presence of a stapedial muscle reflex in the affected ear and normal speech discrimination all confirmed the diagnosis.

The pre-requisites therefore for this simple type of auditory analysis are:

1. The necessary equipment—which need not be expensive.
2. Trained and interested technical staff.
3. Efficient organization of both clinical and technical resources.

The equipment for these tests used in our department is relatively inexpensive. We use the standard Peters SPD 5 audiometer with extra output to give a maximum of 120 db., and the Peters S.I.S.I. attachment.

For acoustic impedance and Békésy work we use equipment by Kamplex of Denmark which has given reliable and consistent results.

For speech scores we use phonetically balanced word lists on tape with intensity control through the audiometer.

I am not advocating general use of the equipment we are using or stressing the particular value of any individual test. What I am advocating is a methodical approach to the problem of deafness itself using modern equipment. The value of individual tests may change but the method of analysis must remain.

Time is essential for analysis and it is not possible to do this during a busy clinic. It is, however, possible to do enough at the initial examination to decide whether a full analysis is necessary. After this an appropriate appointment time can be made.

In modern otological practice a system of auditory analysis is becoming essential if further progress in diagnosis and treatment is to continue. The co-existence of recruitment and tone decay, and of recruitment and negative middle-ear pressure, open up new horizons in this complex problem. Auditory analysis is also of value in assessing the results in old established or newer forms of treatment. It forms an essential part of neuro-otology and will in time remove the artificial differentiation between otology and neuro-otology. The corner-stone of both is the assessment of auditory test results and the principles underlying this are now clear. As more and more otologists become interested in auditory analysis they will inevitably start to provide information required by their neurological and neuro-surgical colleagues.

Just as specialized equipment has become available to meet the need for more exact testing of the function of hearing so ultimately will vestibular testing techniques be improved and developed. It is important, however, to realize that only on a sound basis of good auditory analysis can future progress in vestibulometry follow.

Key to tests used:

F.B.L.B.	— Fowler's binaural loudness balance.	X——X	Air conduction	L. Ear
S.I.S.I.	— Small increment sensitivity index.	O——O	,, ,,	R. Ear
F.F.B.	— Fixed frequency Békésy.	]——]	Bone conduction	L. Ear
T.T.D.	— Threshold tone decay.	[——[	,, ,,	R. Ear
M.E.P.	— Middle-ear pressure.	X-----X	Loudness discomfort level	Left
E.T.F.	— Eustachian tube function.			
S.M.R.	— Stapedial muscle reflex.	O-----O	Loudness discomfort level	Right.
T.M.R.	— Tympanic membrane rigidity.			

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