AUDITORY TRAINING AND SPEECH AUDIOMETRY

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THE rapid development of hearing aids over the past few years had led to a wide interest in the use of residual hearing. Much of this interest has been focused on deaf and partially deaf children. It is well known that hearing loss, if present during childhood, may prevent the development of speech (Morley, 1957).

Conductive deafness (i.e. impairment centred in the outer or middle ear) can be overcome and the patient's hearing for speech brought to normal by the use of a hearing aid. Perceptive deafness (i.e. impairment centred in or beyond the cochlea) however slight as measured by pure tones, may prevent words being heard correctly, whatever the intensity to which they are amplified (Davis, 1948; Silverman, 1950, Huizing and Reyntjes, 1952; Meyerson, 1956). These facts are clearly illustrated by the use of speech audiometry. For this type of audiometry standardized records of speech are played, usually through earphones, and the percentage of words heard correctly at any given intensity is scored on a chart known as a speech audiogram.

In the present study, the effect of auditory training on five children with perceptive deafness, of various ages from 6-10 years, was observed, and progress measured with speech audiometry. In no case is the full medical ætiology available. A comparison between monaural and binaural hearing for speech was also made at the end of the study. Pure tone loss is given in each case at 250, 500, 1,000, 2,000 and 4,000 cycles per second. With the exception of Case CXI, these figures were constant to within 5 decibels.

Literature on the subject of auditory training is scanty. Brown (1949) has reported improvement in hearing for speech in adults with moderate hearing loss. Di Carlo (1948) gives data on hard of hearing veterans. Hirsch (1952) states that it is unusual for auditory training to change hearing loss for speech.

The writers could find no record of any controlled experiment in which the hearing for speech of school-age children was assessed by speech audiometry before and after auditory training, in which lip reading was suppressed. Experiments in which speech perception was measured by combined lip reading and hearing have, however, been carried out by Hudgins

https://doi.org/10.1017/S0022215100054207 Published online by Cambridge University Press

(1953) in America and Clarke (1953) in England. Wedenberg's (1951) work in Sweden, which was concerned with hearing only, was confined to children of pre-school age.

The Training

The training was carried out in an experimental class, which was formed by the Reading Education Authority in 1955, for partially deaf children. The classroom is equipped with a Westrex group hearing aid, the output from which may be controlled to within 5 decibels up to a maximum of 115 decibels. The auditory training programme consisted of normal class lessons and stories recorded at approximately constant levels of intensity. In addition, definite practice was given in listening to a wide variety of speech and other sounds. The group aid was used during the course of the study for an average of 20 hours weekly.

The Tests

Pure tone audiometry was carried out with a Maico audiometer. The speech audiometry was designed and recorded by one of us (D.L.) using monosyllabic words and methods suggested by Mr. Michael Reed.* The words were grouped in lists of ten, all of which were illustrated by appropriate pictures, to which each child was required to point when tested at various known intensity levels. Each group of ten words was subdivided into two parts containing five similar vowel sounds, e.g., "man", "pan", "van", "lamb", "hand". Thus, the test was essentially of the discrimination of consonants. The recording, a permanent disc, was made at the London studios of His Master's Voice, and was standardized on fifty ears of normal children. These normal responses were averaged and showed 100 per cent. recognition at 30 decibels.

Method

Pure tone and speech audiograms (below) were obtained on three occasions on each child during the period of study, and each ear was subsequently trained at appropriate levels of intensity. All cases initially were intolerant to sound intensity above certain levels; the points at which the initial curves cease. By working just below these and increasing the intensity in 5 decibel steps over a period of months, all intolerance up to 115 decibels was overcome. Binaural responses were measured at the end of training, using earphones paired in output.

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https://doi.org/10.1017/S0022215100054207 Published online by Cambridge University Press

Data

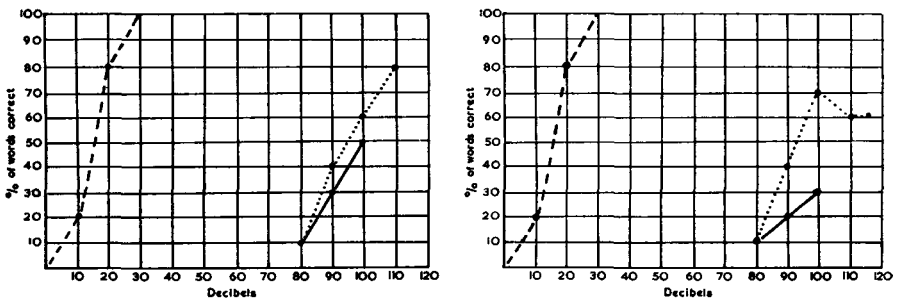
Case I

C.B., a congenitally deaf girl, aged 7 years, of normal intelligence, who had spent the past three years in a school for the deaf. She had worn a hearing aid for 4 years.

Pure Tone Loss.

Left						Right				
250	500	1,000	2,000	4,000	c.p.s.	250	500	1,000	2,000	4,000
65	85	95	90	95	Db. loss	60	75	90	90	95

Speech Audiogram.



---- Normal. ——— March. ..... December.

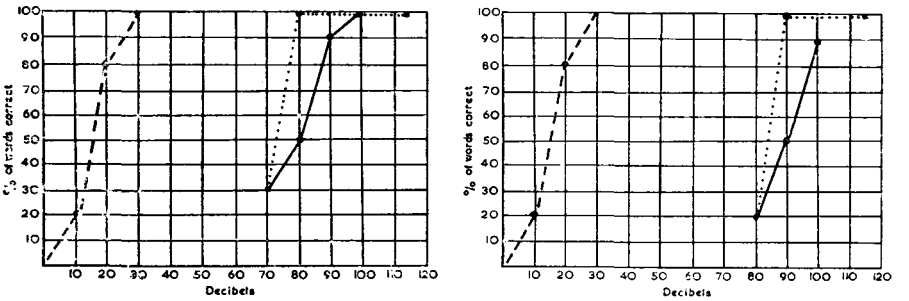
Case II

J.N., a congenitally deaf girl, aged 8 years, of normal intelligence, who had spent the past three years in normal schools and had received speech therapy for three years. During this period she had worn a hearing aid.

Pure Tone Loss.

Left						Right				
250	500	1,000	2,000	4,000	c.p.s.	250	500	1,000	2,000	4,000
30	35	55	85	85	Db. loss	30	45	75	90	90

Speech Audiogram.



---- Normal. ——— March. ..... December.

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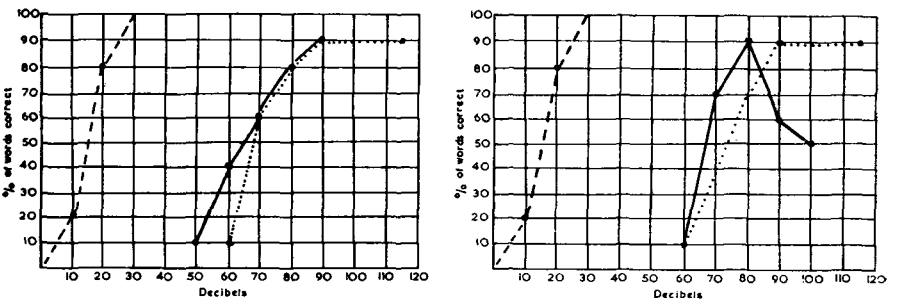
CASE III

M.O., a congenitally deaf girl, aged eight years, of superior intelligence, who had spent the past 3 years in normal school and had worn a hearing aid during this period.

PURE TONE LOSS.

Left						Right				
250	500	1,000	2,000	4,000	c.p.s.	250	500	1,000	2,000	4,000
30	40	50	60	65	Db. *March* Db.	40	50	70	70	75
45	45	55	70	65	Db. *December* Db.	55	55	80	80	75

SPEECH AUDIOGRAM.



---- Normal. —— March. ..... December.

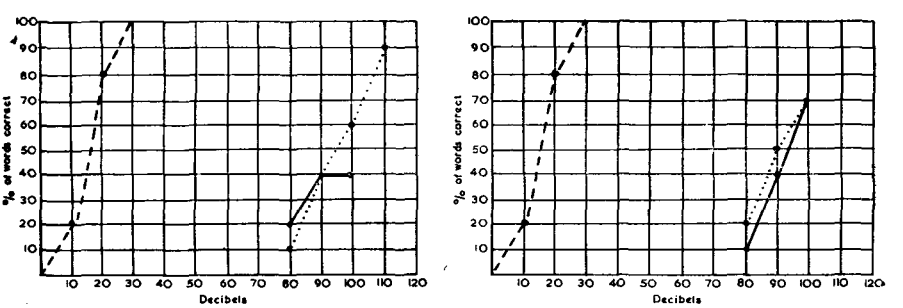
CASE IV

E.G., a congenitally deaf girl, aged 6 years, of superior intelligence, who had spent one year in a normal school and had received speech therapy for two years. During this period she had worn a hearing aid.

PURE TONE LOSS.

Left						Right				
250	500	1,000	2,000	4,000	c.p.s.	250	500	1,000	2,000	4,000
40	55	50	65	40	Db. loss	35	60	70	80	60

SPEECH AUDIOGRAM.



---- Normal. —— March. ..... December.

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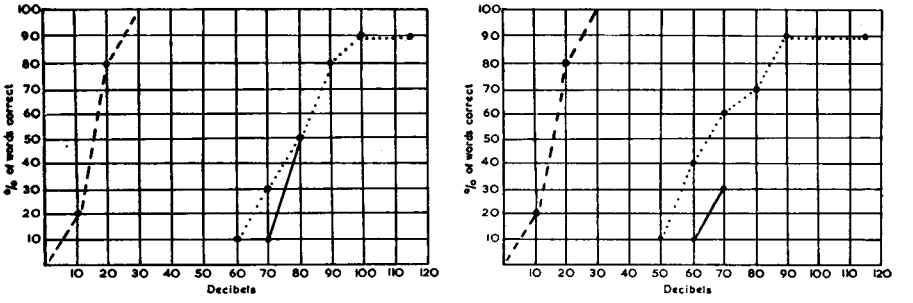
CASE V

A.S., a normally intelligent boy, aged 9 years, who had spent the past 5 years at special schools for the deaf. He had worn a hearing aid for 6 years. His deafness was acquired at 2 years of age.

PURE TONE LOSS OVER PERIOD OF STUDY CONSTANT TO WITHIN 5 DECIBELS.

Left						Right				
250	500	1,000	2,000	4,000	c.p.s.	250	500	1,000	2,000	4,000
40	60	70	80	90	Db. loss	30	50	70	75	90

SPEECH AUDIOGRAM.

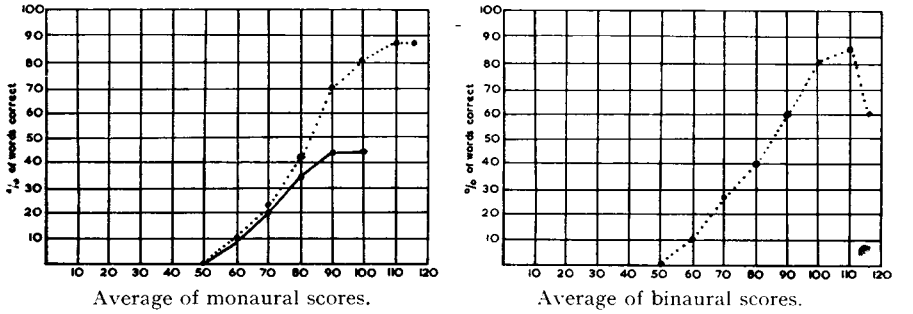


---- Normal. —— March. ..... December.

TABLE OF SCORES OVER INTENSITY RANGE 50–115 db.

Intensity Decibels	50	60	70	80	90	100	110	115
Initial worse ears	2	8	14	36	40	32		
Initial better ears		4	26	32	44	54		
Initial average	1	6	20	34	42	43		
Final worse ears		4	14	34	72	84	82	82
Final better ears	2	10	30	54	70	80	90	90
Final average	1	7	22	44	71	82	86	86
Binaural average	2	12	28	40	60	80	84	62

SUMMARY



Average of monaural scores. Average of binaural scores.

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In this study of a small series of cases carried out over a 9 month period, results show that monaural speech discrimination was raised from an average maximum of 43 per cent. to 86 per cent. and that the range of intensities over which words could be recognized was considerably extended. However, the intensity levels at which speech first became intelligible did not change significantly.

Only in Case V was binaural hearing superior to that of monaural hearing in the better ear.

Discussion

Under normal conditions the intensity of speech changes constantly and rapidly. The ability to discriminate sound over as wide a range of intensity as possible is, therefore, essential to adequate hearing for speech. In the above five cases the factors preventing adequate use of hearing were (i) high thresholds (deafness), (ii) poor discrimination, (iii) subjective distortion and (iv) intolerance.

High Threshold

The use of a hearing aid alone merely raises sound to a level which can be perceived. In the cases under review this was insufficient. Hearing aids had been worn for a number of years yet, after auditory training, use of residual hearing was improved.

Poor Discrimination

In these cases of peripheral deafness, poor discrimination was directly related to lack of auditory experience, which adversely affected language development. The role which language development plays in the discrimination of speech is discussed in detail by Fletcher (1929), Fry (1955), and Miller (1951). Briefly, it may be said that familiarity with language makes it possible for the listener to supply missing sounds and words.

Subjective Distortion

Subjective distortion may be defined as a decrease in perceptive ability resulting from an increase in intensity above a certain level. This should not be confused with objective distortion which may arise from the amplification circuit. Hudgins (1953). Subjective distortion has been related to the recruitment phenomenon by Huizing and others (1952). Case III shows the typical helmet shaped curve in the right ear. The shape of this curve altered during the course of auditory training. Subsequently a saturation level at 90 per cent. was reached. (This was surpassed after further training.) To obtain this result, recorded speech was played to the child at optimum level (80 db.) until familiar. The intensity was then gradually increased into the area where subjective distortion occurred.

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Subsequent studies carried out on a further group of six children, three of whom had this characteristic curve, responded similarly. The writers consider that this observation merits further study.

INTOLERANCE

The intensity at which sound became uncomfortable for the listener varied. In no case could sound be tolerated initially above 100 decibels. Case V illustrates the exceptional degree to which tolerance was raised with resulting improvement in articulation score.

Indirect results of this training were (*a*) an improvement in speech and (*b*) an improved ability to hear conversation with an individual hearing aid. (*c*) A remarkable feature was the spontaneous acquisition and use of new words by all of the children throughout the study. It is suggested that such improved use of residual hearing leads to a higher level of social adequacy (Davis, 1948).

Conclusions

In formulating an auditory training programme for the partially deaf and assessing the benefits derived therefrom, the use of speech audiometry is essential.

Acknowledgments

We are indebted to Mr. P. S. Taylor, Chief Education Officer for Reading, and to Miss Edwards, Headmistress of the George Palmer School, whose pupils co-operated in the standardization of the audiometric tests. Also to Mr. P. Gorman, Cambridge University, for his helpful criticisms.

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