THRESHOLD OF HEARING AND MAGNITUDE OF ACOUSTIC REFLEX IN CHILDREN

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Early identification of hearing loss in children is very importanat for fruitful rehabilitation. Accurate assessment of hearing according to Lamb (1975), is often hindered by the inability or unwillingness of the subject to respond to sound in a prescribed manner. Children constitute a major portion of such difficult-to-test (Fulton and Lloyd, 1975) population.

Pure-tone Audiometry according to Lloyd (1975), is the basis for modern audiological assessment. Audiologists have designed special techniques in pure-tone audiometry in order to elicit ' subjective ' response from the child (Eg., peep show technique by Dix and Hallpike, 1947). But these subjective tests might fail with some ' difficult-to-test' children. Objective hearing tests which do not require voluntary response from the subject might be of use here.

Prediction of hearing sensitivity by Noise-tone difference (Acoustic reflex threshold) is one of the objective techniques in the assessment of hearing. It was used first time, by Niemeyer and Sesterhenn (1972, 1974). Since then many predictive methods have been reported. The differential loudness summation test (Jerger, 1973), sensitivity prediction by the Acoustic Reflex —SPAR (Jerger *et al.* 1974), 1977 SPAR (Hall, 1978), prediction of hearing for single frequencies (Sesterhenn and Breuninger, 1977).

Few investigators (Baker and Lilly, 1976; Lilly 1977; Rizzo and Greenberg, 1979) have given, hearing prediction formulae, based on statistical regression equations.

Using the ratio of Acoustic Reflex Thresholds for noise to tone called Noise Tone ratio, bivariate plot co-ordinate systems were developed for prediction of hearing (Popelka, Margolis and Wiley, 1976; Handler and Margolis, 1977; Margolis and Fox, 1977; Silman and Gelfand, 1979).

Jerger *et al.* (1978), attempted to predict hearing by (1) *Supra threshold amplitude ratio*—ratio of the reflex amplitude of 1000Hz tone and broad-band noise stimuli. *(2) Supra threshold noise tone difference*-—differences in reflex amplitude between 1000Hz and broad-band noise. Three groups of adult subjects were used-normal hearing, flat sensorineural loss and sloping sensorinerural loss. The two supra threshold amplitude indices were not found to be as effective as noise tone difference in reflex threshold for hearing prediction.

The present study was an attempt to investigate noise tone difference (reflex magnitude) in children to explore any possibility of its use in the prediction of hearing.

Subjects: Thirty-three normal hearing children (17 males and 16 females) in the age range of 5 to 10 years were taken for the study. None of them had ear aches or ear discharge previously or at the time of testing. All of them had normal hearing according to Goodman's (1965) classification of hearing impairment (reference: ANSI, 1969). All the subjects had A type tympanogram, static compliance within normal range of 0.30 to 1.60cc (Jerger, 1970) and middle ear pressure within normal limits of±50mm H_2O (Porter, 1972). Some of the ears had to be discarded because, acoustic reflex was either absent or occurred at only high intensity levels precluding the measurement of reflex magnitude. The sensori-neural loss children (of age range 5 to 10 years), whom the experimenter tested, could not be included in the study for the same above mentioned reasons.

Two subjects having moderate sensorineural hearing loss (age 13 years), in whom it was possible to carry out reflex magnitude measurements, were considered for the study.

Instruments: 1. Puretone clinical audiometer MA-30 with TDH-39 earphones and MX-41/AR cushions. 2. Electro Acoustic impedance Bridge-Z073 with Type E Headset, Telex 1470 earphone housed in MX-41/AR cushions and $220H_2$ probe tone. The instruments were calibrated, periodically, according to standard procedures.

Procedure

Puretone hearing thresholds were established for frequencies—250 through $8000H_2$, using ' up 5 down 10' method with principles of Hughson-Westlake ascending technique (Green, 1978).

The instructions and type of response varied depending on subject's age and interest.

Impedance measurements were carried out as follows: Earphone was adjusted over one ear and with the appropriate ear tip, the probe was inserted into contralateral ear. Absolute air tight seal was ensured for each subject. Tympanogram, static compliance and middle ear pressure were obtained using the standard procedure at sensitivity '1'. For measurement of Acoustic Reflex Threshold, pressure meter was set to middle ear pressure, sensitivity knob was turned to'3' position. Balance meter needle was adjusted to the zero of lower red scale. Reflex eliciting stimuli were delivered to test ear through the earphone. Stimulus duration was constantly maintained at 1.5 sees. The level at which there was balance meter deflection by 1.5 units, was considered Acoustic Reflex Threshold (ART). Reflex thresholds, for Broad Band Noise (BBN) and puretones ($500H_2$, 1000 H_2 and $2000H_2$) stimuli were determined. Then for each stimulus, acoustic reflex magnitude, in terms of balance meter needle deflection, was noted at following levels *(a)* at ART *(b)* lOdB above ART (lOdBSL) and *(c)* 20dB above ART (20dBSL).

Five minutes later, acoustic reflex magnitude measurements were repeated to check for reliability. All the testings were carried out in sound treated rooms.

Discussion and Results

According to Jerger (1973), unweighted formula, NTD (ART)

$$=\frac{500H_2\ ART+1000H_2\ ART+2000H_2\ ART}{3}$$

—BBN ART+Correction factor

It was reported by Peterson and Lidcn (1972), that the maximum reflex magnitude was attained at 20dBSL (Ref: ART) and further increase in signal intensity level did not bring about further increase in reflex magnitude. So, in the present study, for computing NTD (reflex magnitude), amount of increase in reflex magnitude, from reflex threshold level to lOdBSL and 20dBSL, were taken into consideration.

Formula used for computation of NTD (Reflex magnitude) is as follows:

(i) *At 10dBSL*

NTD (reflex magnitude)=$N_x—P_x$

Where $P_x=\dfrac{a_1+b_1+c_1}{3}$

$a_1=ya—xa$

$b_1=Yb-Xb$

$c_1=Yc-Xc$ and $N_1=Y_N-X_N$

(ii) *At 20dBSL*

NTD (reflex magnitude) $=N_2—P_a$

Where $P_a=\dfrac{a_2+b_2+c_2}{3}$

$a_2=Za—Xa$

$b_2=Zb-Xb$

$c_2=Zc-Xc$

and $N_a=Z_N-X_N$

Expansions of symbols used in the formula is given in the following Table:

Intensity level of the stimulus	Acoustic reflex magnitude at stimuli			
	$500H_a$	$1000H_2$	$2000H_2$	BBN
ART	Xa	Xb	Xc	X_N
10 dBSL	Ya	Yb	Yc	Y_N
20 dBSL	Za	Zb	Zc	Z

Bata was analyzed using parametric statistics. Mean values of N_1, P_1 N_2 and P_2, computed for right and left ears, are given.in the following table:

Ear	Mean values			
	N_1	P_1	N_2	P_2
Right	2.48	1.97	4.07	3.67
Left	2.34	2.03	3.75	3.63

The difference existing between the mean values of N_1 and P_1 and N_2 and P_2 was not statistically significant.

Mean values of a_1 ,b_1 ,c_1 and N_1 and a_2, b_a, c_2 and N_2 are listed in the following table :

Ear	Mean Values							
	a_1	b_1	c_1	N_1	a_2	b_2	c_2	N_2
Right	2.42	1.92	1.53	2.48	4.15	3.92	2.80	4.07
Left	2.43	2.25	1.44	2.34	4.41	3.87	2.62	3.75

Comparison of values a_1 and a_2, b_1 and b_2, c_1 and c_2 and N_1 and N_2 indicate that there is increase in reflex magnitude as sensation level ref. (ART) increases. This finding is in agreement with previous studies (Wilson and McBride, 1978; Jerger *et al,* 1978).

NTD (reflex magnitude) values were computed using the formula at 10 dBSL and 20 dBSL for 26 right ears, 29 left ears and 19 retested ears.

The statistical Mean (M) of NTD (reflex magnitude) values was determined for each ear, at each level. To find individual variability within the group, the standard deviation (S.D.) values were computed for right and left ears at 10 dBSL and 20 dBSL. The product moment co-efficient of correlation *(r)* was calculated to check for test-retest reliability. Values of M, SD and ' are given in the following table.

Statistical Measures **of** NTD (Reflex magnitude)	Right ear		Left ear	
	10 dBSL	20 dBSL	10 dBSL	20dBSL
M	0.49	0.46	0.33	0.12
SD	0.75	0.17	0.70	0.94
r	0.84	0.91	0.72	0.81

From the above table, it can be observed that mean NTD (reflex magnitude) is larger for right ear than left ear. So, ear difference should be taken into consideration while using the normative data on NTD (reflex magnitude). Mean values in both the ears were greater at 10 dBSL than 20 dBSL. Hence, there was decrease in NTD (reflex magnitude) with increase in sensation level.

Standard deviation values indicate that for both the right and left ears, variability within the group was more at 20 dBSL than at 10 dBSL.

Co-efficient of correlation values were significant at all conditions, indicating good test-retest reliability.

Both the sensorineural loss subjects (used in this study) had moderate degree of hearing impairment. When the mean values of a_x, b_1, c_x and N_x were compared with a_2, b_a and N_2 respectively, an increase in reflex magnitude with increase in sensation level was observed. Mean values of a_v b_x, c_x and N_x and a_2, b_2, c_2 and N_2 for the right and left ears are listed in the following table :

Ear	Mean Values							
	a_1	b_1	c_1	N_1	a_2	b_2	c_2	N_2
Right	2.25	2.0	1.5	1.5	3.25	3.5	2.5	2.5
Left	4.5	2.5	3.5	3.5	6.25	5.5	5.5	5

NTD (reflex magnitude) values were computed using the same formula for four sensorineural loss ears. All the values were negative and are given in the following table :

Subjects (Sensorineural Loss)	Right ear		Left ear	
	10 dBSL	20 dBSL	10 dBSL	20 dBSL
1	—0.5	—0.33	—0.33	—0.66
2	—0.33	—0.66	—0.16	—0.83

Discussions

In the present study, reflex magnitude for broad-band noise stimulus was larger than the reflex magnitude for puretones in most of the normal hearing ears (40 out of 55 ears at 10 dBSL and 38 out of 55 ears at 20 dBSL). This kind of magnitude difference has been observed in adult subjects by Jerger *et al.* (1978). The loudness advantage enjoyed by the normal hearing ears for broad-band noise might be the reason for it.

In the present study, NTD (reflex magnitude) was computed by substracting puretone reflex magnitude from noise reflex magnitude. Hence, for these normal hearing ears, NTD (reflex magnitude) Values were positive. But out of 55 normal hearing ears, 15 ears at l0dBSL and 17 ears at 20 dBSL showed puretone reflex magnitude greater than broad band noise reflex magnitude. This might have been due to sample error. So the study has to be carried out on a large population. On the average (right ear+left ear), NTD value at 10 dBSL is ' 0.41 ' and at 20 dBSL, it is ' 0.29 '.

NTD (reflex magnitude) value is smaller in sensorineural loss ears than normal group at comparable levels (Jerger *et al.* 1978). This finding was supported by the 4 sensorineural hearing loss ears, in the present study. In all the four ears, puretone reflex magnitude was consistently larger than the broad band noise magnitude giving negative NTD (reflex magnitude) values. Average NTD value at 10 dBSL is '-0.33' and at 20 dBSL it is '-0.62'.

Conclusion

In general, in normal hearing ears, NTD (reflex magnitude) values tended to be positive and negative in sensorineural loss ears. If the results of the present study are confirmed by testing a large population of normal hearing children and children with varying degree of sensorineural loss, NTD (reflex magnitude) might reveal its use in hearing prediction.

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