AN INVESTIGATION INTO CHILDREN IN AN ATTEMPT TO DIFFERENTIATE BETWEEN MENTAL DEFECT AND DEAFNESS

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Through the generosity of the South West Metropolitan Regional Hospital Board a research unit for the study of apparently deaf children with defective speech was set up in Belmont Hospital in March, 1953. The primary object of the unit is to attempt to assess by methods which will be discussed later whether children who have acquired no speech are in fact only deaf or whether they are mentally defective, emotionally disturbed, or are suffering from these or other conditions. It is an undoubted fact that some children who have never spoken and who are therefore inaccessible and who may be asocial or antisocial in their behaviour are diagnosed as being mentally defective and spend their lives in mental defective institutions. It has however already been shown in our unit that a number of these children when under observation for a period of time prove to be deaf and probably educable. If facilities were available to continue their education under specialized conditions they could no doubt make useful citizens within their limitations. Before discussing the problems associated with these children in more detail it might be as well to describe the personnel and layout of the unit.

The unit, which is self contained in a special block of the hospital, is capable of admitting up to seven children at a time for investigation. The children sleep in a dormitory and in addition have a large room used as playroom, dining and schoolroom. There are also a playground and large shed attached where they have swings and a sandpit and the usual recreational facilities found in a small school for young children. The day-to-day administration of the unit and the health of the children are left to a qualified nurse, while in addition there are three children's supervisors who look after their general welfare such as feeding, washing, toilet habits and recreations. One of these supervisors has a nursery nurse's training while the remaining two are unqualified apart from experience with children. There is also a full-time Teacher of the Deaf. Psychiatric, electrophysiological, psychological, and ear, nose and throat investigations are carried out on each child. In some instances where the diagnosis tended towards that of mental defect rather than deafness and it was thought that there might be an organic cause, air-replacement studies
have been done at Hurstwood Park Hospital. After the children have been in the
unit for some time case conferences are held where all members of the staff are
present and an attempt is made to assess the child’s disability and its possibilities
in the educational field.

MATERIAL
Since the establishment in March, 1953 some 22 children have been in the
unit for varying periods of time as well as two who were known to be mentally
defective. In all cases they were children who could not be assessed either
mentally or audiometrically in one or even two sessions as out-patients, largely
owing to masking of the underlying condition by emotional upset. The majority
of these children were between 4 and 8 years of age while one was over 12.
Nineteen of these twenty-two children did not speak in any form, and super-
ificially all of them appeared to be deaf. Six of the children were hyperactive, one
usually quite violent. Eight were withdrawn, two very markedly so. Two spoke
with a marked speech defect, and one with a slight speech defect. Many of the
children had neurotic symptoms, such as enuresis, faecal incontinence, screaming
attacks and tantrums. Neurotic reactions were found to be common among the
deaf children in the unit not only as a result of their deafness and consequent
frustration but also as a result of their difficult homes. Fourteen of the children
had parents who frequently quarrelled and some of the mothers had left home.
Other mothers had no time for the deaf child who was more or less an outcast
and rejected by the family, or the child was such a drag on the mother that she
herself became anxious and neurotic. A number of children had spent long
periods in hospital for operations such as hare-lip or illnesses such as tuberculous
meningitis and were unable to adjust themselves to the home environment on
their discharge. Two of the patients had otitis media following measles, five had
had tuberculous meningitis and two had suffered from fits in infancy or child-
hood. In four cases there was a family history of deafness. It is interesting to
note how many of these children had congenital abnormalities. These were
present in eleven of the twenty-two children admitted and included hare-lip
and cleft palate, two cases; eye defects such as squint and coloboma, six cases;
double hernia, one case; undescended testicle, one case; valgus deformity, one
case; kernicterus and erythroblastosis foetalis, one case; and bronchial fistula,
one case. One child had multiple congenital defects.

METHODS
Most of the children on admission were emotionally disturbed and gave no
indication of their true potentialities. This difficulty had to be at least partially
overcome before the child’s disability could be assessed, and the environment
was planned with this in mind. If there was some response to the environment,
then teaching could be started in an attempt to determine the child’s educability.
The reaction of the child to the environment and the teaching play a large part
in determining whether the child is backward due to deafness or mental defect.

Environment. Each child is encouraged to behave as normally as possible
and the staff encourage and help the child to make the most of its abilities. There
are fixed times for meals, toilet and teaching, but apart from these times there is
a large amount of freedom. Problems of behaviour and discipline are dealt with
according to the individual needs of the child rather than to any fixed standard
of behaviour. Outings on a bus or to the parks are weekly treats that help to
give the children a normal life and in time the majority gain confidence and their
behaviour becomes more natural. When the confidence and co-operation of the
child have been gained, tests of hearing and of educational ability can begin.
Educational ability. The child's educational ability is tested on two levels of activity, general and specific. Owing to the nature of the child, tests must follow the interests of the child and a great variety of techniques and apparatus is required. On the general level raw materials such as sand, water, clay and bricks are provided and the child's play with them is observed for signs of ability to use them with increasing skill, to play imaginatively and to work out ideas. Play situations are made such as washing, cooking and cleaning and repeated from time to time to test the child's ability to learn from experience and to relate what he sees done by the adults around him to his own activity. On a specific level, testing is based firstly on the perception of the relation of similarity and difference and secondly on the power and desire to imitate. The first is fundamental to an understanding of the environment and is the essential root of reading skill and of comprehension of number. Ability to acquire this perception is tested by graduated play apparatus. These range from coloured spills which have to be sorted and different shapes which have to be put into their right hole, to words and sentences of different shape which have to be put to the appropriate picture or followed by the appropriate action and, also, to different sized groups of objects which have to be placed by their appropriate number symbol. The power and desire to imitate is obviously dependent to a great extent on awareness of and good relationship with the adults in the environment and is essential to the development of writing and speech. The child's ability to imitate is tested in games in which he must copy the adults' actions before being given what he wants. He may be provided with paint, chalk or crayons and helped and encouraged to use them, or encouraged to imitate speech sounds. Observation is made on how far in these circumstances the child is willing and able to copy the adults around him.

Hearing. The ability to assess hearing must depend upon some positive and objective response to an auditory stimulus. Very few of these children respond to ordinary audiometric routines and therefore other ways have to be found. These depend upon the ingenuity of the people who are making daily contact with the children, bearing in mind the principles of audiometry. Usually, from day-to-day observations, some idea of hearing ability is formed. At some time or other, mostly when the child is eager to do something such as eat or play with a particular toy, his attention is focussed and he will respond to a spoken order; in this way some of the children were found to have normal hearing. In the case of those without normal hearing the play method has to be established over many weeks. The well known Ewing method of response to "go" or some other voiced sound is practised until sooner or later a level of hearing is established. Some of the children were never able to be trained to do this. At the same time other more formal methods were tried. See page 125.

Mental ability. Assessment of mental ability was by means of the Merrill Palmer Pre-School Scale and the Drever-Collins Battery. These were selected because the material is interesting enough for this type of child to play with and also because both tests may be used without the need for speech on the part of the examiner or examinee. Because of their difficulties very few of the children would respond immediately, but in time all except a very few did respond enough for an assessment to be made.

Electrophysiological methods. Various physiological methods for examination and measurement of cerebral auditory function such as electroencephalography, psychogalvanometry (P.G.R.) and various forms of audiometry have been studied in an attempt to assess quickly the nature of the defect in these children. It is unfortunate that the very nature of the defect and the attendant
<table>
<thead>
<tr>
<th>Age</th>
<th>Sex</th>
<th>Family History</th>
<th>Con- genital Defect*</th>
<th>Birth Injury</th>
<th>Relevant Illness†</th>
<th>Environmental Stress</th>
<th>Speech Stunt</th>
<th>EEG Abnormality</th>
<th>EEG K Complex</th>
<th>P.Q.R. Following Sound Stimulus</th>
<th>Hearing</th>
<th>Mental Ability‡</th>
<th>Educability</th>
<th>Length of Stay</th>
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<tbody>
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<td>R.B. 6 M</td>
<td>nil relevant</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>withdrawn</td>
<td>+</td>
<td>+</td>
<td>...</td>
<td>?partial</td>
<td>no co-operation</td>
<td>-</td>
<td>2/12</td>
<td></td>
</tr>
<tr>
<td>M.B. 8 M</td>
<td>nil relevant</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>aggressive</td>
<td>overactive</td>
<td>+</td>
<td>-</td>
<td>...</td>
<td>+</td>
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<td>I.Q. 105</td>
<td>+</td>
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<tr>
<td>J.B. 3 F</td>
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<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>habits dirty</td>
<td>+</td>
<td>-</td>
<td>...</td>
<td>partial</td>
<td>below level</td>
<td>MP scale</td>
<td>?trainable</td>
<td>4/12</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>withdrawn</td>
<td>+</td>
<td>-</td>
<td>...</td>
<td>+</td>
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<td>below level</td>
<td>MP scale</td>
<td>-</td>
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<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>habits dirty</td>
<td>withdrawn</td>
<td>+</td>
<td>+</td>
<td>...</td>
<td>-</td>
<td>normal</td>
<td>no co-operation</td>
<td>-</td>
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<td>-</td>
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<td>+</td>
<td>+</td>
<td>+</td>
<td>partial</td>
<td>M.A. 47/12</td>
<td>+</td>
<td>5/12</td>
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<td></td>
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<td>?</td>
<td>+</td>
<td>normal</td>
<td>+</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>none</td>
<td>I.Q. 75</td>
<td>+</td>
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<td>-</td>
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<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>none</td>
<td>M.A. about 4 years</td>
<td>-</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<td>+</td>
<td>overactive</td>
<td>aggressive</td>
<td>+</td>
<td>-</td>
<td>...</td>
<td>?normal no co-operation</td>
<td>+</td>
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<td>-</td>
<td>-</td>
<td>-</td>
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<td>aggressive</td>
<td>+</td>
<td>-</td>
<td>...</td>
<td>+</td>
<td>normal</td>
<td>M.A. 2 11/12</td>
<td>-</td>
</tr>
<tr>
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<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
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<td>+</td>
<td>...</td>
<td>...</td>
<td>-</td>
<td>due to muscular inco-ordination</td>
<td>+</td>
<td>6/12</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>overactive</td>
<td>+</td>
<td>...</td>
<td>?</td>
<td>+</td>
<td>?normal no co-operation</td>
<td>-</td>
<td>2/12</td>
</tr>
<tr>
<td>W.H. 13 M</td>
<td>Mother rubella in pregnancy</td>
<td>unknown</td>
<td>-</td>
<td>?</td>
<td>+</td>
<td>+</td>
<td>normal</td>
<td>+</td>
<td>...</td>
<td>...</td>
<td>normal</td>
<td>below level</td>
<td>MP scale</td>
<td>?trainable</td>
</tr>
<tr>
<td>K.H. 2 F</td>
<td>Mother rubella in pregnancy unknown</td>
<td>-</td>
<td>?</td>
<td>+</td>
<td>+</td>
<td>habits dirty</td>
<td>+</td>
<td>-</td>
<td>...</td>
<td>partial</td>
<td>no co-operation</td>
<td>-</td>
<td>3/12</td>
<td>Discharged school for deaf but not kept.</td>
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<td>T.J. 5 M</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>withdrawn</td>
<td>destructive</td>
<td>+</td>
<td>-</td>
<td>...</td>
<td>-</td>
<td>none</td>
<td>no co-operation</td>
<td>?</td>
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<td>D.P. 4 F</td>
<td>psychopathy</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>normal</td>
<td>+</td>
<td>...</td>
<td>+</td>
<td>normal</td>
<td>M.A. 4</td>
<td>+</td>
</tr>
<tr>
<td>L.P. 5 F</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>schizoid</td>
<td>+</td>
<td>...</td>
<td>...</td>
<td>normal no co-operation</td>
<td>-</td>
<td>2/12</td>
</tr>
<tr>
<td>A.R. 4 M</td>
<td>nil relevant</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>overactive</td>
<td>withdrawn</td>
<td>+</td>
<td>...</td>
<td>normal</td>
<td>partial</td>
<td>I.Q. 60</td>
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<td>?</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>normal</td>
<td>+</td>
<td>+</td>
<td>...</td>
<td>partial</td>
<td>varied results</td>
<td>+</td>
<td>7/12</td>
<td>Minor epileptic attacks since discharge.</td>
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<td>-</td>
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<td>sadistic</td>
<td>aggressive</td>
<td>+</td>
<td>+</td>
<td>...</td>
<td>-</td>
<td>none</td>
<td>M.A. 4 11/12</td>
<td>?</td>
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<tr>
<td>P.W. 5 F</td>
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<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>withdrawn</td>
<td>obsolescent</td>
<td>+</td>
<td>-</td>
<td>...</td>
<td>+</td>
<td>normal</td>
<td>M.A. 4 7/12</td>
<td>+</td>
</tr>
<tr>
<td>W.W. 5 F</td>
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<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>withdrawn</td>
<td>obsolescent</td>
<td>+</td>
<td>-</td>
<td>...</td>
<td>+</td>
<td>normal</td>
<td>M.A. 4 7/12</td>
<td>+</td>
</tr>
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* See text p. 122. † See text p. 122. ‡ Bed home situation or institution, +. § Mental Age refers to Merrill Palmer test. Minimal level about.
behaviour has made the tests difficult and sometimes impossible to do even after repeated attempts. The following methods and their value when applied to this type of child have been studied:

1. Electroencephalogram: (a) awake for exclusion of cases with a recognized pathology; (b) asleep for study of response to sound.
2. Psychogalvanic reflex in response to auditory stimuli.
3. Audiometry: (a) speech audiometry using standard recordings; (b) pure tone audiometry using peep-show.

(1a) EEG awake. In only a few instances was it possible to obtain EEG's sufficiently free from movement artefact to make interpretation easy, and most tests had to be confined to one anterior and posterior and to one or two transverse recordings. Over-breathing tests and recordings with the eyes closed were not practical. It was thus not possible to make observations on EEG changes such as blocking of the alpha rhythm in response to sound.

(1b) EEG asleep. In the early stages of sleep, stimuli such as a prick or sound, if sufficiently startling, may produce a brief, large amplitude group of waves with a characteristic form—the K complex—maximum at or near the vertex. Some workers have thought that it is possible by this means to obtain an audiogram. It is however not at all clear that the appearance of a K complex indicates that a sound stimulus has arrived at the auditory cortex. The specific response of the auditory cortex occurs much sooner after the sound stimulus than does the K complex and is confined to that area. It is very small in size and can rarely be detected without special methods.

It has been suggested that the K complex in man may correspond to the response that can be evoked in animals by stimulation of the brain-stem reticular formation. The response in animals can also be produced by an auditory stimulus and it seems that this response may occur independent of the activity in the specific projection to the primary auditory cortex. The occurrence of a K complex following an auditory stimulus shows that the auditory pathway up to the brain stem is functioning, but it does not necessarily follow that if the subject has been awake he would have heard a sound. Apart from the uncertainty of the meaning of the K complex in relation to actual sensation there is from the point of view of audiometry the undoubted fact that clicks are far more reliable than pure tones in producing a complex. This fact has been mentioned by other workers and it has been verified here.

One further and perhaps the greatest problem has been to obtain the light sleep in which the K complex is seen. It is important however to try and obtain an EEG during sleep not only for the study of the K complex but because epileptic tendencies and certain cerebral pathological conditions may be revealed. The study of the K complex will certainly indicate whether or not the peripheral auditory pathway is functioning and there is here a quick method of determining something of the hearing of a child.

(2) Psychogalvanic reflex (P.G.R.). An auditory stimulus will probably not produce a P.G.R. unless the sound has an unexpected or startling quality. Preliminary results by Ackner and Pampiglione at the Maudsley Hospital have shown that as soon as a state of light sleep is obtained a stimulus will no longer evoke changes in the skin resistance. It is perhaps then permissible to assume that in order to obtain a P.G.R. or change in skin resistance the sound must be perceived. If a P.G.R. is obtained following a sound stimulus then it would appear that both the peripheral and central auditory pathways are functioning. A test on these lines should indicate whether or not a child has any hearing, but
the results have been disappointing in that on some occasions, even when a child was known from observations to have a considerable amount of hearing, no P.G.R. was obtained with the loudest sounds available. Stimuli such as a prick or patting on the head did produce a response except in one case and there was therefore good evidence that the efferent side of the reflex mechanism was unimpaired. Where there was a response to loud sounds results differed from day to day. This variable response to sound was a common observation in the unit. In order to obtain audiograms by this method several workers have used a slight electric shock following the sound stimulus in order to condition the subject and thus obtain threshold values of hearing. It was thought that this method would probably be upsetting to children to whom a peaceful, stable environment was essential, and it has therefore not been used. If a P.G.R. is obtained following a sound stimulus then there can be no major interruption to the auditory pathway at any level. If a P.G.R. is not obtained it does not mean that the subject is necessarily deaf, but that the sound may have lost its startling or unexpected quality. The absence of a P.G.R. where there is known to be hearing usually appears to have a psychological explanation, but in one or two of the children the absence seemed almost pathological. It is interesting to note here that in a series of 50 defective children studied, a P.G.R. was obtained in response to sound stimuli in the majority of cases.

(3a) Audiometry. Speech or music using standard recordings. A method was evolved for determining the level of hearing of speech or music in the children who could obviously hear something, but who either could not be encouraged to co-operate in pure tone audiometry or who were unable to do so. Two types of tape recording were made, either of music to which the child seemed to respond or, if the child seemed to understand speech, a recording of commands such as "show me the house", "show me the car", the objects being in front of the child at the time of the test. The output from the tape recorder was put through the audiometer to the earphones so that the level at which it was being played could be determined. Judgment of the response to music depended chiefly on facial expression and the results were not very satisfactory. The children who could do the other test enjoyed it and obviously had great satisfaction in picking up the various objects and finding the right one. The children who did this test could not be said to be greatly defective although they were certainly backward.

(3b) Audiometry. Pure tone using the peep-show. For the younger children who did not know objects the peep-show on the same lines as Denmark's modification of Dr. Hallpike's original idea has been built. Three of the children under six have been examined so far. Two learnt the idea of the test fairly rapidly and audiograms were obtained after three or four visits. One difficulty encountered is that the child's attention wanders when the sounds are at threshold and nearby levels and the hearing may be better than is indicated. This method too is obviously not without its pitfalls.

RESULTS
The 22 children admitted did not form a clear-cut clinical group, although in twos or threes they might have been said to resemble each other. There were no constant factors present in the history, such as rubella in the mother during pregnancy, injury or cyanosis at birth, or history of middle-ear disease. A definite history of rubella during pregnancy was obtained in only one case and hyperemesis gravidarum in another. At present the numbers investigated are too few to warrant any supposition as to the importance of aetiological
factors apart perhaps from those who had meningitis, but when more children are seen it is possible that clear-cut groups may emerge which may show some correlation with aetiology, family history or congenital abnormalities. Nine of the eleven children with congenital abnormalities were finally considered to be either totally or partially deaf. Whether this tends to show that in these cases the deafness was congenital it is impossible to say at the present time, as the opportunities for carrying out post-mortem examination on such children are almost negligible. Only one child in the group had a clearly abnormal EEG, the type of abnormality being similar to that seen associated with epilepsy. There was no constant finding in the EEG's of the other children. No gross focal abnormality or asymmetry of the rhythms was observed except in the one instance, but in a few cases there was more slow activity of 4–5 c/s. and medium amplitude in the temporo-occipital areas than might have been expected for a child of that particular age. This type of abnormality has not been seen sufficiently often for any significance to be attached to it at the moment. The appearance of slow activity in a child's EEG does not necessarily indicate some underlying cortical pathology. Most of the EEG's were thought to be within normal limits.

As has already been stated many of the children have neurotic symptoms. The majority of these children quickly responded to the environment of the unit where they were accepted as members of a group, were given affection and so felt secure. In the course of a few weeks their tantrums and enuresis tended to disappear and they began to play with the other children instead of being isolated and asocial units as they were on admission. Where the methods used to gain confidence and co-operation were not enough the child remained withdrawn. With these children practical tests of hearing and educational ability were found to be impossible. Fourteen of the twenty-two children showed improvement in co-operation and awareness over periods ranging from three to twelve months and five of them did not. The two children who were known to be mentally defective and not deaf and who were being used for controls among the problem group also did not improve in co-operation and awareness. Their reactions to training, teaching and daily routine were almost negligible and bad habits such as destructiveness, dirtiness and inability to feed themselves were much more difficult to eradicate, while it was much more difficult to inculcate new habits. Three of the children were not in the unit long enough for it to be possible to come to any conclusion concerning their reaction to the environment. Of the sixteen children who had bad home conditions ten improved and four did not. Four of the fourteen children who showed improvement were judged to be sufficiently stable to be able to take their place in a normal environment. The behaviour of the others in spite of their improvement would still cause difficulty in a school or at home and it seems that there is need for longer treatment and observation in these cases.

**DISCUSSION**

It is known that some children presenting a picture similar to those in this unit, of lack of speech and difficult behaviour, have eventually improved sufficiently for them to take their place alongside normal children and have made worthwhile progress. Various problems then arise. How may the child be fully assessed? When and how do they first change from being too difficult for normal methods of education to becoming able to take their place in a normal school? What kind of environment is needed to make the child amenable to a normal learning situation in the shortest possible time?
It is quite clear that the majority of children need a period of stay in the unit before any assessment of their disability can be made. Electrophysiological methods can help to give some idea of whether the auditory pathway is functioning. However, even if it were shown conclusively that a stimulus was arriving at the auditory cortex, there is no means of telling how that sound is being interpreted except by observation. Apart from the necessity of giving the child confidence and improving its social behaviour, it was found that many of the children had to be taught that sound had a meaning before any assessment of their hearing could be made. In the same way a child had to be encouraged to learn so that his ability to do so could be judged. In order to do this it is necessary for the children to have almost individual supervision and tuition, and in large classes they would undoubtedly be unable to make the progress which they do in this unit. One great difficulty is to place the children who have been found to be educable along normal lines. It is possible that much could be accomplished where home tuition is available. A house purchased through the generosity of the Nuffield Provincial Hospitals Trust and the Regional Board run on home lines and in charge of a foster mother will be opened soon for those children in whom emotional upset appears to be the greatest factor causing their disability. It is hoped that these children will respond favourably to the home environment and so make investigation of their condition possible. According to their ability they could finally take their place in a normal deaf school or could be trained to do some sort of work at which they could earn a living. One point to be noted is that the earlier these children can be assessed and taught the better their chances of responding to teaching. Those children who have had little or no education before the age of ten and upwards are unlikely in most cases to benefit by training. We do not yet know when these children change from a picture primarily of defectiveness to that of the deaf, backward adolescent found in mental defective homes. Observation over several years of a number of such children may help to solve this problem, and also to give some idea of the most suitable environment for them.

From this brief general survey it will be seen that these children present a most difficult problem, but certainly not one which can be dismissed. There is yet no means of making a satisfactory diagnosis, but it is already felt that much can be done over a period of time to assess their condition and educability and that where there is any doubt about a child it is entitled to a period of observation in a unit similar to this.

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