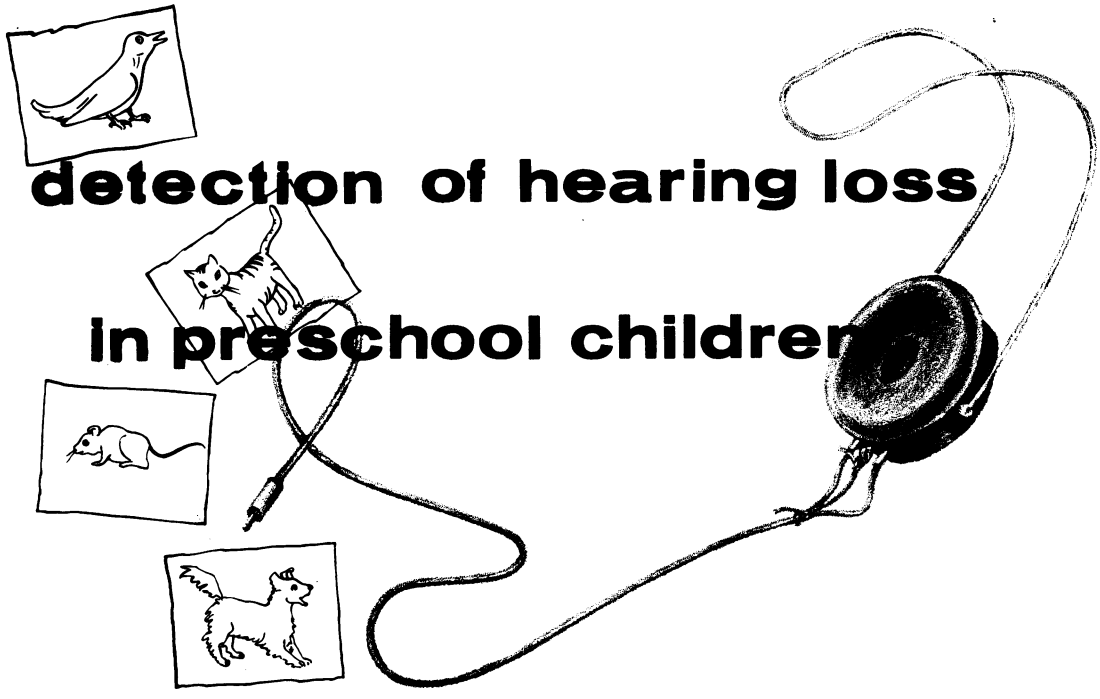

detection of hearing loss in preschool children

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AN INDIVIDUAL pure tone sweep check has proved relatively effective in mass screening preschool children for hearing loss in a study in Rochester, N. Y. A great majority of the children were screened successfully, and threshold tests confirmed hearing loss in about half the screening failures. The screening test, an adaptation of the sound toy test described by Myklebust (*1*), requires a minimum of equipment and time.

The advantages of finding cases of hearing loss in preschool children have long been recognized. Speech training is most effective if begun before the child is of school age; progress of the hearing loss may be arrested by early treatment; and school adjustment is facilitated by knowledge of the child's capabilities on admission to school. However, mass testing of preschool children has not been generally undertaken, primarily because of doubt whether it could be done efficiently. Although a wide variety of methods for testing hearing of young children has been devised, none has been generally accepted as completely satisfactory for mass screening.

Because of the wide variation in procedures recommended for testing hearing in preschool children, the Rochester study was designed with a twofold purpose: (*a*) to work out a simple but effective hearing test for mass screening of an apparently well preschool population using readily available equipment and (*b*) to judge the value of mass screening with the test from the standpoint of case finding and time required to carry on the program.

Material and Method

Children in the study were drawn from those attending guided observation play groups or parent cooperative nursery groups housed in 10 public schools, those enrolled in 3 private

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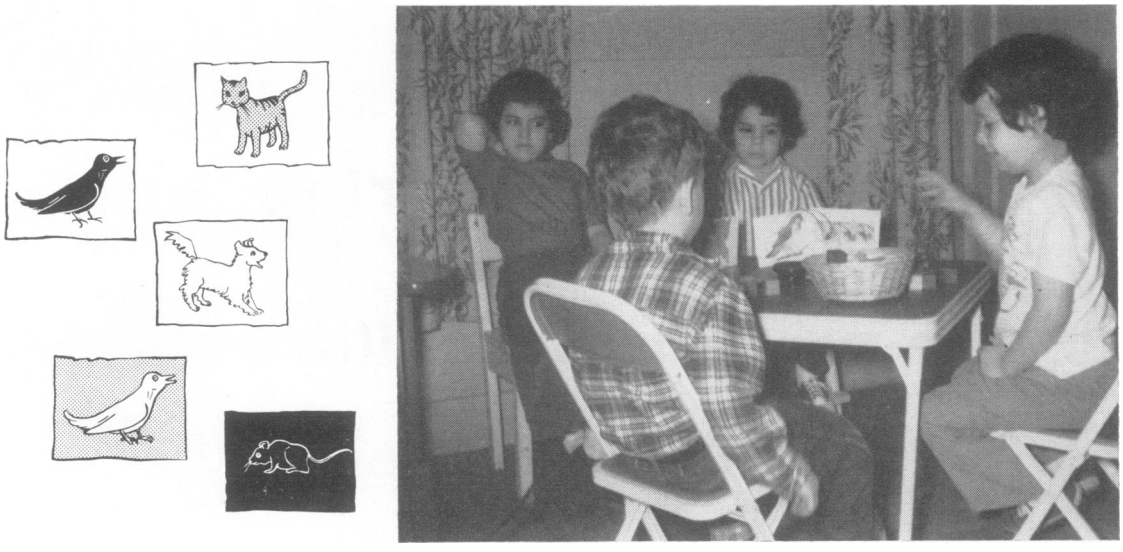


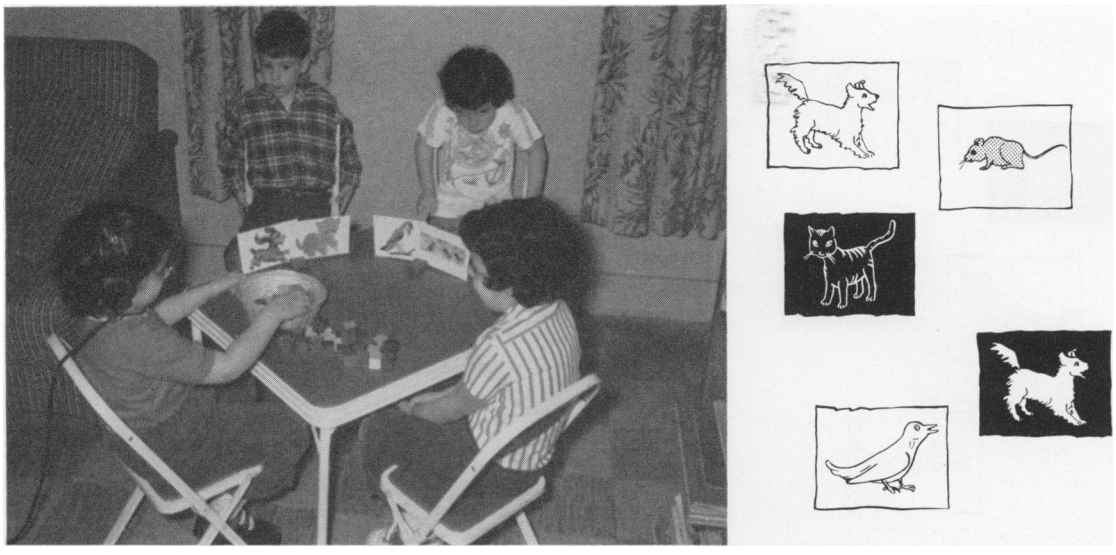
Practicing for the pure tone test, the child drops blocks into the basket.

day nurseries, and a group registering for kindergarten for the next year in 1 public school.

Screening was done in a quiet room in a school. An audiometer (*A*) with binaural headphones was used on the first 2 days of screening, but because some of the children resisted wearing the double headphones, an instrument (*B*) with a single headphone attached to a metal headband was used for all subsequent screening tests. A square of sponge rubber to which a picture of a bird had been pasted was used to cushion the free end of the headband. The single headphone was not only more acceptable to the children, but it also facilitated communication with them during the screening. The frequencies used were 1,024, 2,048, 4,096, and 512 c.p.s., presented in that order. Testing was limited to four frequencies because the short attention span of young children makes it necessary for the tester to work quickly. The frequencies selected were used by Myklebust (*1*) in a research study with preschool children and were the basis for the percentage table prepared by Fowler and Sabine for the American Medical Association in 1947 (*2*).

A child-size folding table with a red leather top and two matching folding chairs were used. Two children were seated at the table, and two more children were seated nearby so that they could observe. As recommended by Mykelbust (*1*), pictures of a dog, a cat, a bird, and a mouse were used to represent 512, 1,024, 2,048, and 4,096 c.p.s. respectively. The pictures were mounted on 4″ x 6″ white cards, and the cards were inserted in slits in small wooden blocks so that the pictures were upright and in the children's view. In front of each of the two seated children was a pile of 1-inch solid-colored wooden cubes. A small basket was placed on the table so that the children could reach it with ease. It should be noted that the equipment needed to supplement standard audiometer equipment is inexpensive and easy to obtain.

To prepare the two children at the table for the test, the audiometer earphone was placed face upwards on the table so they could hear the tones when they were turned on at full intensity. It was explained to the children that they would hear the sound of a dog, a cat, a bird, and a mouse, the tester pointing in turn to each picture, and that when they heard the sound they were to drop a block into the basket. The tones were sounded, at irregular intervals, until the two children were conditioned, that is, until the children gave clear evidence by their response that they knew precisely what to do whenever they heard a tone. This conditioning procedure was repeated with each set of two children. When screening 3- and 4-year-olds the tester placed the phone on her own head in an effort to ward off timidity or resistance on the child's part. After a moment



Animal pictures represent the four tones used in the screening test.

she removed it, and an assistant placed it on the child's right ear, the tester saying to a boy that he was to be an airplane pilot and to a girl that she was to be a telephone operator. In addition to placing the earphone on the child's ear, the assistant saw that the child always had a sufficient number of blocks before him and helped him to and from the testing room. Use of a testing team of two made it possible to work with more dispatch.

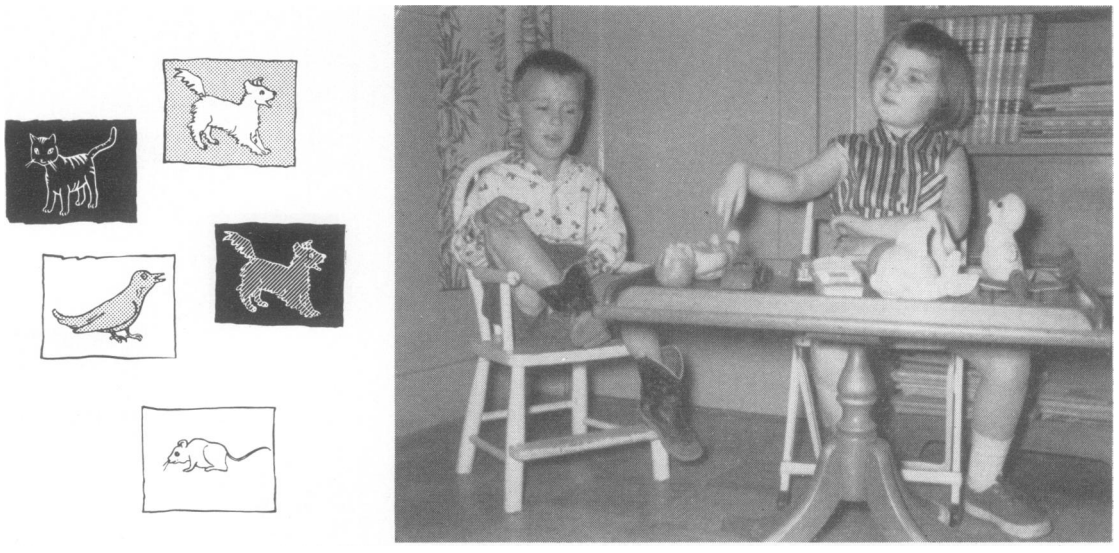
The tester swept through the four frequencies, presenting them in the order given above to one child at a time at an intensity of 20 db. Each time the child heard a tone he would drop a block into the basket, which was now directly in front of him. Each frequency was presented twice. If the child indicated he heard the tone both times, he was considered to have passed at that frequency; if he failed to hear both times, he was considered to have failed. If he heard the tone only once out of the two presentations, it was presented a third time, and he passed or failed at the frequency presented depending upon his reaction to the third presentation. If the child failed to hear any one frequency in either ear he was considered to have failed the screening test.

The interrupter switch on the audiometer was used between each presentation of each tone, at irregular intervals, so that the tester could immediately detect random responses. If the child dropped a block into the basket when no tone was sounded, he was cautioned to listen carefully and to drop the block only when he heard the tone.

For each child who failed the screening test, an appointment was made for a more complete evaluation at the clinic of the Rochester Hearing and Speech Society. This consisted of a second screening test, followed by a pure tone threshold test and an otological examination for all children who failed the second screening test. In addition, all children who reported for the clinic evaluation, regardless of the outcome of the second screening test, were given a free field speech reception test.

An audiometer (*C*) with binaural earphones was used for pure tone threshold testing. Auxiliary equipment and general procedure were the same as described for the screening test. Frequencies of 1,000, 2,000, 4,000 and 500 c.p.s. were presented in that order, the method described in the Manual for a School Hearing Conservation Program (*3*). A child who had a loss of 20 db for any two frequencies or a loss of 30 db for any single frequency was considered to have failed the threshold test (*4*).

The free field speech reception test was the children's auditory test developed by Monsees (*5*). This test uses a phonograph recording of nine words familiar to young children: baby, duck, car, dog, bus, fish, airplane, boat, and ball, each word being preceded by the carrier phrase, "Show me the." The child was



For the speech reception test, the child points to an object when he hears it named.

seated at a table 3 feet from the loudspeaker. On the table were toys representing the above-named objects. In a practice session with live voice, the procedure was explained to the child. The phonograph recording was then played at a level about 30 db above the child's pure tone threshold. Speech reception threshold was determined by attenuating to a level where the child could point correctly to the toys 50 percent of the time.

The otological examination consisted of inspection of nasal passages, pharynx, and tympanic membrane.

Medical recommendations were made by the otologist of the Rochester Health Bureau, Dr. Lawrence J. Nacey. Educational recommendations were the joint decision of the otologist, a consultant in speech and hearing therapy of the Rochester Board of Education, Dr. Rolland J. Van Hattum, and the tester. All screening and threshold testing were done by Geyer.

Results

A total of 461 children ranging in age from 2½ through 5½ years were given the initial screening test. The test appeared to be beyond the ability of 8 children (1.7 percent) who were suspected of being mentally retarded, and 22 children (4.8 percent) could not be tested because of shyness, fear, or negativism. The percentage of children who could not be screened varied from 12.3 percent at age 2½–3½ to 3.3 percent at age 4½–5½ (table 1).

Fifty-three of the 431 children (12.3 percent) successfully tested failed the initial screening. All but three of these failures were given the second screening test. Twenty-eight children failed the second screening test, and all 28 (6.5 percent of the total group followed) also failed the threshold test. No significant relationship between test failure and age of child is apparent (table 2).

All the children whose hearing was within normal limits at 500, 1,000, and 2,000 c.p.s. in one or both ears on the second screening or

Table 1. Unsuccessful sweep check testing, by age

Age	Total children in study	Screening unsuccessful	
		Number	Percent
2 yr. 6 mo.–3 yr. 5 mo.	65	8	12.3
3 yr. 6 mo.–4 yr. 5 mo.	213	16	7.5
4 yr. 6 mo.–5 yr. 5 mo.	183	6	3.3
Total	461	[1] 30	6.5

[1] Includes 8 children with possible mental retardation and 22 children whose cooperation could not be elicited.

Table 2. Results of screening 428 [1] preschool children, by age

Age	Number of children screened	Failed first screening test		Failed second screening and threshold tests	
		Number	Percent	Number	Percent
2 yr. 6 mo.–3 yr. 5 mo.	56	9	16.0	5	8.9
3 yr. 6 mo.–4 yr. 5 mo.	195	19	9.7	7	3.6
4 yr. 6 mo.–5 yr. 5 mo.	177	22	12.4	16	9.0
Total	428	50	11.7	28	6.5

[1] Does not include 3 children who failed first screening test but who were not given subsequent tests.

the pure tone threshold test (according to the above-mentioned standard) obtained a speech reception threshold equal to or 5 db lower than that obtained by first- and second-grade children with normal hearing on whom the system was calibrated. However, whereas the latter performed the test until it was completed, the children in our study, especially the 3- and 4-year-olds, sometimes lost interest and had to be recalled to the task. For children with bilateral loss on the pure tone threshold test, the binaural average was determined. The difference between the speech reception threshold and the best binaural average of the pure tone threshold varied from 2 db to 15 db, with a mean of 11 db. In general, it was felt the two thresholds were in close enough agreement to confirm each other.

Medical care was recommended for 19 of the 28 children who failed the pure tone threshold test. Speech reading was recommended for 1 other child and considered as a future possibility after reevaluation for 3, 2 of whom also had medical recommendations. Thus specific medical or educational recommendations, or both, were made for 21 children, 5 percent of the total group followed.

According to a record of the time it took to condition and screen each child, the average time per child was 5½ minutes.

Discussion

The findings of this small study indicate that mass screening of preschool children is a worthwhile public health procedure. Of 431 apparently well children, 6.5 percent were found to have a valid hearing loss, and medical or educational recommendations for treatment were made for most of these. The screening test proved successful with the vast majority of the children, and it was a fairly accurate case finder with a relatively low rate of overselection.

It should be emphasized, however, that it is one thing to screen preschool children but quite another to obtain an accurate threshold test on them. While both procedures require patience, testing experience, understanding of young children, and keen observation on the tester's part, the former can be performed quickly and is simply a matter of the child's indicating whether or not he hears the tone. Obtaining a true threshold of hearing (not of interest) for each frequency poses a real problem. Myklebust (*1*) has pointed out the improvement in response as the child grows older. For example, he found that the mean threshold reading at 1,000 c.p.s. for children between 3 and 3½ years (6 ears) was 14.16 db, in comparison with 3.50 db for children between 5 and 5½ years (10 ears). This point has been brought out also by Westlake (*6*): "Children of 3 and 4 years of age show less consistency in their response to the pure tone tests and show a wider deviation from accepted normal thresholds than the older ones do, but these are very probably due to other factors than auditory acuity."

A final point to be made in discussing hearing screening programs, particularly when they involve very young children, is the significance of the child's response or inability to respond to the hearing test itself. Lack of response is a revealing symptom of the child's total behavior, and if persistent it should be followed up by more complete audiologic and neuropsychiatric evaluation in a diagnostic center. Since many retarded children have central auditory perceptive problems, accounting for inability to respond to a screening test on the basis of mental retardation is not justified.

With these points in mind, it would seem realistic to recommend that careful mass screening be carried on with preschool children and that two successive failures to pass the screening test should be followed up by a pure tone threshold test. Referral to an otologist should be made on the basis of the threshold audiogram even though its complete accuracy may be questioned by the tester. The growth of nursery schools and organized play groups for children of preschool age should provide an accessible population for such a public health program.

Summary

In a study in Rochester, N. Y., an individual sweep check for hearing loss was successfully administered to all but 6.5 percent of 461 children from 2½ through 5½ years of age. Fifty of fifty-three children who failed the screening test were screened a second time. Twenty-eight of these children failed the second screening test and a subsequent pure tone threshold test. Thus 6.5 percent of 431 children successfully screened were considered to have a hearing loss. Medical or educational recommendations were made for 21 of them.

The average time required to condition and screen a child in this study was 5½ minutes.

From the standpoint of prevention, amelioration, and educational therapy, mass screening of the preschool population is worth while. The method described here appears to be one way of effectively and quickly screening this population.

REFERENCES

(*1*) Myklebust, H. R.: Auditory disorders in children: A manual for differential diagnosis. New York, N. Y., Grune and Stratton, 1954.

(*2*) Tentative standard procedure for evaluating the percentage loss of hearing in medicolegal cases. Report of the Council on Physical Medicine of the American Medical Association. J. A. M. A. 133: 396–397, Feb. 8, 1947.

(*3*) American Academy of Ophthalmology and Otolaryngology Committee on the Convention of Hearing: Manual for a school hearing conservation program. Rochester, Minn., 1951.

(*4*) Newby, H. A.: Evaluating the efficiency of group screening tests of hearing. J. Speech & Hearing Disorders 13: 236–240 (1948).

(*5*) Children's auditory test. Volta Rev. 55: 446 (1953).

(*6*) Westlake, H.: Hearing acuity in young children. J. Speech Disorders 7: 7–15 (1942).

EQUIPMENT REFERENCES

(*A*) Maico F-1 Standard, Serial No. 2392, Maico Co., Inc., Minneapolis, Minn.

(*B*) Western Electric, model 6 BP, Audivox, Inc., Boston, Mass.

(*C*) Peters, model 23, Alfred Peters & Son, Ltd. Electron Works, 89 Arundel Street, Sheffield, England (distributed in this country by Sonotone Corp., Elmsford, N. Y.).

DOCUMENTATION NOTE

A bibliography of 25 articles on testing of hearing in young children has been deposited as document No. 5289 with the American Documentation Institute, Photoduplication Service, Library of Congress, Washington 25, D. C. A photoprint copy may be obtained by remitting $1.25; a 35-mm. microfilm copy by remitting $1.25. Advance payment is required. Make check or money orders payable to Chief, Photoduplication Service, Library of Congress.