words within the hour following the stellate-ganglion block ; then she gradually sank back into mutism.

Approximately one-third of the patients have a feeling of relief, are less contracted, and are more supple ; and many walk very much better after a week. This improvement may be temporary, and sometimes the former condition will re-establish itself when the infiltrations are stopped. Or the improvement may be permanent, especially if the patient is determined to collaborate.

An example of this is the case of a 42-year-old physician who had had hemiplegia for 18 months, with a blood pressure of 200/100 mm. Hg, and had walked with difficulty, using a stick ; the arm movements were incoördinate. After 39 stellate-ganglion blocks on the opposite side to that of the paralysis he can walk without his stick, and is now planning to resume some of his activities.

In another case, a man who could not hold a pencil in his contracted hand could, after 16 infiltrations, carry for fifteen minutes a basket filled with fruit.

Possibly these patients who can still be improved by delayed stellate-ganglion blocks could be benefited by sympathectomy. In my opinion they represent 25% of the cases I have treated, but I must say that for reasons of humanity I have made an attempt in some very old cases—of four to five years' duration. Let us hope that in the future such patients will be treated at an earlier stage. We must think of the despair of these unfortunate people abandoned without hope to their terrible fate.

Pierre Stricker, a neurosurgeon from Mulhouse, after performing a stellate-ganglion block for a two-year hemiplegia and seeing the patient resume his occupation, has since 1942 treated several cases of hemiplegia by repeated infiltrations of the upper cervical ganglion, and has just recently published some case reports which fully confirm those recorded above.

A recent attempt has been made to treat hemiplegia by carotico-jugular anastomosis. This operation does not seem to increase the number of arteries visible on the angiogram : the blood is mostly diverted into the veins, which become dilated, especially in the bulbar region.

According to the results of our experiments, the simplest and most efficient method seems to consist in giving emergency stellate-ganglion block treatment in cases of embolism and thrombosis, and, for patients who have missed this early chance, to resort to treatment which may vary from infiltration to resection of the thrombosed carotid and the various methods of sympathectomy—section of the vertebral nerve roots or gangliectomies.

Conclusion

These are the facts and comments I wish to submit. I do not think that I have unduly emphasized the extent of the results obtained.

If it is true, as I have read, that there are each year in the United States 500,000 cases of apoplectic strokes and hemiplegia, I feel that a method which makes it possible to diminish the importance of these accidents deserves some consideration. There is, moreover, another side to the question—the tragedy brought into the life of those who survive the stroke by the persistence of hemiplegia and particularly aphasia. A famous American magazine some months ago very clearly described the facts which I have just stated, and gave the principles and results of the stellate-ganglion block. Since then I have received 200 letters, from different countries of the world, expressing the despair of those whom we call, without conscious irony, "cured apoplectics."

Anyone reading such distressing messages cannot fail to wish for the development of a method which would considerably minimize the gravity of the accident.

FURTHER OBSERVATIONS UPON THE DIAGNOSIS OF DEAFNESS IN YOUNG CHILDREN

WITH PARTICULAR REFERENCE TO THE MAKING OF RECOMMENDATIONS FOR SPECIAL EDUCATIONAL TREATMENT

BY

M. R. DIX, F.R.C.S.

*Member of Scientific Staff, Medical Research Council ;
Assistant, Otological Research Unit, Medical Research
Council, and Aural Department, National Hospital,
Queen Square, London*

AND

C. S. HALLPIKE, F.R.C.P., F.R.C.S.

*Director, Otological Research Unit, Medical Research
Council ; Aural Physician, National Hospital, Queen
Square, London ; Assistant Aural Surgeon,
University College Hospital, London*

Since our first description of the peep-show technique for pure-tone audiometry in children under the age of 6 years (Dix and Hallpike, 1947), the equipment has been in regular use at weekly clinics at the National Hospital, Queen Square. In the course of this work certain developments have taken place.

In the first place, the mechanism of the equipment has been greatly improved and reconstructed in a simple and readily reproducible form. Secondly, we have had the opportunity during the examination of the considerable number of subjects involved—350 in all—of becoming familiar with certain technical and psychological difficulties which may arise in the course of the testing procedure, and have been able to formulate effective means of recognizing and overcoming these difficulties.

Furthermore, in the course of these investigations we have been asked to make recommendations, upon the basis of our findings, for the special educational treatment (S.E.T.) of the children in accordance with the well-known classification of deaf children proposed by the Board of Education (1938) in its special report. Here certain interesting difficulties have been encountered. Finally, we have been able in a number of cases to carry out a follow-up with a view to assessing the validity of our educational recommendations.

The publication of the present communication has, therefore, the following aims : (1) to give a detailed account of the mechanical improvements in the apparatus ; (2) to describe the psychological and other difficulties which may arise in the course of the test procedure and the methods of overcoming them ; (3) to describe and discuss our clinical material and test results ; (4) to describe and discuss the problems arising in connexion with the making of recommendations for S.E.T. ; and (5) to give the results of our follow-up.

Apparatus—1. The Child's Equipment

The general lines of the tests and of the peep-show equipment are best illustrated by two diagrams reproduced from our original paper (Figs. 1 and 2). The test procedure depends upon the conditioned response of the subject to a series of short pure-tone stimuli delivered from a loud-speaker. These pure-tone stimuli are synchronized with the

FIG. 1.—Diagram of the peep-show test apparatus.

flashes of a signal lamp. The child sits in front of the wooden box shown in Fig. 1, within which are displayed a series of attractive pictures. In order to be seen, these pictures have first to be illuminated by the child by the pressing of a button. Thereafter he inspects them through a viewing aperture. This press-button mechanism works only when the synchronized light/sound stimuli are being delivered. The stimulation mechanism is under the control of the tester, who observes the child closely from behind a screen. The pure-tone stimuli are variable in frequency in fixed octave intervals from 256 to 4,096 c.p.s. The intensity is calibrated in decibels above the threshold of hearing of a normal subject with his head in the position of the test subject. During the test an instructor is seated on the subject's right hand, and performs the important functions of controlling the child, encouraging him to co-operate in the test, and of changing the picture by the operation of a simple mechanism when necessary.

The test begins with the instructor focusing the child's attention on the viewing orifice. When the tester observes that this has been accomplished he applies the double signal, and the instructor at once presses the button, illuminates the picture, and encourages the child to inspect it.

When this has been done the tester withdraws the signal and the picture disappears. After this demonstration has been repeated two or three times the child soon learns to press the button and illuminate the picture when, and only when, the double signal is being given. As soon as this reflex has been established the next step is to eliminate the light signal in the front of the box. This the instructor does by closing a simple shutter over the light. The test is then continued, using the interrupted sound stimuli only. In subjects without hearing this elimination of the light signal makes further response impossible; on the other hand, in subjects with sufficient hearing to detect the sound signal the elimination of the synchronized light signal makes no difference to their response and they continue to react to the sound signal alone. The intensity of the sound signal is then reduced progressively until a threshold reading is obtained. In Fig. 3 is shown a photograph of the equipment in its present form, as seen by the subject.

In order to gain his fullest co-operation it is important that the child should regard the peep-show as some attractive toy or game, and the design of the apparatus has thus been kept as simple and as small as possible. The box is painted in a gay colour with decorations carefully calculated to make the viewing-hatch the centre of attraction. This should be on the child's eye level as he sits comfortably in front of the box. The signal lamp is placed close enough above the viewing hatch to be included within the child's field of vision when he is inspecting this hatch. It should also be rather dull and inconspicuous in comparison with the brilliantly illuminated picture. Furthermore, the mechanism of its elimination—that is, by closure of a simple shutter—should be obvious to the child.

The child's press-button mechanism should be of the simple bell-push variety; it needs to be of comfortable size, easy to work, and conveniently situated for operation by his right hand. Anything in the nature of a hand-rest in the vicinity of the bell-push is better avoided, as this usually results in the child keeping his hand very near or on the switch, and his responses are thus made more difficult to observe. Two

FIG. 2.—The apparatus in use.

FIG. 3.—Photograph of equipment in its present form as seen by the subject.

small pilot lights are provided in the side of the box which faces the tester. These indicate to him the proper functioning of the signal lamp and the illumination of the pictures. The viewing aperture is closed by glass, which serves the purpose of preventing the child interfering with the picture. In addition, the reflections from the glass make it difficult for the child to see anything of the unilluminated picture. Details of the internal mechanism of the apparatus are given in Fig. 4.

2. The Pictures

It is important that the pictures should be brightly coloured and of suitable size. The size used is $7\frac{1}{2}$ by $6\frac{1}{2}$ in. (19 by 16.5 cm.). We find the pictures most easily obtainable from suitable magazines and books. They are mounted on thin aluminium plates made up into magazines of 25 to 30, which are loaded into the back of the apparatus at the beginning of a test. It is important to select pictures suitable for the age and sex of the subject, and this can easily be arranged. They are changed from time to time in the course of the test; this is done by the instructor by a simple string mechanism which operates very rapidly and quietly. It is seldom that more than 25 pictures are required for a full audiometric test.

3. The Tester's Equipment

That part of the equipment used by the tester—that is, the tone generator, interrupter switches and their associated circuits—has not been substantially modified from that described in our original paper. The output of a beat-frequency oscillator is led by way of a 60-decibel attenuator (input attenuator) to a power amplifier and thence through a 40-decibel attenuator (output attenuator) to a 12-in. (30.5-cm.) moving-coil loudspeaker. This arrangement of attenuators has been found necessary for the maintenance of background noise at a level insufficient to constitute a stimulus. This is, of course, a matter of great practical importance. For example, the deafness in certain subjects may be confined to the higher frequencies, with normal or near-

normal hearing within the chief frequency range of 50 cycles mains' hum. Unless measures are taken with such subjects to keep the hum level below signal level at normal threshold intensity throughout the range of test frequencies, spurious responses will be obtained at the high frequencies to the hum alone and an apparently normal audiogram will result.

By far the greatest part of the background noise arises from the amplifier, and its elimination could thus be effected by introducing all the attenuation needed between the amplifier and the loudspeaker. This, however, would be impracticable, as the power dissipated would call for resistance elements of gross physical dimensions.

Our own arrangement of the attenuation has proved quite adequate in fulfilling the need for a background noise level which is well below the signal level at normal threshold intensity throughout the test frequency range. With this arrangement, threshold determinations up to 60 decibels above the normal threshold are made by variation of the input attenuator alone, with the output attenuator set at its full attenuation of 40 decibels. For the higher intensity levels the output attenuation is reduced.

Interrupter Switches.—These are operated by hand. We have tried automatically operated switches, whereby it is possible to apply sound stimuli at a uniform rate, free from onset transients. In practice, however, we have seldom found that such transients, which arise from a simple rotatory switch in the output of the amplifier, have any significant disadvantage. Moreover, the use of such a switch simplifies the apparatus, and accordingly facilitates variations by the tester of the interruption rate and duration of the stimuli. Such variations are very important for the avoidance of monotony in the test procedure.

Test Procedure and its Difficulties—1. Management of the Children

Experience has demonstrated the vital importance of the correct management of the children both before and during the test. Careful attention must be paid to the following details.

Preparation

It is essential that the children should not be presented for the test when tired, hungry, or otherwise unfit. They are therefore always seen by appointment after a carefully worded letter of instructions has first been sent to the parents; without such precautions children may be presented in a rather peevish and fretful state, which makes accurate testing impossible.

FIG. 4.—Internal mechanism of the apparatus.

Preliminary Interview

This is of great importance. It is a mistake in the course of this interview to attempt any examination of the ears, nose, and throat. Also, the avoidance of white coats by the examiners is of definite assistance in many cases. One examiner plays with the child with a few simple toys on a table, while the second examiner takes the history from the parents. No other spectators should be present at this stage of the interview. In its course, both examiners are able, by observing the child's performance and reactions, to gain some useful impressions both of the state of his intelligence and of his hearing. An electrically operated Klaxon horn is placed behind the child, concealed from him by a screen. This can be operated by one or other of the examiners in the course of the interview and, if heard by the child, nearly always evokes a well-marked reaction which can easily be observed. In the case of a very shy or nervous child rapid co-operation can often be obtained by first allowing him to observe another child playing with the toys.

This interview should not occupy more than 5 to 10 minutes, and it is necessary in its course for the examiners to be convinced, first, that the intelligence of the child is sufficient for the peep-show procedure, and, secondly, that his friendly co-operation has been obtained. The part played in this interview by the examiner in charge of the child, in thus gaining his confidence and introducing him to the test, is certainly a vital one. It is not, however, a very difficult role, and should certainly be within the powers of any intelligent person with a liking for children, given reasonable experience. In the course of this interview it is possible also to pick out certain classes of children who are obviously unsuited for the test, and to recognize certain others who may require special management.

Types of defect which render children unsuitable for the test include:

Mental Defects.—A normal mental age of 3 years is required for the peep-show procedure. The toys and games used in the interview are matched to this level of mental attainment. Any striking inability to manipulate the toys nearly always indicates a mental age of less than 3 years. In such children we always proceed with the peep-show test, but seldom find this possible to carry out.

Visual Defects.—The peep-show procedure is impossible without a visual acuity sufficient for the appreciation of the pictures. This point is carefully checked during the interview.

Motor Defects.—Children with paralysis or severe ataxia may be unable to co-operate in manipulating the press-button switch.

Before proceeding to the test the child's mother is carefully warned of the need to remain quite quiet during the course of the test, and that she should content herself, if referred to by the child, with the adoption of an encouraging demeanour. On no account should she give the child any instruction, in particular "not to touch."

2. Management of the Test

General Considerations.—The intensity regulation of the initial sound stimulus is a matter of some importance. Thus a child with a considerable degree of residual hearing may be disturbed by an initial sound signal of 100 decibels. It is generally possible in the course of the preliminary interview to obtain some indication whether the hearing loss is very slight or very severe, and the initial intensity is regulated accordingly. In general this is set at 80 decibels.

Manipulation of the Pictures.—Once the test is under way and the child has been brought to the point at which he illuminates the picture himself, it is important to allow him sufficient time to inspect it before withdrawing the signal and so eliminating the illumination. The changing of the pictures should be done by the instructor as unobtrusively as possible in order not to deflect the child's interest from the viewing-hatch to the picture-changing

mechanism. The frequency with which a picture needs to be changed depends very much on the character of the child. With an attentive or enthusiastic subject the same picture may maintain his interest for some time.

The duration of the test procedure seldom exceeds 12 to 15 minutes. This applies to rather difficult cases and to cases with relatively little hearing loss in which a large number of responses are required. In co-operative children with severe hearing losses the test procedure may be shorter than five minutes.

3. Difficulties

These fall into two main groups: first, difficulties which occur at the start of the test; and, secondly, difficulties which occur in the course of the test.

Difficulties Arising at the Start of the Test

These occur with certain types of children and may make it impossible to get the test procedure under way at all. The types of children concerned may be described under the following headings:

Timid and Apathetic Children.—Most of these appear to be children with an unhappy or unnatural home background. Some had been brought up by foster parents, others in institutions; others, again, appeared to have suffered from the effects of parental severity: all conditions which seemed to have had the effect of destroying natural curiosity and enterprise. The timid children would do nothing without first gaining the approval of the instructor or parent, and great patience and perseverance were needed to elicit in such a child the necessary spontaneous responses. It has often proved most helpful to allow a child of this kind to watch another operating the peep-show. In the apathetic children spontaneous responses occur, but only with sound intensities well above threshold. This is a serious cause of incorrect threshold readings, with exaggeration of the apparent deafness. A failure of interest on the part of the child and a lack of uniformity in his responses generally indicate this difficulty, which may also be accentuated by the use of unsuitable pictures. We have on a few occasions found it necessary to make repeated observations on children of this kind before arriving at a reliable estimate of their deafness, sometimes without the presence of the parents.

The Restless Child.—Certain restless and enterprising children persist, at any rate at the beginning of the test procedure, in pressing the bell-push at random without any signal being given. This situation requires careful management on the part of the tester, who must give the signal at a moment when the child is in an expectant attitude but not apparently preparing to make such a random movement. This is of great importance. Thus, in the case of a deaf child, unable to hear the sound signal, if this is given at a moment which coincides with a random movement the child will be rewarded by seeing the picture. He will not, however, appreciate that this is a reward for a correct response to an audible signal; and, being thus encouraged to indulge in further random movements, will speedily be confused and discouraged from further co-operation. Certain interested children may persist in keeping their finger on or near the button between signals. This, of course, makes observation of the responses very difficult, and must be corrected by removing the child's hand. This must be done gently and with great tact, since in certain cases it appears to discourage the child from further co-operation.

Difficulties During Course of Test

Once the child's spontaneous response to the dual signal has been obtained, the light-shutter is closed and the sound signal is applied alone. Here we reach the crucial part of the test procedure. In favourable cases, and these are the majority, no difficulty arises. The child responds without hesitation to the sound signal and thus leaves the examiners in no doubt that it has been heard. In certain children, however, in whom the preliminary interview has established the likelihood of a fair amount of residual hearing, the

child may give no definite response to the sound signal alone. The difficult situation which then arises may be analysed as follows:

(i) The child hears the sound signal, but for some reason does not understand the need to respond to it in the absence of the light signal. A little experience with the test almost always makes this situation clear. Thus, at the moment of the sound signal the child will nearly always move his hand in an arrested response, or he may look inquiringly at the instructor. Such a movement accurately synchronized with the signal will generally be apparent to the tester on careful scrutiny. If this is detected the child can then be encouraged openly to press the bell-push, when the test generally proceeds without further difficulty.

(ii) Certain children may hear the sound signal but refuse to press the button until they have first satisfied themselves of the coexistence of the synchronized light signal. Such a child will respond at once to the sound signal by first opening the light shutter. On seeing the light he will proceed at once to press the button and illuminate the picture. This sequence of responses does not, of course, invalidate the test, and need not at once be checked.

(iii) Certain children respond very slowly. Indeed, the response to the sound signal may be delayed for as long as 8 to 10 seconds. The cause for this is obscure; nevertheless, this delayed response may occur quite constantly without change of the delay interval, and may be relied upon.

(iv) Certain totally or very severely deaf children may have given a false impression to the examiners at the preliminary interview of having a considerable degree of hearing. Most of these children are highly intelligent, have remarkably good speech, and may be good lip-readers. The faulty assessment of their hearing at the preliminary interview thus occasioned may result in the peep-show procedure being begun with the sound signal of insufficient intensity. Failure to respond on elimination of the light signal may then indicate a degree of deafness which is quite correct but, nevertheless, surprising to the examiners. This situation is met by reverting to the double signal with much higher sound intensities.

4. Procedure After the Test

After completion of the test procedure a detailed examination of the ears, nose, and throat is carried out. The report of our findings, which is finally sent to the appropriate educational authority, comprises information upon the following points: (1) the cause and pathology of the deafness; (2) the prognosis; (3) the possibility of relieving the deafness by means of treatment; (4) the degree and audiometric character of the deafness; and (5) the possibility of alleviating the deafness by means of hearing-aids. Finally, recommendations are made for S.E.T. as fully discussed below.

Our examination findings, taken in conjunction with previous otological reports, have made it clear in most cases that the deafness is due to some neurolabyrinthitis or other irreversible pathological process occurring during gestation or in early post-natal life. In such cases clear advice is given that no treatment is likely to effect improvement and that further deterioration of hearing must eventually be expected. In other children otolaryngological examination may make evident the possibility that the deafness is due, at any rate in part, to some catarrhal otitis likely to be improved by treatment. It is, of course, of the greatest importance to recognize such a cause for the deafness and to advise appropriate surgical treatment—for example, removal of tonsils and adenoids, and insufflation of the Eustachian tubes. When this course is advised it is wise to postpone a final estimate of the deafness and any recommendations relating to S.E.T. until the treatment has been completed and a further audiometric test made. We have observed a number of children of this kind with very severe deafness due in part to an inner ear affection, but with

obvious catarrhal changes in the tympana associated with enlarged tonsils and adenoids. Removal of the tonsils and adenoids has in these cases greatly reduced the degree of the deafness and substantially modified the character of S.E.T. recommended.

Clinical Material and Test Results

We have investigated with the peep-show a total of 350 children with a view to determining the possible part played by deafness in the production of backwardness in speech and in other ways. The age distribution of these children was as follows:

Age	No.	Age	No.
2 years	10	5 years	61
3 "	80	6 "	44
4 "	68	Over 6 years	87

Of this total, the tests were successful in 302 and unsuccessful in 48. The latter group is discussed first.

Unsuccessful Tests.—The causes of failure are shown in Table I. It will be seen that failure to carry out the tests was attributable in 45 cases to some obvious mental, visual,

TABLE I

Age Group (Years):	2	3	4	5	6	Over 6	Total
Mentally defective	1	9	13	3	1	8	35
Too young and/or slightly backward	2	3					5
Visual defect: unable to see picture		2		1			3
Paralysis: unable to press button		1					1
Psychological abnormality					1		1
Unexplained failure of test		2		1			3
Total	3	17	13	5	2	8	48

or motor defect. The three unexplained cases of failure all occurred in our earlier experiences with the peep-show, before the present equipment came into use.

Successful Tests.—In 42 of the 302 cases successfully tested by the peep-show technique it was impossible for a variety of reasons to proceed to recommendations for S.E.T. for backwardness due to deafness alone. Some of the children were in need of preliminary treatment for disorders of the ears, nose, or throat likely to be concerned with their deafness, while others required special management for other defects. These 42 cases are classified in Table II.

TABLE II

Age Group (Years):	3	4	5	6	Over 6	Total
Preliminary treatment needed for ears or nasopharynx	4	6	6	4	2	22
Mentally defective or retarded	1	1	3	1	8	14
Epilepsy			1		1	2
Psychologically abnormal			1		1	2
Paralysis					2	2
Total	5	7	11	5	14	42

Problems Arising in Connexion with the Making of Recommendations for S.E.T.

In the remaining 260 cases in which the test was successful the question arose of making recommendations for S.E.T. Our chief aim in endeavouring to bring about an improvement in the technique of pure-tone audiometry in these children has, of course, been to establish the pure-tone audiogram as a more efficient basis for such recommendations, and in this we have followed the pioneer work of the Ewings, of Manchester, whose well-known publications constitute a notable landmark in the history of this difficult subject (Ewing, 1930). Due emphasis is also laid upon this point in the report of the committee of the Board of Education, in which it is pointed out that deafness assessment is the most important single factor in determining the character of the S.E.T.

A further passage worthy of quotation appears on page 42 of the committee's report: "The analysis of the acuity of hearing by examination with the pure-tone audiometer forms a scientific basis for the provision of a hearing-aid or the teaching of speech to a child with defective hearing . . . records of the hearing of their children should be available to teachers of Grade II and Grade III children." Our primary aim has been to make such records available to educational authorities after solving the technical difficulties of obtaining them. We have, in addition, extended the scope of our reports in most cases to the making of specific recommendations for S.E.T. on the basis of the committee's well-known classification of deaf children. Here, of course, considerable difficulties have arisen, as the problems involved in the making of such recommendations extend clearly beyond the domain of auditory capacity alone and must ideally include, as duly emphasized in the committee's report, an expert assessment of speech development, vocabulary, mental capacity, lip-reading ability, and a number of other faculties which it is proper to describe as lying beyond our scope.

No great difficulties have been encountered in assessing the mental capacity, and we can certainly say that the behaviour of our subjects, under the conditions of our preliminary interview and during the test itself, has seldom left us in any doubt about the presence or absence of any significant degree of such mental defect. Furthermore, following their recognition by ourselves, such defects have always been confirmed in a subsequent expert examination by a child psychologist. This applies to all of the 49 children specified as mentally defective in the preceding Tables.

In the assessment of speech defects, vocabulary, and lip-reading ability our difficulties have, of course, been much greater. In nearly all of our subjects the speech defects were obvious ones, due, as shown by the clinical history and subsequent audiometry, to a failure of speech development resulting from deafness occurring within the first two to three years of life. We have attempted no precise analysis of its characteristics.

For the purposes of recommendations for S.E.T. our material might be summarized as consisting with few exceptions of children of normal or near normal mental capacity suffering from failure of speech development due to deafness in infancy of which the audiometric characteristics have been reliably determined. We have divided them upon an audiometric basis into groups which correspond fairly closely to those of the well-known classification

of deaf children recommended in the report of the committee of the Board of Education (1938).

Our audiometric classification is as follows:

Average Decibel Loss for 1,024 and 2,048 c.p.s.	
Group I	Less than 30 decibels
" II	30-40 "
" III	40-80 "
" IV	80-100 "
" V	Greater than 100 decibels

Groups I, II, IV, and V are discussed first.

Group I.—This corresponds on the whole to Grade I of the Board of Education, with a slightly lower hearing-loss limit—30 instead of 35 decibels. All 17 of these were backward children, and 11 exhibited speech defects attributed to causes other than deafness.

Group II.—This corresponds approximately to the higher audiometric strata of Grade IIA of the Board of Education.

Groups IV and V.—These correspond to the Board of Education's Grade III. In both we emphasize that hearing-aids should be tried. We indicate that these are likely to help in Group IV, but unlikely to help in Group V.

Group III.—This group is an important one—in the first place on account of its size, the total number of subjects being 133. It is important, too, on account of the difficulties of which we have been conscious in accurately assigning all the subjects concerned to one or other of the Board of Education's educational grades. In most cases the amount of the audiometric loss, taken in conjunction with the mental capacity and our very rough estimate of speech development, has made appropriate a provisional assignment to Grade IIB. Our recommendation in these cases has been for education as a partially deaf child in a school where hearing-aids are available. In certain children of our audiometric Group III we have been aware of the possibility that backwardness in speech development, vocabulary, lip-reading, etc., might well necessitate education in a school for the deaf—that is, that their educational grading should be III and not IIB. Such a differentiation, however, has not lain within the scope of our own examination, and we have in these circumstances thought it appropriate to make a provisional recommendation in accordance with the higher grading, IIB.

Results.—The audiometric classification of our material is given in detail in Table III, in which our audiometric grades are set off against the grades of the Board of Education to which they approximately correspond.

TABLE III

Grading and Educational Management of Deaf Children as Recommended by Board of Education* (1938)		Authors' Audiometric Grading	Age Groups (Years) of Subjects						Total
			2	3	4	5	6	>6	
<i>Grade I</i> (decibel loss <35).—Children with defective hearing who can nevertheless without special arrangements of any kind obtain proper benefit from the education provided in an ordinary school—elementary, secondary, or technical		Group I (decibel loss <30)	0	1	4	4	4	4	17
<i>Grade II</i> (decibel loss 35-60).—Children whose hearing is defective to such a degree that they require for their education special arrangements or facilities but not the educational methods used for deaf children without naturally acquired speech or language. These facilities range from a favourable position in an ordinary school class-room to attendance at a special class or school	<i>IIA.</i> —Those children within Grade II who can make satisfactory progress in ordinary classes in ordinary schools provided they are given some help, whether by way of a favourable position in class, by individual hearing-aids, or by tuition in lip-reading	Group II (decibel loss 30-40)	0	1	4	1	2	6	14
	<i>IIB.</i> —Those children within Grade II who even with the help of a favourable position in the class, individual hearing-aids, or tuition in lip-reading fail to make satisfactory progress in ordinary classes in ordinary schools	Group III (decibel loss 40-80)	1	21	18	28	23	42	133
<i>Grade III</i> (decibel loss >60).—Children whose hearing is so defective and whose speech and language are so little developed that they require education by methods used for deaf children without naturally acquired speech or language. This grade includes the totally deaf		Group IV (decibel loss 80-100)	2	10	6	4	1	8	31
		Group V (decibel loss >100)	4	25	16	8	6	6	65
Total			7	58	48	45	36	66	260

* The Board of Education was superseded in 1945 by the Ministry of Education. The "ordinary" schools referred to in the report and in the present paper are now known as primary or secondary schools.

Follow-up

With a view to ascertaining the practical value of the peep-show test procedure in prescribing the educational management of these deaf children, we have recently followed up a number of our cases. We selected 40 children whose ages fell into the following groups:

Age	No.	Age	No.
3 years	14	6 years	5
4 "	11	Over 6 years ..	2
5 "	8	Total	40

In 35 of these cases it was possible to carry out the test successfully; in five this was impossible. In one the failure of the test was attributed at the time to defective vision due to a congenital cataract which made it impossible for the child to see the picture. In the other four cases the failure was attributed at the time to mental defectiveness, and this diagnosis was confirmed when we came to follow them up. In 33 of the 35 successful cases recommendations for S.E.T. were made as follows:

Group II	1 case
" III	14 cases
" IV	4 "
" V	14 "

In each of the groups specified above, the intelligence of the children was normal or near normal. The remaining two children were successfully tested but were not recommended for S.E.T. on account of suspected mental defect, later confirmed. In the course of the follow-up, reports were obtained in all 40 cases from the teachers and others in charge of the children's education. The information obtained from this follow-up is set out below under the headings of the four groups, with illustrative case histories. Groups II, IV, and V are considered first.

Group II

The single child in this group had been educated, in accordance with our recommendation, in an ordinary school.

FIG. 5.—Audiogram of P.R.

P. R., a girl aged 4, had been at nursery school for one year. Her teacher thought she was a little deaf since measles six months previously. Examination: Repeated nursery rhymes; intonation fair. Played intelligently; responded to hooter. Ears, nose, and throat healthy. Fig. 5 shows her audiogram. Recommendation: To continue at ordinary school in front row. For retest of hearing in a year's time. Follow-up: Recommendation accepted by school M.O. Teacher's report (two years later): "Quite up to standard; no hearing-aid used."

Group IV

In all four children in this group our recommendations for education in a special school for the deaf had been accepted, and in three admission had been secured at the time of the follow-up, with satisfactory reports of progress. In particular, hearing-aids were found to be useful.

J. H., a boy aged 4, began to speak at 16 months but made very little progress after admission to a sanatorium at that age for tuberculous glands. Now responds only to loud voices. Examination: Appeared to have no speech. Played intelligently; responded to hooter. Ears, nose, and throat healthy. His audiogram is shown in Fig. 6.

FIG. 6.—Audiogram of J. H.

Recommendation: Special school for severely deaf. Hearing-aid likely to help. Follow-up: School M.O. recommended admission to special unit for deaf children attached to ordinary school. "Medresco" hearing-aid supplied. Teacher's report (one year later): "Makes good use of his remaining hearing. Benefits from hearing-aid; intelligent, and progressing well."

The audiograms of the other three children in Group IV are shown in Fig. 7.

FIG. 7.—Audiograms of other three children in Group IV.

Group V

All 14 children in this group had been educated in accordance with our recommendations in special schools for the deaf. Satisfactory progress was reported by the school authorities in all. In only two was a hearing-aid reported to be of any value.

J. M., a girl aged 4, talked at 14 months. Speech has not progressed since meningitis at 3 years 8 months. Repeats nursery rhymes, etc., but intonation faulty. Examination: Would not speak. Played intelligently; no response to hooter. Ears, nose, and throat healthy. Fig. 8 shows her audiogram. Recommendation: Special school for deaf. Hearing-aid unlikely to help. Follow-up: School M.O. recommended admission to day school for partially and totally deaf children where group hearing-aids used. Teacher's report (one year later): "Has settled down very nicely. Remembers a certain amount of language she had before her illness. 'S,' 'N,' and 'T' sounds are missing. Lip-reading very good. Hears nothing with amplifier."

FIG. 8.—Audiogram of J. M.

In addition to J. M., seven other subjects in Group V had some residual hearing. Their audiograms are given in Fig. 9.

FIG. 9.—Audiograms of seven other children in Group V.

Group III

All of the 14 children in this group had been recommended by ourselves for education as partially deaf children, in accordance with a Board of Education grading of IIB.

In three cases the school M.O.s had preferred an educational grading of IIA and in two others a grading of III. In all five of these subjects the appropriate educational

arrangements had been in force for some time at the period of our follow-up. In the other nine subjects our educational grading of IIB was accepted by the school M.O.s. At the time of the follow-up, however, five were still awaiting admission to schools for the partially deaf, and four of these were meanwhile continuing attendance at ordinary schools. Case histories of three subjects in Group III are appended.

M. R., a boy aged 3, had meningitis at 13 months. Says "mummy" and "daddy," but little else. Mother thinks he is slightly deaf. *Examination*: Would not speak. Played intelligently. Brisk response to hooter. Nose and throat healthy. Tympanic membranes dull and retracted. His audiogram is shown in Fig. 10. Recommendation: Special school for partially deaf, hearing-aid to be used. Follow-up: School M.O. recommended tuition with hearing-aid by teacher of deaf. Case reviewed two months later, when progress justified recommendation for education in ordinary school. To sit in front row and use aid. Report of teacher of deaf: "With hearing-aid after nine months could repeat three-word phrases perfectly. Now wears aid whole of working hours unless playing rough game. Hope he will attend partially deaf unit when 5."

FIG. 10.—Audiogram of M. R.

FIG. 11.—Audiogram of L. L.

FIG. 12.—Audiogram of S. R.

FIG. 13.—Audiograms of 14 children in Group III, lying within the shaded area.

16 months later: "Progress in past nine months largely due to quickness in imitating child sitting next to her. Good at manual work and knitting. Can hear story only if very close to teacher." Mother reported that the hearing-aid was very useful at school.

S. R., a girl aged 3. Maternal rubella second to third month of pregnancy. Babbles constantly. Says "mum" and "no"; no other words. Mother does not think she is deaf. *Examination*: No speech. Very shy, but played intelligently. Responded to hooter. Ears, nose, and throat healthy. Fig. 12 shows her audiogram. *Recommendation*: Special school for partially deaf. Hearing-aid to be used. *Follow-up*: School M.O. recommended school for deaf. Medresco aid supplied. Teacher's report (two years later): "Too severely deaf to be taught language except as deaf child. Benefits from aid. Very strong voice. Lip-reading better than speech. Progress satisfactory."

The audiograms of the 14 children in Group III lie within the shaded area in Fig. 13. In 9 of these cases Medresco aids had been supplied and were reported as useful. In two cases no aid had yet been tried. Of the remaining three cases, in which an aid had been tried without benefit, two of the subjects were mentally backward in addition to their deafness and could not manage the aid for this reason, while the third had recently been supplied with spectacles and found both devices too much to manage.

Discussion

The results of our investigation call for particular consideration under the following headings: (1) the accuracy of the audiometric test results; (2) the practical relationship between these test results and the ability of the subjects to understand connected speech; and (3) the validity and practical value of educational recommendations made upon the basis of our examination findings, of which the most important is the pure-tone audiogram.

Accuracy of the Audiometric Test Results

The most convincing evidence of the accuracy of the test results is that which we have derived as examiners from our personal observations of the several hundred children whom we have had the opportunity of observing during the course of the tests, in particular the alacrity of their responses and the repeatability of the threshold values. It has also been possible in a few children to carry out pure-tone audiograms by means of conventional audiometer tests in addition to the peep-show test. In these cases we have found that the peep-show readings give results which correspond very closely to the readings obtained for the better ear with the conventional audiometer. Fig. 14 shows the pure-tone audiogram and peep-show test results in a particularly co-operative child aged 5.

FIG. 14.—Pure-tone audiogram and peep-show test in a co-operative child aged 5.

Some comment is perhaps called for upon the fact that with the peep-show audiogram we have contented ourselves with a measurement of binaural hearing capacity. This we have done, as it is the unaided hearing capacity which determines the child's disability and therefore the character of the S.E.T. required. Furthermore, the conditions of our examination make impossible the extra expenditure of time which would be needed for the separate testing of the two ears. It is, of course, helpful to have this additional information, particularly when hearing-aids are to be used, and a modification of the peep-show procedure which makes this possible has recently been described by Denmark (1950). Telephone receivers were employed, and the procedure was used for deaf subjects in the Liverpool School for the Partially Deaf, where more time is available for the examination than is possible under the conditions of our own tests.

It is necessary also to add that, given particularly favourable circumstances—that is, opportunity for prolonged or repeated examinations with particularly co-operative or intelligent children—it is often possible in children under the age of 6 years to obtain very serviceable pure-tone audiograms by means of the conventional pure-tone audiometric procedure, using telephone receivers. Such conditions, however, rarely occur in our own clinic.

Relationship Between the Pure-tone Audiogram and Hearing Capacity for the Conversational Voice

The problem involved here is a well-known one and needs to be considered in relation to the pathology of the deafening disease. Dix, Hallpike, and Hood (1949) discuss the matter in some detail and give results of pure-tone and speech audiometric tests carried out in a large number of adult subjects suffering from a variety of deafening diseases. The conclusions reached may be stated as follows: that in the case of simple conductive deafness—that is to say, due to disease of the conducting mechanism of the ear, in particular the middle ear—pure-tone audiometric losses are related to the hearing loss for connected speech in the comparatively simple manner which was fully described in our previous paper (Dix and Hallpike, 1947).

When, however, the deafness is of the so-called perceptive type, arising from disease of the inner ear or cochlear nervous pathways, the relationship of the pure-tone audiometric loss to the hearing capacity for speech is more obscure; in general the latter is likely to be greater than that predictable from the pure-tone audiogram.

The term "perceptive deafness," however, is a comprehensive one and includes a variety of pathological processes affecting quite different nervous elements of the cochlear mechanism, and in other papers (Dix, Hallpike, and Hood, 1948; Dix and Hallpike, 1950) it has been shown that failure of speech comprehension is a particular characteristic of perceptive deafness due to disease processes affecting the hair cells of Corti's organ. On the other hand, in perceptive deafness due to lesions affecting the fibres of the eighth nerve or the physical constitution of the fluids of the inner ear speech comprehension may be relatively good and is much assisted by hearing-aids as in the case of conductive deafness due to middle-ear lesions. It is quite clear, therefore, that the practical relationship between the pure-tone audiogram and hearing capacity for speech cannot be discussed intelligently without reference to the pathological processes concerned.

In the case of young children much less can be said of the pathological processes responsible for deafness, as in very few of them it is possible to carry out reliable bone-conduction tests, still less up-to-date investigations such as loudness recruitment tests, upon which we have come to rely as a diagnostic index of active hair-cell disease. There is, however, a good deal of collateral evidence that in many of our own subjects the deafness has been due to some affection of the inner ear and eighth nerve—that is, a neuro-labyrinthitis occurring during gestation or early post-natal life. While hair-cell damage is known to be one of the features of the pathological processes involved, other features, such as cochlear-nerve degeneration and physical changes in the labyrinthine fluids, are also known to occur, and it seems to us that these latter factors are likely, at any rate in part, to be the cause of the residual deafness which was present at the time of our examination. Certainly it must be said that tinnitus, which is a particular feature of active hair-cell disease, is not as a rule complained of by deaf children. For these reasons, therefore, it seems unwise to assume for the present that the perceptive deafness of children is necessarily of the so-called uncompensated type in which hearing for the conversational voice is relatively bad, unrelated to the pure-tone audiogram, and difficult to correct by means of hearing-aids.

It is hoped to make the pathological processes involved in the deafness of children the subject of a further communication.

Validity and Practical Value of the Educational Recommendations

The evidence obtained from our follow-up, although not comprehensive in view of the small number of subjects involved, nevertheless provides good support for the validity of our educational recommendations in respect particularly

of Groups IV and V. Some difficulty has arisen in the case of the 14 subjects comprising our Group III, in only nine of whom had it been found advisable to accept our recommendation for an educational grading of IIB. In the case of the remaining five subjects an educational grading of III had been preferred, mainly on account of severe speech defects, and it seems necessary to say that in this group pure-tone audiometric findings need to be reinforced for the purpose of educational recommendations by a more elaborate evaluation of speech development than anything we have attempted. It may be supposed that such an examination might ideally be carried out by a competent authority—for example, a teacher of the deaf—as an immediate complement to our own examination of the hearing, and of the ears, nose, and throat. Here, however, certain difficulties arise, and much must obviously depend upon the practical circumstances of the case. It would appear, for instance, that in many subjects a final assessment of suitability, particularly in respect of speech development, etc., can best be made by the headmasters of the special schools for which the children are recommended.

If this be the case, and if these headmasters require such interviews as a matter of routine for the purpose of making assessments, then it would seem that provisional recommendations for S.E.T. made upon the basis which we adopted have much to be said for them, provided always that the error rate involved is as low as that shown by our follow-up.

In other respects the aims of our examination procedure would seem to be satisfactory, as also the claim that can be made for its results—namely, that it is possible, by its means as perhaps by no other, to put at the disposal of the educational authorities concerned information upon the causes and character of the deafness, in particular the pure-tone audiogram, which must continue to provide in their hands an essential basis for the educational treatment of deaf children.

Summary

In a previous communication (Dix and Hallpike, 1947) a description was given of the peep-show equipment and its use in the diagnosis of deafness in young children. The advantages of the equipment are summarized again as follows: (1) Pure-tone audiograms greatly facilitate the making of recommendations for S.E.T. in deaf children. They are obtainable by means of the peep-show procedure in nearly all subjects of normal intelligence within the age group 3 to 6 years. (2) The test is carried out rapidly and nearly always in the course of a single interview. The length of the examination, including a preliminary interview for case-taking, seldom exceeds half an hour. (3) The technique is simple and does not require long or difficult training on the part of the examiners. (4) Stress is laid upon the well-known practical advantage of the pure-tone audiogram in facilitating subsequent observations upon the progress of the deafness. (5) The examination provides a useful measure of the subject's mental capacity.

These claims have been substantiated by tests carried out in the course of the past four years on some 350 cases. In the course of this work certain improvements have been made in the mechanism of the equipment, and a full description of these improvements is given.

Certain technical and psychological difficulties which may arise during the testing procedure are discussed. Particulars are given of the means we have found most effective for overcoming these difficulties.

The results obtained in 350 cases are described. In 260 of these, educational recommendations were made upon the basis of the pure-tone audiometric findings. For this purpose we have employed a classification based

upon the audiometric findings which is closely related to the educational grading of deaf children prescribed by the Ministry of Education.

The validity of the audiometric findings and of the educational recommendations based thereon was investigated in the course of a follow-up of 40 children, the results of which are described and discussed.

Consideration is also given to the relationship between the pure-tone audiogram and the hearing capacity for the spoken voice. Emphasis is laid upon the fact that this relationship depends essentially upon the pathology of the deafening disease.

It seems justifiable to assume that in the majority of deaf children pure-tone audiometry provides a useful measure of hearing capacity for speech.

It is a pleasure to acknowledge the great help that we have received in the course of this work from a number of our colleagues. Dr. J. L. Dunlop, county medical officer, Hertfordshire, and Mr. Henry Sharp, aural surgeon, Hospital for Sick Children, Great Ormond Street, have referred many patients to us for examination. Mr. R. Bolam, of the staff of the Otological Research Unit, devised and constructed the mechanism of the present peep-show, which has now stood the test of several years' hard work. Mr. Bernard Adams kindly designed and executed the decorations. Miss A. E. Young, aural almoner, Hospital for Sick Children, and many teachers of the deaf and other school authorities have all rendered great assistance. Finally, Dr. J. L. Burn, medical officer of health, Salford, Mr. Terence Cawthorne, and Dr. J. E. A. Underwood of the Ministry of Education, have all read the manuscript and made valuable suggestions.

The peep-show equipment has been constructed by Marconi Instruments, Ltd., upon the basis of our specifications and was recently put on the market by them.

REFERENCES

- Board of Education (1938). *Report of the Committee of Inquiry into Problems Relating to Children with Defective Hearing*. H.M.S.O., London.
 Denmark, Frank G. W. (1950). *J. Laryng.*, **64**, 357.
 Dix, M. R., and Hallpike, C. S. (1947). *British Medical Journal*, **2**, 719.
 ——— (1950). *Proc. roy. Soc. Med.*, **43**, 291.
 ——— and Hood, J. D. (1948). *Ibid.*, **41**, 516.
 ——— (1949). *Ibid.*, **42**, 527.
 Ewing, A. W. G. (1930). *Aphasia in Children*. Oxford University Press, London.

Rabies incidence has been declining steadily in Israel since the start of the intensive nation-wide campaign in October, 1950, according to Dr. Martin M. Kaplan, chief veterinary officer of the World Health Organization, who recently returned from a visit to that country. The Israel anti-rabies campaign, which is being waged with the assistance of W.H.O., includes, among other measures, a mass vaccination of dogs with a new vaccine which has proved harmless to them and seems to give a greater immunity of longer duration than other vaccines so far produced. The number of rabies cases in animals has dropped from an average of 100 a year before the start of the campaign to 10 (one bull, one jackal, and eight unvaccinated dogs) in the course of the past 15 months. All dogs in Israel have been registered, and vaccinated animals have received suitable identification. All stray dogs are being destroyed, while newborn animals are vaccinated when they reach 6 months of age. Vaccination is compulsory and free of charge. Although it is still too early to determine to what extent vaccination alone has brought about the fall in rabies incidence in animals, Dr. Kaplan believes that the concentrated attack has played an important part in this matter. The drop is mirrored also in the decline in human deaths from rabies, which were none in 1951, whereas they numbered 20 between 1948 and 1950. In addition the number of people receiving Pasteur treatments following dog bites, which averaged 4,000 a year before the start of the campaign, has been cut to about one-half.

HABITUAL ABORTION

FURTHER OBSERVATIONS ON THE PROPHYLACTIC VALUE OF PROGESTERONE PELLET IMPLANTATION

BY

P. M. F. BISHOP, D.M., M.R.C.P.

Endocrinologist to Guy's Hospital and Chelsea Hospital for Women, and to the Department of Obstetrics and Gynaecology, Postgraduate Medical School of London

AND

N. A. RICHARDS, M.D., M.R.C.O.G.

Chief Assistant, Chelsea Hospital for Women

Recently we (Bishop and Richards, 1950) reported on a series of 45 patients with a history of habitual abortion who had received an implant of progesterone during the pregnancy under consideration. The results, which are shown in Table I, were commented upon by Dr. Richard Doll as follows: "Provided the 'normal'

TABLE I.—Results of First Series (45 Cases)

No. of Successive Abortions Immediately Preceding the Treated Pregnancy	No. of Patients	Outcome of Treated Pregnancy		Percentage Successful Results
		Success	Failure	
A. Primary Habitual Abortion				
2	20	18	2	90
3	8	7	1	88
4 or more	5	3	2	60
B. Secondary Habitual Abortion				
2	8	6	2	75
3	1	1	0	100
4 or more	3	3	0	
C. Primary and Secondary Habitual Abortion Combined				
2	28	24	4	86
3	9	8	1	89
4 or more	8	6	2	75

incidence of spontaneous abortion is of the order of 10% and the incidence of abortion due to recurrent factors is not much less than 0.1%, it is reasonable to conclude that the present figures indicate an effect of treatment. Should, however, the true incidence of 'recurring' abortion be of the order of 0.01%, the present results could easily be attributed to chance."

The Biological and Medical Committee of the Royal Commission on Population (1949) concluded that "the proportion of all pregnancies ending in spontaneous abortion may be placed between the relatively narrow limits of 7 and 11%." Javert (1948), analysing 56,803 pregnancies, found the incidence of primary habitual abortion—that is, three or more consecutive spontaneous abortions beginning with the first pregnancy—to be 0.3% and the incidence of secondary habitual abortion to be 0.2%. Malpas (1938), studying about 6,000 pregnancies, found the incidence to be 1.4%, and Bishop (1937), analysing 2,687 case histories from the Guy's Hospital Maternity Service, found that 0.4% of women had more than one initial idiopathic abortion at less than five months, and that 0.1% had three initial idiopathic abortions. Since the publication of our paper, Ripman (1951) has analysed 2,474 case histories from the Guy's Hospital Maternity Service and has excluded the last recorded pregnancies in order to diminish the error due to incomplete information concerning these last pregnancies. He has found an overall abortion rate