INFANT TESTINGS FOR AUDIOLOGICAL PURPOSES: A REVIEW OF LITERATURE - 1985-1989

Register NO.M8915

AN INDEPENDENT PROJECT WORK SUBMITTED IN PART FULFILMENT FOR FIRST YEAR M.SC. (SPEECH AND HEARING) TO THE UNIVERSITY OF MYSORE.

ALL INDIA INSTITUTE OF SEEECH AND HEARINGS MYSORE-570 006.

MAY, 1990

MY BELOVED

AMMA AND APPA

CERTIFICATE

This is to certify that the Independent Project entitled: **INFANT TESTINGS FOR AUDIO-LOGICAL PURPOSES: A REVIEW OF LITERATURE -** 1985-1989 is the bonafide work, done in part fulfilment for First Year M.sc, (Speech and Hearing) of the student with Register No.M8915.

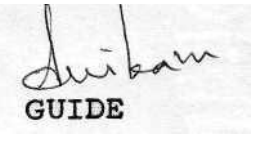
Mysore

May, 1990

All India Institute of speech and Hearing
Mysore-6

CERTIFICATE

This is to certify that the Independent Project entitled: **INFANT TESTINGS FOR AUDIOLOGICAL PURPOSES: A REVIEW OF LITERATURE** - 1985-1989 has been prepared under my supervision and guidance,



GUIDE

Mysore

May 1990

DECLARATION

This Independent Project Entitled: **INFANT TESTINGS FOR AUDIOLOGICAL PURPOSES: A REVIEW OF LITERATURE -** 1985-1989 is the result of my own study undertaken under the guidance of Dr.(Miss) S.Nikam, Prof, and Head of the Department of Audiology, All India Institute of Speech and Hearing, Mysore, and has not been submitted earlier at any University for any other Diploma or Degree.

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INTRODUCTION

An audiologieal evaluation primarily provides information which helps in identifying an auditory disorder, to assess the degree of handicap and provide a plan for the management of the same. For evaluating the auditory mechanism, there are various tests but most of than are standardized primarily on an adult population. There is a great need to develop newer techniques and testing procedures to assess the hearing system of infants.

In the past, the hearing-impaired infants could not be tested emsily by psychophysiological techniques or would have to wait many years before their auditory system could be assessed, consequently the infant would lose the critical years for speech and language development, and now in the field of infant testing newer. Evaluating techniques and testing procedures have come upon to make the clinician' s job relatively easy and by making use of these techniques that are available the auditory system of the infant may be evaluated accurately and systematically in a short period of time.

Infancy is the early stages of development where the infant is still learning new things, it would therefore be difficult to assess auditory system of the infant.

The audiological evaluation of children from birth to five years of age is often difficult sometimes frustrating and it takes a competent audiologist to evaluate the infant in relation to his audition. Therefore, a few handicaps more serious in the development of a young child than impairment of hearing. A hearing loss in a child which goes undetected can impair the intellectual development and creat poor speech and language development, therefore the child with a hearing loss will have a serious communication handicap.

The identification of hearing loss in infants is not an easy task and the hearing impaired child often presents a confusing clinical picture. Delays in the identification of infants with hearing loss is not uncommon and everytime a wrong diagnosis of hearing loss is made an irretrievable loss of time for habilitation of the child* s hearing problem occurs. While evaluating children we should remember that no child is too young for hearing testing and the earlier and more accurate the identification of hearing impairment the better the prognosis for alleviating the hearing handicap.

As stated earlier an improper diagnosis in a child or any impairment in hearing in a child impedes the attainment of his best potential language function; constricts the personality development gives raise to deviant emotional, behaviours and culminates educational achievement.

Even a minimal loss in the early years of life have been reported to have a profound effect upon speech and language development. This is because there exists critical periods for the development of language function and a deprivation of the auditory impact will impede the acquisition of almost all aspects of language.

The above information clearly indicates the importance of hearing in a child. Therefore, unless the hearing loss is recognised early their attainment of future success will be in jeopardy, to give every possible benefit to them an accurate diagnosis of the problem is imperative.

In the recent past a number of tests have been developed for the diagnosis of hearing loss. Initially only gross measures were employed which did not give information regarding differential diagnosis of the hearing impaired children from other disabled children. In order to choose an appropriate remedial program differential diagnosis in children is a must. Therefore to know about the tests for infants will undoubtedly help in diagnosing the hearing impairment, if any, in an infant thereby aiding in apt management.

This project has aimed mainly at reviewing the different auditory assessing techniques that are available and to analyze

which are the tests that are best suitable in either infant hearing screening or in diagnosing the infant and what types of these tests serves the purposes best and that are most widely used by audiologists and researchers.

PURPOSE OF THE PROJECT

1. To know the advancement of different types of testings in infant auditory assessment in the recent five years.
2. To understand the different variables viz, subject variable, stimulus variables and administration variables which are used in this project.
3. To know the type of testings which are most widely used in infant hearing assessment,
4. To understand merits and demerits of two or more tests that are used widely in infant testing.
5. To know about the effect of variables such as age, sex, normality, abnormality on auditory system of the infant.
6. To know the purpose served by majority of the testings i.e. screening or diagnostic.

Sl No	Authors	ARTICLE: Year	Review	Experiment	Case Study	SUBJECT VARIABLE: Age	Sex	Normal/Abnormal	No. of Subjects	PURPOSE: Diagnostic	Screening	TYPE OF TESTING: High risk Registers	Behavioural Audiometry	Crib-O-Gram	VRA	Pure tone Audiometry	Impedence	BSERA	Ecoch G	Respiratory Audiometry	STIMULIE VARIABLE: Others	Intensity	Frequency	Clicks	Tone Pips	Noise
1	Liden G, and Harford, E.R.	1985	30 Years Review			Paediatric population	NM	Normal	NM		✓	✓	✓		TROCA & VRA		✓	✓		✓						
2	Mencher G.T. Mencher L.S. & Rohland S.L.	1985		✓		Infants 36 to 41 weeks	Both	N	268		✓															
3	Gerber, S.E.	1985	✓			26 to 36 weeks	Both	Abnormal (Preterm infants)	18		✓		✓											Frequency Modulated Tones			White noise NBN widenoise

Sl. No.	Authors	ARTICLE: Year	Review	Experiment	Case Study	SUBJECT VARIABLE: Age	Sex	Normal/ Abnormal	No. of subjects	PURPOSE: Diagnostic	Screening	TYPE OF TESTING: High risk Registers	Behavioural Audiometry	Crib-O-Gram	V R A	Pure tone Audiometry	Impedence	STIMULIE VARIABLE: B S E R A	Ecoch G	Respiratory Audiometry	Others	Intensity	Frequency	Clicks	Tone pips	Noise
4	Smith A.D. Picton T.etal	1985			✓	31 to 37 wks.	Both	Abn. (Preterm babies)	NM		✓			✓				✓								
5	Taylor I.G.	1985	✓			7 to 9 mos.	M	N	NM		✓															
6	Thompson G & Folsom R.C.	1985		✓		1 year	Both	N	30		✓		✓										2K to 4 KHZ warbletone	✓		
7	Edwards C.G. Smith A.D. & Picton T.W.	1985		✓		37 to 43 wks,	Both	N	10	✓								Used to find threshold								

Sl. No.	Authors	ARTICLE: Year	ARTICLE: Review	ARTICLE: Experiment	ARTICLE: Case Study	SUBJECT VARIABLE: Age	SUBJECT VARIABLE: Sex	SUBJECT VARIABLE: Normal/ Abnormal	SUBJECT VARIABLE: No. of subjects	PURPOSE: Diagnostic	PURPOSE: Screening	TYPE OF TESTING: High risk Registers	TYPE OF TESTING: Behavioural Audiometry	TYPE OF TESTING: Crib-O-Gram	TYPE OF TESTING: V R A	TYPE OF TESTING: Pure tone Audiometry	TYPE OF TESTING: Impedence	TYPE OF TESTING: B S E R A	TYPE OF TESTING: Ecoch G	TYPE OF TESTING: Respiratory Audiometry	TYPE OF TESTING: Others	STIMULUS VARIABLE: Intensity	STIMULUS VARIABLE: Frequency	STIMULUS VARIABLE: Clicks	STIMULUS VARIABLE: Tone pips	STIMULUS VARIABLE: N o i s e
8	Roush, J. & Tait, C.A.	1985		✓		3 to 4 years		N	75		✓					✓	✓									
9	McMillan, P.M. Benett, M.J.et al	1985		✓		Neonates		N	51		✓							✓					220 & 600 Hz probetone 500,1K 2K, 4K activators			
10	Ferullo, R.J.	1985			✓			NM	2		✓		✓													
11	Ruth, R.A. Dey sigmans & Mills, J.A.	1985			✓	Infants		NM	NM		✓			✓					Done for Hg screening ✓							

NO.	Authors	ARTICLE: Year	Review	Experiment	Case Study	SUBJECT VARIABLE: Age	Sex	Normal/ Abnormal	No. of subjects	PURPOSE: Diagnostic	Screening	TYPE OF TESTING: High risk Registers	Behavioural Audiometry	Crib-O-Gram	VRA	Pure tone Audiometry	Impedence	BSERA	Ecoch G	Respiratory Audiometry	Others	STIMULIE VARIABLE: Intensity	Frequency	Clicks	Tone pips	Noise
12	Oller, K Eillers, R.E. etal	1985		✓		One infant deaf 11 normals	..	Both	12		✓	✓	✓		✓									Clicks used		
13	Flexore, C & Gans, D.P.	1985		✓		2 to 4 mos.	..	(Both) Normals & multi handicapped compared	..		✓												2 KHz			Speech & Noise
14	Sprague, B.H. etal	1985		✓		Neonates 24-130 Hrs. old	....	N	..	✓							Impedence done at 660 Hz	Done at 220 Hz Probetone					40,60,80dB HL				
15	Riko, K Hyde, M.L. etal	1985			✓	..	..	Both	..		✓	✓					..	✓									

Sl. No.	Authors	ARTICLE: Year	ARTICLE: Review	ARTICLE: Experiment	ARTICLE: Case Study	SUBJECT VARIABLE: Age	SUBJECT VARIABLE: Sex	SUBJECT VARIABLE: Normal/ Abnormal	SUBJECT VARIABLE: No. of subjects	PURPOSE: Diagnostic	PURPOSE: Screening	TYPE OF TESTING: High risk Registers	TYPE OF TESTING: Behavioural Audiometry	TYPE OF TESTING: Crib-O-Gram	TYPE OF TESTING: V R A	TYPE OF TESTING: Pure tone Audiometry	TYPE OF TESTING: Impedence	TYPE OF TESTING: B S E R A	TYPE OF TESTING: Ecoch G	TYPE OF TESTING: Respiratory Audiometry	STIMULIE VARIABLE: Others	STIMULIE VARIABLE: Intensity	STIMULIE VARIABLE: Frequency	STIMULIE VARIABLE: Clicks	STIMULIE VARIABLE: Tone pips	STIMULIE VARIABLE: Noise
16	Shimizu, H Walters, R.J etal	1985		✓		Infants	-	N	190		✓		Done at 4 to 6 mos. ✓	✓	✓			70 dB 30 dB								
17	Elberhinge Wahlgreen, O	1985		✓		Infants	Both	N			✓							ABR estimation by means of Bayesian Inference				115 dB SPL	120 Hz to 5KHz	30/sec ✓		
18	Rotteveel, J.J. Colon, E.J. etal	1985		✓		1 to 5 days of age	Both	-			✓							ABR measured			BMC - AR composite group & in Infants	30dB to 70 dB SPL		11.1/sec		
19	Plotnick, C.H.& Leppler, J.G.	1986		✓		Neonates	-	High risk Infants	356		Screened for beha.responses ✓				✓							100 dB SPL	500 Hz,1500 & 3000 Hz			

Sl. No.	Authors	ARTICLE: Year	Review	Experiment	Case Study	SUBJECT VARIABLE: Age	Sex	Normal/ Abnormal	No. of subjects	PURPOSE: Diagnostic	Screening	TYPE OF TESTING: High risk Registers	Behavioural Audiometry	Crib-O-Gram	VRA	Pure tone Audiometry	Impedence	BSERA	Ecoch G	Respiratory Audiometry	Others	STIMULIE VARIABLE: Intensity	Frequency	Clicks	Tone pips	Noise
20	Peters, J.G.	1986		✓		Neonates			185		✓							✓					35 dB nHl			
21	Kaga, K Hushira, S & Marsh, R.R.	1986		✓		40 wks.		preterm babies	25		✓		Done at 1-3 mos. range and 4 mos. 2 yrs. ✓										500, 1K, 2K, 4K Hz tone			
22	Flexor, C & Guns, D.P.	1986			✓	N-2.25-3.75 Abn-37.2-111.6 months		Normals & multi-handicaps	10 + 10		✓		✓													
23	Rottevee1, J.J. Colon, E.J.etal	1986		✓		39 to 41 wks.													ABR measured				35 dB SPL to 70 dB	256 to 512 Hz	4.7/sec.		

Sl. No.	Authors	ARTICLE: Year	Review	Experiment	Case Study	SUBJECT VARIABLE: Age	Sex	Normal/ Abnormal	No. of subjects	PURPOSE: Diagnostic	Screening	TYPE OF TESTING: High risk Registers	Behavioural Audiometry	Crib-O-Gram	VRA	Pure tone Audiometry	Impedence	STIMULIE VARIABLE: BSERA	Ecoch G	Respiratory Audiometry	Others	Intensity	Frequency	Clicks	Tone pips	Noise
24	Hall, J.W. & Tucker, D.A.	1986		✓		Infants & Adults		Both		✓								ABR measures used in acute management of brain injury								
25	Dunn, H.H. Johnson, S. etal	1987			✓	1 to 3 yrs.		Both	975		✓	✓	✓	✓												
26	Halpern, J. Dunn, H.H. & Malachowski, N	1987			✓			Both	975		✓	✓	✓	✓												
27	Hans, D.P.	1987		✓		6 to 192 mos.	Both	Abn.	82		✓	✓	✓										20,40,60,80, dBHL for 2 sec.	500 Hz 2K Hz and speech			NBN & Speech ✓

Sl. No.	Authors	Year	ARTICLE: Review	ARTICLE: Experiment	ARTICLE: Case Study	SUBJECT VARIABLE: Age	SUBJECT VARIABLE: Sex	SUBJECT VARIABLE: Normal/ Abnormal	SUBJECT VARIABLE: No. of subjects	PURPOSE: Diagnostic	PURPOSE: Screening	TYPE OF TESTING: High risk Registers	TYPE OF TESTING: Behavioural Audiometry	TYPE OF TESTING: Crib-O-Gram	TYPE OF TESTING: V R A	TYPE OF TESTING: Pure tone Audiometry	TYPE OF TESTING: Impedence	STIMULIE VARIABLE: B S E R A	STIMULIE VARIABLE: Ecoch G	STIMULIE VARIABLE: Respiratory Audiometry	STIMULIE VARIABLE: Others	STIMULIE VARIABLE: Intensity	STIMULIE VARIABLE: Frequency	STIMULIE VARIABLE: Clicks	STIMULIE VARIABLE: Tone pips	STIMULIE VARIABLE: N o i s e
28	Prager, D.A. Stone, D.A. & Rose, D.N.	1987	✓			Infants			1360		✓			✓				ABR compared with COG								
29	Bray, P & Kemp, D	1987		✓		6 weeks to 13 years		N	55		✓								Cochbear echo test was used							
30	Primus, M.A.	1987		✓		17 mos.					✓											40 dB SPL	125 Hz to 4K Hz			Speech noise
31	Yang E.Y.Rupert A.A. & Moushegian, G	1987		✓		1 year neonates		N		✓			✓					DevelopmentalBC-ABR is measured				15,25,35,dB nHL	500 & 1000 Hz	30/sec		

Sl. No.	32	33	34	35
Authors	Abramarich, S.J. Hyde, M.L. etal	Rotteveel, J.J. Colon, E.J. etal	Swigonsk, N Shallop, J etal	Talbott, C.B.
ARTICLE — Year	1987	1987	1987	1987
ARTICLE — Review				
ARTICLE — Experiment	✓	✓	✓	
ARTICLE — Case Study				✓
SUBJECT VARIABLE — Age	within 24 hours	25 to 52 weeks	Birth, 3 mos. & 6 mos.	
SUBJECT VARIABLE — Sex	Both			
SUBJECT VARIABLE — Normal/ Abnormal	High risk babies	Abn.preterm infants	High risk infants	Hg. impaired infants
SUBJECT VARIABLE — No. of subjects			137	17
PURPOSE — Diagnostic	✓			✓
PURPOSE — Screening		✓	✓	
TYPE OF TESTING — High risk Registers			✓	
TYPE OF TESTING — Behavioural Audiometry			✓	✓
TYPE OF TESTING — Crib-O-Gram				
TYPE OF TESTING — V R A				✓
TYPE OF TESTING — Pure tone Audiometry				Conditioned pure tone thresold obtained
TYPE OF TESTING — Impedence				
STIMULIE VARIABLE — B S E R A	Done to detect hearing	ABR was recorded	Screened for ABR	
STIMULIE VARIABLE — Ecoch G				
STIMULIE VARIABLE — Respiratory Audiometry				
STIMULIE VARIABLE — Others				
STIMULIE VARIABLE — Intensity	30 to 40 dB NHL	70 dB		
STIMULIE VARIABLE — Frequency	2K to 4K Hz	30 Hz to 3K Hz	NBN tones of 500 Hz and 4K Hz	
STIMULIE VARIABLE — Clicks	40/sec	11/sec.		
STIMULIE VARIABLE — Tone pips				
STIMULIE VARIABLE — N o i s e			NBN Noise	

Sl. No.	Authors	ARTICLE: Year	Review	Experiment	Case Study	SUBJECT VARIABLE: Age	Sex	Normal/ Abnormal	No. of subjects	PURPOSE: Diagnostic	Screening	TYPE OF TESTING: High risk Registers	Behavioural Audiometry	Crib-O-Gram	V R A	Pure tone Audiometry	Impedence	B S E R A	Ecoch G	Respiratory Audiometry	Others	STIMULIE VARIABLE: Intensity	Frequency	Clicks	Tone pips	Noise
36	George, M.P. Kuminsk, J.R. & Beauchaine, K.A.	1988		✓		Infants			89		✓							ABR done				80 to 20 dB nHL		100 μ sec clicks		
37	Dahle, A.J. & Mc Collister FP	1988		✓		Infants 2 to 75 mos.		Neonatal Herpes (HSV -infection)	20	✓			✓				✓	✓								
38	Primus, M.A.	1988	✓			11 to 15 mos.			16	✓					✓ VRA vs Modified VRA								500Hz 1K, 2K		Broad Band noise	
39	Robinson, D.O. Allen, D.V. Root, L	1988			✓	6 to 13 mos.	Both	N	137								Imp.screening done						226 Hz			

Sl. No.	Authors	ARTICLE: Year	Review	Experiment	Case Study	SUBJECT VARIABLE: Age	Sex	Normal/ Abnormal	No. of subjects	PURPOSE: Diagnostic	Screening	TYPE OF TESTING: High risk Registers	Behavioural Audiometry	Crib-O-Gram	V R A	Pure tone Audiometry	Impedence	STIMULIE VARIABLE: B S E R A	Ecoch G	Respiratory Audiometry	Others	Intensity	Frequency	Clicks	Tone pips	Noise
40	Eggermont, J.J. & Salamy, A	1988		✓		465 -full term infants - 178 pre-term infants		Abn.	643		✓							ABR done to compare preterm & fullterm infants								
41	Schwartz, D.M. Pratt, R.E. Schwartz, J.A.	1989		✓		24 to 38 wks.	Both	Abn.Low birth wt Hyper-bilirubemia	10(F) + 10 (M)		✓							ABR Recorded				35 to 95 dB NHL	1000 to 1500 Hz	✓		
42	Pool, K.D. & Finitzo, T	1989		✓		6 mos. through 75 yrs.		Both normal and pathologic cases	200	✓								Latencies & Thresolds determined.				20 dB HL to 103 dB HL	100 to 3000 Hz		100 μ Sec.pulses presented	

ANALYSIS

Table-1: Showing the purpose served by the articles.

Sl .No.	Articles served	No.	Percentage
1.	Total number of articles	42	–
2.	Number of articles served the purpose of screening.	33	78.5
3.	Number of articles served the purpose of diagnosis	9	21.4

Table-2: Showing the type of testing.

Sl.No.	Type of testing	NO.	Percentage
1.	Total number of articles	42	-
2.	Visual reinforced audiometry	4	9.5
3.	High risk registers	3	19.0
4.	Behavioural audiometry	13	30.9
5.	Crib-o-gram	6	14.2
6.	Pure tone audiometry	3	7.1
7.	Impedance audioraetry	5	11.9
8.	Brain stem evoked responses	25	59.5
9.	Electrocochleography	1	2.3
10.	Respiratory audiometry	1	2.3

Tabie-3: Showing subject variables.

Sl.No.	Subject variables	No.	Percentage
1.	Total number of articles	42	
2.	Total number of articles which used normal infants	14	33,3
3.	Total number of articles which used abnormal infants.	10	23,8
4.	Number of articles which have used both normals and abnormals	9	21.4
5.	Number of articles which have not mentioned.	9	21.4

Table-4: Showing the article variables

Sl.No.	Article variables	NO.	Percentage
1.	Total number of articles	42	
2.	Number of articles which have used experiment	26	61.9
3.	Number of articles/have used case studies.	9	21.4
4.	Number of articles which have used review.	7	16.7

RESULTS

The following results can be drawn from the above data:

Total number of articles included in the study - 42

Out of this 33 articles have undertaken screening - 78.5%

and 9 articles have undertaken diagnosisi - 21.4%

The type of audiometry done in different articles are listed in the table-II. This shows that

majority have utilized brain stem evoked responses - 59.5%

and behavioural audiometry (59.5% and 30.9% - 30.9%

respectively)•

The subject variable are listed in table III.

14 articles have used normal Infants. - 33.3%

10 articles have used abnormal infants - 23.8%

9 articles have used both normals and abnormals infants. - 21.4%

9 articles have not mentioned the subjects considered for the study - 21.4%

Around 26 of the articles are of experimental in nature. - 61.9%

9 articles have undertaken case study - 21.4%

7 articles basically review in nature - 16.7%

CONCLUSIONS

Majority of the articles used auditory brain stem evoked responses which is the mostly preferred method of infant testing.

- Behavioural audiometry seems to be the second major method used in the study which shows that the contribution of the behavioural audiometry in infant screening is still considered as valid and essential.
- High rish registers have also been used as a valuable resources in the hearing assessment.
- Screening, behavioura/Audiometry and auditory brain stem evoked responses are more often used in when comparing between normals and abnormals.
- In the field of diagnostic audiology abundant research are being carried out in the area of infant testing, these are mainly oriented to find out the best applicable way of testing and to know the differences between normals and multihandicapped in terms of auditory response, and also to know is there any difference between updated and prematured infants.
- The brain stem evoked response audiometry studies have shown that they are reliable, sensitive method of hearing screening and plays a major role in early assessment,
- The automated computer program to analyze auditory brain stem responses has broad application in the field of neurology and audiology.

- The cost effectiveness of auditory brain stem responses is found to be better than crib-o-gram.
- Crib-o-gram failed in screening 2/3rd of infants and auditory brain stem responses measurements failed in only more than half of infants.
- Even though high risk registers are valuable but they are imperfect when compared to, auditory brain stem responses. Auditory brain stem responses plays major role in the early assessment. Because all the infants who passed auditory brain stem responses screening have also passed on subsequent follow up hearing screening so the auditory brain stem evoked responses found to be reliable in infant screening.
- Visual reinforced audiometry can be valuable screening method when the child is very young.
- Modified visual reinforce audiometry revealed to have an average 5.5 dB improvement in thresholds.
- Racial difference: There is only one study available on this aspect. The authors reported of significant difference between whits and blacks regarding impedance screening.

Normal infants compared with multiply handicapped infants:

- In one study no difference found regarding the responsiveness to stimuli between normals and multihandicaps.

- In another study normal infants showed attentive type of behavioural responses whereas multiply handicapped infants exhibited more of reflexive type of behavioural responses.

Full term babies compared with preterm babies:-

- Prematurity does not affect auditory brain stem responses and behavioural responses to auditory stimuli,
- Prematurity does not cause a different rate of maturation for auditory brain stem responses,
- Peripheral auditory maturity is not affected by prematurity.

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