Filtered Music: A Hearing Test for Young Children

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SUMMARY

A group of 127 nursery school children were hearing-tested by means of filtered music audiometry; 18 failed to respond satisfactorily, and of these 11 were found to have previously unsuspected conductive hearing loss. Of the remaining 7 with normal hearing, 4 were subjected to language tests, and all 4 scored poorly. The technique was then applied to 120 cerebral palsied children, and of these 15 failed to respond satisfactorily; 9 had conductive hearing loss and 2 had sensorineural hearing loss. The filtered music technique is as yet infrequently used and is presented as a quick, easy and reliable screening test. A mentally retarded child suspected of having a hearing loss, can in most cases be easily assessed by filter and audiometry.

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For many years there has been some dissatisfaction with the traditional methods of screening hearing in children who are too young for formal pure tone audiometry. At the Forest Town School for Cerebral Palsied Children, there are a large number of handicapped children, their handicaps ranging from mental retardation through the whole gamut of brain damage to severe athetoid cerebral palsy. Although in recent years, promising experimental work has been done throughout the world, a quick, easy and accurate screening test has not found general acceptance. Following the work of Norman Crabtree, who for some 10 years has been using a technique of filtered sound at the Birmingham Children's Hospital,[1] it was decided to try this method at Forest Town School.

The test consists of presenting, in a free field environment, a selected band of music, which has been passed through a programmable filter and delivered to 2 loudspeakers. The response of the child is then observed and recorded on a normal audiogram card. During the years all the more conventional methods of the free field testing had been used, including distraction tests and peep-show audiometry of different types. In our patients these tests were found to be cumbersome and generally unreliable.

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The use of evoked response audiometry permits the estimation of hearing thresholds both accurately and objectively.[2] Some aspects of this technique are, however, still largely experimental. The practical difficulty of sedating hyperactive handicapped children to a reasonable level of stillness, without over-sedation, presents a great problem. Evoked response audiometry is, in any case, not designed as a screening test.

Impedance audiometry does offer a simpler practical objective test of hearing, and has been successfully used as a screening test in children under the age of 6 years. Unsuccessful results (22,6%) are primarily due to rejection of the earphones or to an unwillingness of the child to remain still long enough to obtain complete results.[3] This applies particularly to hyperactive or athetoid subjects.

Other methods, including skin galvanometry, records of increase in respiratory rate, electrocardiographic and electro-encephalographic recordings, have been considered and tried at times, and while each of these techniques certainly has a part to play, none was found to be entirely satisfactory in the assessment of the handicapped child.

PATIENTS, MATERIAL AND METHODS

Test Situation

A sound-treated room with a low ambient noise level is used. The room at present in use has an ambient noise level of not more than 26 dB. In this room, the child is seated on a chair of fixed position, between 2 good quality loudspeakers. Each loudspeaker is placed 1 metre from the child's ear. A trained experienced observer sits facing the child, level with the subject across a small, low table (Fig. 1). The sound stimulus is 'pop' music, recorded at constant intensity. This music, having frequency components throughout the normal audio range, is introduced into the system via a tape recorder and then fed directly into the filter unit built by Dr C. Ruch. (Fig. 2).

The filter is suitably buffered on both the input and output sections so as not to cause distortion due to loading of the tape recorder circuitry or by the audiometer unit. For normal use a bypass switch is provided which shorts out the filter. Filter bands are selected by a 4-position rotatory switch mounted within easy reach of the therapist. By means of the audiometer (Maico M. A. 18) the filtered sound is processed to obtain varying levels of intensity.

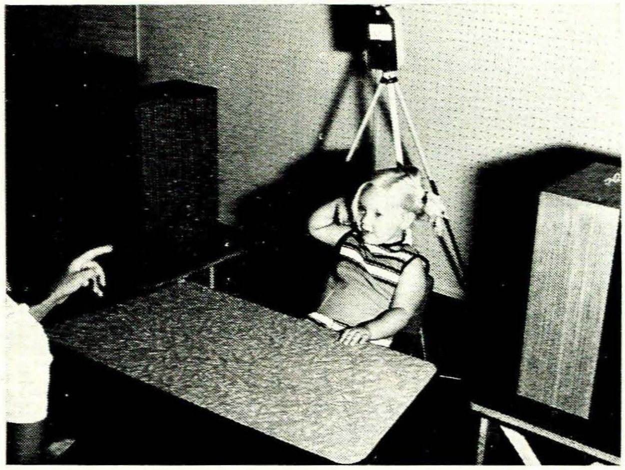

Fig. 1. Therapist puts the child at ease before testing. Note the arrangement of the apparatus.

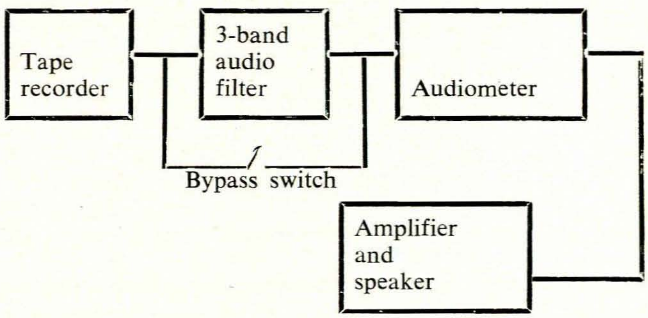

Fig. 2. Filter unit built by Dr C. Ruch.

The active filter networks are synthesised with integrated circuit amplifiers and have pass bands as follows:

1. DC—1 000 Hz.
2. 1 000 Hz—3 500 Hz.
3. 3 500 Hz—25 000 Hz.

The filter characteristics are almost identical with those suggested by Norman Crabtree.[1]

The therapist operating the equipment is able to monitor the test procedure with a talk-back system. The child is brought into the room and seated at the table. If unable to sit, he is held on the parent's lap. The basic test is explained to the parent, but the child is not prepared in any way. The music is presented, using an ascending method of loudness intensity, and the response of the child is noted. The technique requires close co-operation and rapport between the observer and the presenter, who watches and records the level of the responses through a one-way mirror (Fig. 3). In this way a double check of the responses is possible.

The manner of the child's responses varies considerably, e.g. looking at or pointing to the speaker. The basic responses are similar to those of other free field tests, except that the intensity and frequency of the sound stimulus used, is known exactly. The test is carried out as quickly as possible to prevent fatigue, and is usually completed with the 6 test signals in under 4 minutes.

Fig. 3. Presenter observing responses through one-way mirror.

Occasionally a signal is repeated in order to check the level of response. It must be stressed that the child is merely required to detect the presence of the sound stimulus and no qualitative judgement of the music is required.

SELECTION OF PATIENTS AND RESULTS

In order to test the efficacy of the technique, a group of 127 children selected at random from normal nursery schools in and around Johannesburg, were taken. Some of their siblings were also tested. The ages ranged from 2 months to 6 years. The test subjects were from middle-class families. Of the 127 normal children tested, 18 failed to respond satisfactorily, either because their audiometric results fell below the level which we considered to be acceptable, or because the subjective clinical impression gained by the observers was that they responded sluggishly or did not detect directional changes of sound accurately.

This group of 18 was then examined clinically, and of these 11 were found to have otological problems (Table I).

TABLE I. RESULTS OF CLINICAL EXAMINATION ON 'NORMAL' GROUP FAILURES

No otological pathology	6
Bilateral secretory otitis media	3
Bilateral secretory otitis media and sinusitis	1
Impacted wax	3
Secretory otitis media with grommets which had been extruded	1
Severe nasal allergy, chronic mouth-breather; no otological pathology	1
Severely scarred tympanic membranes with retraction, nasal allergy and superimposed infection	1
Large septic tonsils, bilateral secretory otitis media	1
Scarred tympanic membranes with healed perforations	1
Total	18

Otological problems: 11 (61%)

Four of the 7 children in whom no otological pathology had been found were subjected to language tests (the Northwestern Syntax Test and the Peabody Vocabulary Test), and all 4 scored poorly.

The screening technique was applied to a group of 120 children who were pupils at several schools for the cerebral palsied. The pathology varied from mental retardation to severe forms of brain damage with spasticity, athetosis or ataxia. Of the 120 children tested, 15 failed to respond satisfactorily. Of these 15, 11 had previously unsuspected otological pathology which included both middle ear disease in 9 children, and sensorineural hearing loss in 2 of them (Table II).

TABLE II. RESULTS OF CLINICAL EXAMINATION OF CEREBRAL PALSIED GROUP FAILURES

No otological pathology	4
Bilateral high frequency sensorineural hearing loss	2
Wax in ears	1
Bilateral chronic suppurative otitis media and sinusitis	1
Right secretory otitis media and atresia of the left external auditory canal	1
Bilateral secretory otitis media	4
Right secretory otitis media	1
Bilateral secretory otitis media with grommets which had been extruded	1
Total	15
Otological problems: 11 (73%)	

DISCUSSION

We feel that the filtered music test has the following advantages:

1. Rapidity of test—127 children were tested in just under 6 hours.

2. The limited number of stimuli prevents distraction and adaptation, yet a wide range of frequencies is covered.

3. The children respond to low sound levels because the stimulus presented is both interesting and rhythmic.

4. There is accurate control of the intensity presented.

5. There are minimal distractions in the test room because the observer is static and there are no furtive movements behind the test subject with resulting shadows and rustlings.

6. There is accurate control of frequency. It has been stated that it is possible to produce a high frequency rattle sound and a low frequency rattle sound, and that the stirring of a spoon on the rim of a cup produces high frequency sounds, while at the bottom of the cup low frequency sounds are produced. The rustle of tissue paper is said to consist mainly of a high frequency sound. Fisch[2] believes that this is a fallacy and we firmly support his statement. Moreover, it is a dangerous fallacy. 'The production of high or low frequencies with a rattle is a very tricky and questionable undertaking. It depends to a considerable degree on the force with which the rattle is shaken and even with the greatest care it is doubtful whether such a distinction can safely be made. The rustle of paper is by no means a high frequency sound but white noise.'[3]

7. The distance from the loudspeakers to the subject's ears remains constant. While Fisch believes that it does not matter at what distance from the child's ear the stimulus is presented, we feel that this may be of some importance. We have chosen an arbitrary figure of 1 metre and keep it constant.

8. The presenter is able to recheck a particular response at a set frequency band, if in any doubt.

9. There is a double check on the most subjective part of the test, because both presenter and observer can agree or disagree on responses. The presenter observes the subject through a one-way mirror.

10. It is possible to carry out a hearing aid evaluation in a young child.

The disadvantages of this test that we have encountered up to now, are that the equipment is sophisticated and expensive, and the observers must be experienced and adequately trained. Finally, the equipment is not mobile and the child must be brought to the test situation.

We have now been using this test for some 18 months. Its correlation with the results of pure tone audiometry is high, and we therefore feel that it is a reliable screening procedure. We have been able to test successfully infants as young as 2 months of age.

We should like to thank Dr C. Ruch, a bio-electrical engineer, who constructed the filters.

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