#### ELECTROPHYSIOLOGICAL TESTS IN HUMAN FOR AUDIOLOGICAL PURPOSES -

A REVIW OF LITERATURE, 1985-1989

Register No.M8903

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

ALL INDIA INSTITUTE OF SPEECH AND HEARING: MYSORE - 570 006

MAY 1990

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PARENTS

## CERTIFICATE

This is to certify that the Independent Project entitled: <u>Electrophysiological tests in</u> <u>Human for Audiological Purposes - A Review of</u> <u>Literature, 1985-1989</u> is the bonafide work, done ia part fulfilment for First Year M.Sc., (Speech and Hearing) of the student with Register No.M8903.

Mysore May 1990

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All India Institute of Speech and Hearing Mysore-6.

## CERTIFICATE

This is to certify that the Independent Project entitled: Electrophysiological Tests in Human for Radiological Purposes -A Review of Literature, 1985-1989 has been prepared under my supervision and guidance.

MYSORE MAY 1990

#### DECLARATION

This Independent Project entitled: <u>Electrophysio-</u> <u>logical Tests iN Human for Radiological Purposes -A</u> <u>Review of Literature, 1985-1989</u> is the result of my own study undertaken under the guidance of dr.(Miss) S. Nikam, Professor and Head, Department of Radiology, All India Institute of Speech and Hearing, Mysore aNd has not been submitted earlier at any University for any ether Diploma or Degree.

Mysore

May, 1990

Register NO.M8903

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I am indebted to my Bhaiya Sri KiraN Kamar Lal for his timely encouragement and help in other aspects and also to my Bhabhi Mrs.Premalatha for her love and affection which reinforced me to complete this project early.

I thank my other classmates and friends who helped me in writing this project, directly or indirectly.

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#### INTRODUCTION

The clinical utilization of the electrophysiology of the auditory system has opened a new era in our ability to diagnose receptive auditory impairment. Baring the last three decades, there has been a substantial impetus in electric response audiometry (BRA) due, no doubt to the developments in computer technology and te enhanced insights into auditory physiology particularly at the level of the sense organ and the brain stem.

The methods currently available to assess the auditory function are many and varied ranging from very simple behavioural tests such as observing the child's behavior in response to the sounds produced by toys, bells aad noisemakers, to very sophisticated computer averaged objective methods, such as, electrical response audiemetry (ERA).

#### Need for Electrophysiological tests:

One of the problems encountered by the clinician in testing patients with hearing loss is in testing the mentally handicapped, physically handicapped and language impaired population. Early identification and diagnosis is especially essential in these groups as hearing loss can interfere with their language development and further treatment and management. This can also interfere with their social, adaptive and cognitive development. In older to test children, many modification of pure tone and speech testing procedures have been made which makes use of a variety of conditioning techniques, to get reliable audiograms. Despite, these, problems persist in testing children, especially if they are too young say less than one year, where the clinician has to rely more on behavioral observations. Also, in certain difficult to-test patients, or children with multiple handicaps such as cerebral palsy or children with emotional problems like autism, conventional test procedures do not yield reliable results. With the development of objective testing methods, the electrophysiological tests have been found with greater accuracy in identifying hearing problems.

It was found that using the electrophysiological tests accurate estimate of hearing is possible. Even age related changes in hearing can be assessed accurately. Apart from the normal, other subjects were also tested using these objective measures and these were found to give reliable results.

In general, all auditory response systems, both specific (direct) and non-specific(medlated) can be broadly classified into:

1. Behavioural response system

2. Electrophysiologlcal response system.

2

#### Electrophysiological response system:

Auditory responses prefaced through the electrophysiological response system manifest themselves as recorded changes in the electrical properties of body structures, as a result of direct (specific) or indirect (non-specific/ mediated) auditory stimulation.

The electrophysiological response system can be further classified as:

1. Electrodermal response (EDR)

- 2. Electroencephalic response (EER)
- 3. Electrocardiac response (EKR)

#### Electrodermal response (EDR):

It involves studying the recordable changes in the electrical properties of the skin. These changes occur as a direct result of either increased or decreased sweat gland activity, and the changes in the electrical properties of the sweet glands is recorded.

Radiological procedures utilizing the electrodermal response (EDR) system is referred to as "Electrodermal audiometry" (EDA). It is also known as "Psychogalvanic skin resistance" (PGSR) and "Galvanic skin response" (GSR) (Bordley and Hardy (1949), Goldstein and Derbyshire (1957).

## Electroencephalic responses (EER):

Responses evoked by the auditory stimuli end produced through the electroencephalic response (EER) system are represented as changes in the on-going electrical activity at the cortex. These electrical events can be recorded using scalp electrodes and constitute the Electroencephalogram (EEG) This EEG activity undergoes change when there is sensory stimulation (Berger, 1929).

Audiological procedures employing the EER system have been termed "Eleectroencephalic audiometry"(EEA) (Golstein, and Derbyshire, 1957).

#### Electrocardiac response (EKR):

The electro-cardiac response is measured as a change upon stimulation in the electrical activity of the heart. This response system is quite non-specific to auditory stimulation and like EDR, EKR is mediated through the autonomic nervous system. The apparent objectivity of electrophyaiologic responses must be carefully qualified, since the techniques may be objective but the interpretation of the graphic recording, meter variations or other signals are still open to subjective error.

Radiological procedures employing the EKR system have been termed "Electrocardiac Audiometry" (Goldstein, 1963).

Among all these electrophysiological tests, the most commonly used tests are, (a) Auditory Brainstem Response (ABR);

(b) Electrocochleography (ECochG)

(c) Middle Latency Response (MLR).

The clinical application of ABR began in the 1970s. These early potentials waveform was first recorded by Sohmer and Feinmesser (1967) and later described by Jewett and Williston (1971).

These auditory evoked potentials can be classified in various ways. One common classification is baaed on the latency "epoch" of response. The various epochs are designated as :

First; 0 - 2 msec.

Fast : 2 - 10 msec.

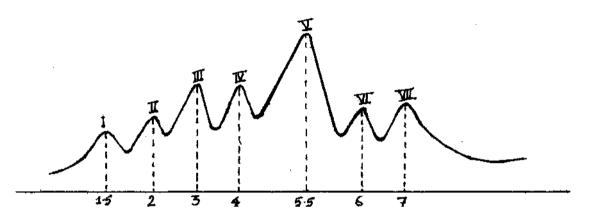
Middle; 10 - 50 msec.

Slow - 50 - 300 msec.

Late - 300 - and above msec.

Among the above possible, auditory evoked potentials (AEPs) Auditory brainstem responses (ABR) is one of the several clinically useful evoked potentials and is extensively used than other electrophysiological tests. As the name suggests, the origin of these waves is in the brainstem. These waves are identifiable within 10 m.sec. after stimulus onset. Stimuli which are commonly used for electrophysiological tests are; Clicks, brief tonepips, and tone bursts. In a normal person following stimulus presentation, a series of 7 waves have been identified and numbered as wave I, wave II, ..... Wave VII. (Jewett and Williston, 1971).

Typical brainstem response is:



The sonree of origin of these 7 waves are as below: Wave I - Auditory nerve

Wave II - Cochlear nudeus

Wave III - Superior olivery complex

Wave TV - Lateral Lemniscus

Wave V - Inferior Collicolus

Wave VI - Medial Genicnlate body

Wave VII - Auditory radiation.

Among these, wave V is the one which is most identifiable and is often used as a criteria for determining threshold.

The parameters which are considered in interpreting BSERA wave forms are:

1. Absolute latency of the waves

- 2. Wave form morphology
- 3. Interpeak latency values
- 4. Intra aural latency differences
- 5. Amplitude ratio of V/I waves.

Based on these, diagnosis of hearing loss and identification of possible site of lesion too is possible.

#### Purpose of this project:

- To study the advancement in different electrophysiological tests in the recent 3 years.
- To know the diffrent variables viz. subject variables, administration variables, stimulus variables, which are used in the tests.
- 3. To Know about the effect of variables of age, sex, normal and disordered.
- To find out the changes in the auditory system post parameters, methodologies and instrumentations over the years, i.e. last 5 years.
- 5. It is helpful for researchers, clinicians, students and those who are interested in the field of electrophysiological tests to get organized data and methodology, getting an overall view of research.

They get information on recent advances in technology and methods of testing.

REVIEW OF LITERATURE

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Articlic     Articlic     Articlic     Articlic     Articlic       1     1     1     1     1     1     1       1     1     1     1     1     1     1       1     1     1     1     1     1     1       1     1     1     1     1     1     1       1     1     1     1     1     1     1       1     1     1     1     1     1     1       1     1     1     1     1     1     1       1     1     1     1     1     1     1       1     1     1     1     1     1     1       1     1     1     1     1     1     1       1     1     1     1     1     1     1       1     1     1     1     1     1     1       1     1     1     1     1     1     1       1     1     1     1     1     1     1       1     1     1     1     1     1     1       1     1     1     1     1     1     1		Dicotic	<u></u>	2			
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Author Author Author Paul Kileny E Susan L. Shea Shea Shea Christine Paul Kileny Paul Kileny Shea Shea Christine 1986 1986 1986 1986 1986 1986 1986 1986	t t	Sex Socio-Scono- Bac	ut of		Both Years		
Author Author Nancy S. Christine Ollo et al Musick et al Rodendo Rodendo Rodendo Rodendo Redrigues et al Frunk I. Randall C. Beattle et al Frui Kileny & Susan L. Shea	Subject	Age Socio-econo- Sex Age	Feth Years 1945 Foth	Years 21 - 57 22 - 57 Mewometic Measurents Measurents	Both 21 - 44 21 - 44	18-38 Years electrode	18-54 years ERP 40 Hz
	Subject	Sectorecono-	BSERA in mentally vears years foth foth	Years 21 - 57 22 - 57 Mewometc Measureacts Measureacts	Both 21 - 44 21 - 44	18-38 Years electrode	18-54 years ERP 40 Hz
29, 22, 22, 23, 53, 56, 57, 57, 56, 57, 57, 57, 57, 57, 57, 57, 57, 57, 57	Subject	Skperiment Socio-econo- by Sex Sex Sex	I BSERA in Wentelly retarded 26 - 34 Aears fioth	Years Intervave St - 57 Searches Meuromes	i Effect of Intensity and Inequency 21 - 44 Stars Both Afol	19-28 years	18-54 years fo Hz ERP MLR and
	Subject	Secto-econo- by Secto-econo- by Sex	Peeth Pe	21 = 57 21 = 57 21 = 57 12 Acoustic 12 Acoustic 1986 1986 1986 1986	1986 I I I I I I I I I I I I I I I I I I I	18-28 Years	18-24 years ERP MLR and MLR and MLR and MLR and V r v r v r v r v r v r v r v r v r v r v

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variable	Tone burst/		<u> </u>		
	CIICKS	>	7	>	298/12
stimulus	BCochG	~			
and sti	SLIM		· · · · · · · · · · · · · · · · · · ·		
	BSERA	afirear SBA barreado araw	штојеvви ЯбА Беки етем	ADR in coms type head-indured sass	sgw Aga betuseem
Administration		2 KHz to 4 KHz	SHO HZ TO 500 HZ TO	5 KH2 500 H2 to	50 €¢ 2H 000£
Ъ	Intensity	भूम सुर	JH 81P 04	89 <del>-</del> 98	ମସିଥି ୭ସୁ ଶିହି ୦୪
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	ьтордеша Оғуғт	chlear pathology Suspected retro-	•	70 acute severely 70 acute severely	Cochlear hg. loss
variables	Hearing normal/ abnormal	Не. гоза сазез	Vorgel	25 Normal	Íserion
bject v	mic status Socio-econo- Socio-econo-				•
Sut	X#S	પરુભ્ય	4 Males,6 Females	, प्रुल्	યુરુલ
	эбү	19 - 80 Years	55 - 25 Aests	51 -76 years	Mean age 45.4yrs
Articles	Case study	Effect of 2K- 4KHz hearing sensitivity	lo szu bne besű gairetlil letigib	i Lertosqa Ada Don fustoo	oirtemoibuA noiterugilnoo Ada bus
ž	Experiment	<u> </u>	>	>	······
	Y€ar	9961	9861	9961	986L
4000 CL 1975 400	Author	Christopher D. Bauch & Wayne C. Olsen	William D. & Kevin T. Kavanagh	James W. Hall	William J. & Anne Greville
		e e	<del>ب</del>	32.	IN 10
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	Symmetry difference.				·
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	acreated Yoneated Teresterce	>	>	7	7
able	Tone burst/ pips		0 <del>0</del> 8\{.1	* 7	
s variabl	CIICKS	≎ <b>e</b> s/2*6	· · · · · · · · · · · · · · · · · · ·	40 per sec. 10, 33, 67	098/6 11 & 66/8ec
stimulus	ວປວວ JE	· · · · · · · · · · · · · · · · · · ·			
and sti	8.1M	М.К. мауе form wes detected			osis aiso M.R. vas also beau
	ASIBE		been saw ASA	ABR Was recorded	рэви гам ЯЦА
Administration	E sedneuck	2H 005 2H 001	≈H 0051 ₩ 0001	3 KHZ 150 to	2000 to 2000 to
N.	Intensity	Tha add on a add of	JHN ED 09	ୀର ଶନ ୦୮	100 qB pe SFL
	Dicotic	<u> </u>	<u>&gt;.</u>	<u>\</u>	
	Tetusnow			2	>
	ргорієщ <b>я</b> Оғрег	I	<b>,</b> .	bətəəqsus mətaninıd	Patients with dimension of the Alcheminenty
variables	Hearing normal/ abnormal	Kormal	Normal	Not mentioned	Normal and SN hg. loss cases
Subject	Socio-econo- Socio-econo-				
22	xəS	*₩*N	*₩* N	પરબદ	૫૧૦૬
	эбү	55 - 55 years	17 - 57 years	54 - 57 Years	43 - 78 years
Articles	Case study	Agin to tosilä Tetti esser	Test Te-test Veri Rdi 11 ty	ni ətər Ada əfqitiyu sizorois	AEPs in dimension of the Alzheimen type
F.	Experiment	· 1	>	>	<u>~</u>
	Х <del>е</del> ал Х	986L	9861	9861	9961
	Author	Kevin T. Kavanagh & William D. Domico	Paul R. Kileny & Joni Peters Kripal	John T. Jacobson et al	Allson M Grimes , Cteryl L. Grady & Anita Pikns
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	SAMMUGERA	_				18
	Amplitude Affference,	. 7	>	>	7	>
	difference Latence	7	>	>	7	2
variable	Tone burst/ pips					
	ciicks		298/07 ¥ 01	598\0 <u>5</u>	25/860	598/0I
stimulus	942002g	-				······································
and st	MLR	<u> </u>				
Administration	Anges Ang Anges Anges Anges Anges Anges Anges Anges Anges Anges Anges Anges An	sew Affice each	ABEP Were recorded	ABEP were	ABR Were tecorded	ABR Was becorded
ún1st:	Frequency	zH 0003	2H000E of 001	2H000% 01 001	зня с	2H 000E
Å.	YJIen9JnI	*W*N	JH AD 27	75 9B HL	90 dB peak . SPL	85 <b>68 HL</b>
	Dicotic	>				
-	Moneutel		>	<u> </u>	<u> </u>	<u> </u>
	bropjeus Ofiet	encephalopathy Chronic toxic	Idiopathic peri- pheral facial	Exposed to lead through food		mist-sig Signat
ariables	Hearing normal/ abnormal		sətədə tü Sətədə tü	l	Implaned Cochlear sissifiesis	
ect v	ensese sta Socto-scono		<u> </u>			<u></u>
çqns	XəS	प्र‡ ० व्य	યુરુક	यने ० ह	4.M.	(.M.N)benotinem for
	уде	35 - 49 Years	stiubà	8 ~ 56 years	\$IubA	40 Weeks
Articles	Case study	SSEf & electro Ngaragmography	niery Brain bayora eata potentisi	ABEP in a symptometic besogxe-bsed	-sfs cha- rscterla- tis sci ta and ca and samuti	ABA and behavioral responses in tainin mistate
AF.	Srperiment	<u> </u>	>	>	>	>
	Year	9861	9861	9861	996 T	9861
	Author	Pater Paulsen & Janne Jansen Jensen	Ben-Devid J. et al	Holdstein Y. et al	Vanden Honert C. & P.H.Sty- pul Kowski	Kimi taka Kage etal

	Symmetry				1 9
-	Amplitude Ampliterence.		7		
-	Latency difference	7		λ.	7
variable	Tone burst/		>		5 Sd Sd
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stimulus	୭୳୦୦୦୦				stered beretered
and sti	WLR				ecorded LR was
	Ayaza	araw zAGA babrocar	asw Ada benisido	удатотот Яба реготвед	esanred BK M88
Administration	Eedneuch	2000 <b>to</b> 2000Hz	2 KHZ to 8 KHz & 0.5 KHz	zH 0022 - 021	2H 08
N N N	Vjienajni	p.e. SPL 100 dB	90 489 96 489 04	JHr (11) 08	रुट्ट व्यव्न सः 0 व्यव्न
	τιορτο		>		. >
	Monautal		>	>	<u> </u>
	proplems Other	sisonels? sightim	· · · ·		
variables	Hearing normal/ abnormal	Normal hearing	Normsl hearing Normsl hearing	Sensory Newsl	ormal Hearing
ect	mic status Socio-econo-				
iqns	x=s	ut of	Not mentioned	ц <del>то</del> б	benoltnem to
	эбү	9 - 59 Years	t Lubk	50 - 70 years	6 - 43 years
Articles	Case study	əlqitinm ni ABA sisorə[ə2	Frequency Specificity of ABA	to tosti staryqasiq AdA no	LD LD LD LD
Arti	Experiment	<u> </u>	>	>	>
	Year	9861	9861	9861	78et
	Author	Quaranta A Minimui F & Longo G.	Lenkli E. & Mair W.S.	Rosenhall Ulf et al	Kevanisk '. vili Z & ' lagidze Z.
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	ebujitumA eccence.	<u> </u>	7	7	7
ļ	difference Latence		7		7
variable	Tone burst/ \$\$			≎ <del>9</del> 8,4	098/1-11
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and sti	WLR		·	, , , , , , , , , , , , , , , , , , ,	AEPS were recorded
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Administration	Frequency	2H 0071 03 035	TRN C of SH OSI	2 KHZ 1 001	2 KHZ 2 KHZ to
1	Intensity	ገട ഈ 0/	225 879 511 97 979 56	<b>be</b> 3Ы ንተ <b>fo</b> 25 ዓB	JHa 815 07
ţ	Dicotic			·····	2
ļ	Letuenom	<u> </u>	<u> </u>	2	
	problems Other		No Neurological disease		
variables	Hearing normal/ abnormal	Normal hearing	Jusijag LamioN	<b>Могта</b> д ћеатіл <u>в</u>	Тештой
t g	Socio-econo-				· · · · · · · · · · · · · · · · · · ·
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ſ	yde	50 - 23 Years	50 - 30 <i>heats</i>	50 - 30 <i>Xesta</i>	51 - 40 Xests
Articles	Cese study	Yoneuperî wol -Tefîlî golsne ş AdA no gni-	sisb sourcelend SAEA Tol	noittetet AGA noittenut	etyt teliligmA and electrode fiscement
\$	Experiment	<u> </u>	>	t	. >
	Year	2861	2861	7861	2861
<b>J</b> an - 19 - 19 - 19 - 19 - 19 - 19 - 19 - 1	Author	Svensso Owe et al	Elberling C. and Parbo J.	Elberling C. and Don M.	Randal C. et al
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	Ampliference.	7	7		··· 7
	Latency difference	7	•	7	
variable	Tone burst/	· · · · · · · · · · · · · · · · · · ·	sq14	<b>38</b> 8∕ <del>111</del>	
	¢JŢ¢Ķ8	7	>		0\sec
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and sti	MLR		•		
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inist	E redneuch	benoitnem toN	t KHZ to zHX 8	zHX 91 01 zHX 6	<sup>2</sup> H 009 \$ 00
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variables	Hearing normal/ abnormal	tradity for	Moderate to profound bearing loss	<u>í sarto</u> ří	orsîdered Jangl
Subject v	-orosa-o2502 eujeje oim				
Sul	×es	Ato8	म्द्रभ्य	*W*N	•W•N
	¥ġê	agriod wey	Fre School	† Lub <b>k</b>	rt i setence La infants
Articles	Case study	guireerog ABA diw sejencen ni msrD-odirD	evittiber ABA lo sulev	səîrapəri fişi ABA ABA	evelopmentel no condrotion AR
¥	Experiment	>	>	>	>
	Year T	2861	2861	2861	<b>78</b> 21
	Author	Dævid A.P. Donald A.S. Devid N. Rose	Faul R. K1- leny & Meredith G. Magathan	Michael P. Gorga et al	Edward Y. Allen L et al
				53.	ž

	Symmeter				22
	Amplitude.	2	2	7	>
	difference difference	>	2	>	
ble	\jslud snoT eqlq	· · · · · · · · · · · · · · · · · · ·			
variable	creks	o∂\$/0ŋ	>	598/04 ¥ 0L	1/36C
stimulus	Broche				NGC ESPONSES
and sti	S.IM				
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Administration	Loundar J.	2HX 4 & 2HX 2	zhx 4	ZH 000E 03 001	2H 000+ => 2H05
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	Dicotic			· · · · · · · · · · · · · · · · · · ·	·
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variables	Hearing normal/ abnormal	. Asir faiH ssidsd	Lauron	Sudden hearing Loss	Normal
ubject v	-01009-01002 Sutets th R				
Sul	XəS	Both	प्र॰व	*W*N	३ <b>७७१७ - २</b> १ ३ <b>७७१७ - २१</b>
	964	Within 24 hours	25 - 65 years	54 - 80 years	stosta beccs becotioned
Articles	Case study	Hearing detection Figs gains	by ABR Scoustic tumour Acoustics BR	nebbua ni 938A asenise b	Sports foots footseu
AF1	Experiment	7	l	>	<u>&gt;</u>
	Year	2861	286L	<b>L</b> 861	286:
	Author	Abramovích J.S. et al	Abramovich J.S.	Wilder A. et al	Faul H. Stypul Kowsk, &
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	Symmetry					·2 :	3
	Amplitude.	7	7	5	7	2	7
	Latence difference	<u> </u>	7	7	7	>	7
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stimulus	£Cocµe						
and sti	S.IM	ACK W25 L9D10291		recorded MLR was			/
Administration a	ASERA		ABR waa ABR waa	ABR Was Debrocet	ABR were recorded	ABK W85 Debiodet	Serded
iini str	Eredneuch	30 FO 3 KH2	2нх е - ое	2HXE 07 0E	4000 Hz &		2H 00
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	Dicotic		···			·	
	- Isturnom		>	<u>&gt;</u>	>	<u> </u>	>
	problems Other	preterm in- fants until	Preterm in- Farts until 3 months	Preterm infants	Cochlear & Acoustic neu- roma patients		
variables	Hearlng normal/ abnormal				SN hearing Loas	bected Suspected	(eus
t a	mic status Socio-econo-	· · · · · · · · · · · · · · · · · · ·					
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	yde	25-52 Weeks	25-52 Weeks	ss - Ssweeks	Xegta 54 - 63	<b>MBBKE</b> 33 - 44	уеага
Articles	Case study	ni 904 mistaiq stnsini	ni 984 mrsjarg stastai	nî AJM 2 A8A misjeiq sinsînî	Effect of stimulus repetitation repetitation filt	MGR from JCN gra- Louidres	8 arte ct caused calorie gring
A	Experiment	>	>	>	>	$\overline{}$	>
	Year	<b>486</b> 1	£861	£961	<b>LB6</b> I	<b>296</b> T	286T
	Author	Rotteveel J.J. et al	Rotteveel J.J. et al	Rotteveel J.J. et al	Kathleen C.M. Camp bell & Paul J. Abbas	Michael P. Gorga et al	Steen Gimsing
<b>i</b> _			60.	·iy	5	63.	÷.

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	Argeunuss				2 4
ļ	Amplitude difference.	7	>	7	7
ļ	difference Latency	7	7	>	7
variable	Tone burst/			· · ·	કુંત
	CIICKS	oss/01	>	<u>&gt;</u>	098/£*6
stimulus	94500E				
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	ANER	aew Ada betegiteevni	ABA recording taken	ави ЯЯА Гесогдео Бертозет	
Administration	E redneuch	2HX & 07 2H 06	зкну † ор 2ну 2	ZHNG OF ZH OOOE	2H 005
A.	Intensity	113 eq 113 eq	DELOW LIK 10 to 30 dB	92 वष्ठ भर्मा	JHE SE OS
ļ	Dicotic	· · · · · · · · · · · · · · · · · · ·	· · · · · · · · · · · · · · · · · · ·	<u>&gt;</u> .	
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	btopjewa Ofvet	•			
variables	Hearing normal/ abnormal	LsmroN	19m7ov	Коттаl Коттаl Вод Злітвен	Normal Normal
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Subjec	X@S	५३०व	५२०व	દ્યુ ૦૧	પરબ્લ
Ì	÷¢4	35 - 50 years	50 - 40 Aests	55 - 45 Years	74 - 34 years 74 - 34 years
Articles	Case study	Å agg lo joalii Ada no xas	Objective Ponotian of UL	BSR to single ilumits squis	anor of A.M Qiq
5	Experiment	>	>	7	>
	H H P M	2861	<b>7861</b>	2861	8961
	Author	Sturzebec- -her E and Werbs M.	Thornton A.R.D. et al	Gerwell G. et al	Barajas J.J. et al
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I	Symmetry				2 5
Ī	Amplitude.		7	7	7
	Latency difference	>	>	7	. 7
variable	Tone burst/ pips				
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stimulus	54200E		· ·		····
and st	WI'B				
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Administration	Eredneuck	zHX č ot Oč		2000 £ \$000 £	5 KH2 200° 1K &
Ŕ	Ιυςουτά	JHA ED 28	20 to 80qB nHL	TO AB HL	기위 원한 000 우구 원한 09
1	Dicotic	<u></u>			
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	bropjema Ofrer	Hyperthermic for Hyperthermic for edvanced cancer			eston eston
variables	Hearing normal/ abnormal	Not mentioned	Abnorma] hearing	Normal	SN hearing loss
eu t	Socio-econo- sujeje sim		Credustes from Intensive care		
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¥ [	fxperiment	I	>	>	>
Ì	Year	8961	8961	8891	8861
	Author	James W. Hall Joan M. Bull et al	Michael P. Gorga Jan R.Kawi- nski, & Kathryn A Beauchaine	Nina Kraus and Therese Mc Gee	teres teres teres teven sinnson
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variable	Tone burst/						
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stimulus	BCochG	· · · · · · · · · · · · · · · · · · ·					
and st	ыгу						
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bject v	Socto-econo- Socto-econo-	primery school Children of		· · · · · · · · · · · · · · · · · · ·			
Sut	`xə <sup>S</sup>	tt of	Reth	Female	Female		
	9Q6	10 - 17 Years	18-28 Years	25 - 35 years	stiuba		
Articles	Case study	ABR in Dyslexic children children	Interaction of Click Polo.Stim Jevel and repn. AGA no sign	fni esta fiet on ABA	sais-iisH bus iiumits svaw IAGA		
AFT	Experiment	7	>	>	>		
	Year	8861	8861	8961	8861		
	Author	Aksel Grontwed et al	Randall C. Beattic	Vishaka Rawool & Stenley Zerlin	Stanley Zerlin		
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Ar	Experiment	· · · · · · · · · · · · · · · · · · ·	>	$\geq$	>
	Year	8861	9861	8861	8861
	Author	Maurizi M. et al	Lanklio E. et al	Stenley Zerlin	Cymthia G. et al
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Articles	Case study	ABR in acute severe head Yaului	BAEF after iiradiation of istophal ca	BERA in A Di destness in nembiido	јати́а эпоТ ≉Я8А
¥	Experiment	<u> </u>	>	>	>
	Year	8861	8861	9861	9961
	Author	Moffat D.A. et al	Lan S.K. et al	Purmessur M N S et al	Michael P. Gorga et al
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Articles	Case study	dəəts nik in	-sonsdai Ass ABA ai fasm	ABR threshold estimation eupindoe	Frequency dependence and binaural inter- ection	ຊາອງອກອາຊາຊີ ມີດຣ ທາງອງອາດຸດ ອງດອງດາມ ທານ
	Experiment		>	>	3	>
	Year	9861	8861	8861	8861	8861
	Author	Lesley Å. Jones & Richard J. Baxter	F.Grandon et al	Bell-I-E. & Thernton A.R.C.	Sherri MD & Newell T.D.	Jos J. Eggermont & Alan Salamy
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variable	Tone burst/ Tone burst/			20/ sec 10° 52	
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2	Experiment	>	· >	l	7
	Year	8861	8861	8961	8861
	Author	Kavin T. Kavanagh Willlam D. et al	Lynn G.S. Michael R. Seitz	Cynthia G. Fowler & Robert S. Broadard	Buller N. et al
7	Lon O N	06	5	32.	<b>Š</b>

	Author	Irvin J. Gerling	Kevin T. Kovanagh et al	Frank E Musiek et al	Anita Maiste & Terence Picton
	Year	6861	6861	6861	6961
Å	frentregxz	<u> </u>	<u> </u>	>	>
Articles Subject variables	Case study	Stimulus parameter interection. A .instigu immion	ABR/MLR in the mentally handi bad	nî GJI', AEA Mîlw zînîjîg Maîa dîrû Erolasî Erolasî	Evoked poten- tiels to frequency sodulated tones
	yde	55 - 22 <i>Aeste</i>	8 months to 52 years	23 -11 years	23 - 42 years
Subjec	xs <sup>2</sup> -orio-econo- mic status	H≤	प्रे <b>अ</b>	પ્વગ્લ	•W•N
	Hearing normal/ abnormal	pernology With Cochlear Hearing loss	Төштой За 1789л	1088 ਮੁਫਤ17 ਸੁੱਖ	hearing Normal
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and stin	 Ялм		MLR Was		ditory evoked tentials were beniei
stimulus	ECochG	·····	<u> </u>	, <b></b>	
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able	Tone burst/ sqiq	* · · <b>&gt;</b>	54.1 .1		P: P: P:
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and stiv	 אדש	recorded MLR was			AEPs were recorded
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variables	Hearing normal/ abnormal	Kormâl	<b>йогта</b> 1	Тетой	<b>ສະເ</b> ງເຫຼັງ ກອງລະເອີນ ອີກອ່ໄວຄູ
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	÷pÅ	60 - 85 years	18 - 30 Xesta	21 - 38 years	41 - 82 years
Articles	Case study	ABR and MLR in elderly sjoels	Frequency specific Sievel prixsem ABA	Electrode position	-ibu <del>A-sisi</del> g Steed Poten- cory evoked poten- sisis
ž	Experiment	>	>	7	>
	Х <b>ө</b> аг	6861	6861	686 T	6861
	Author	Lenzi A. et al	Suzanne C. Purdy et al	Randall C. Beattie & Leslie A Taggart	Milford C. A. and Birchall J.P.
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Articles Subject variables	problems Other		· · · · · · · · · · · · · · · · · · ·		
	Hearing normal/ abnormal	Иогта 1	Normal	1 <i>59</i> Ď	Normal Cochlear Loss, cord loss Normal Cochlear
	mic status Socio-econo-		· _		·
	xəS	Litoa	4308	цтов	ประส
	уде	19 - 31 years	31 - 69 years	19 - 67 Years	10 - 82 Years
	Case study	FIR filters for peak identit- citon	Age effect in Ageich sudiology Aga ni bas	EER in Cochlear Efneifeg fneigmi	fo noifsmifts (AS sect pairsed bro
Art	Exbertwenc	<u> </u>	>	>	· >
	Year	6961	6861	6861	6 <del>8</del> 6 I
	Author	Pratt H. Urbach D. Bleich N.	Detruyne & Tyber- ghein J.	Pelizzone M. et al	Vander Dreft J.F.C.
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Normal     Normal     Normal     Normal     Normal     Normal     Normal       1999     1989     1989     1989     1989     1989     1989       19-30 years     Adult     3 years     Normal     Normal     Septiment       19-30 years     Adult     3 years     Normal     Septiment       19-30 years     Adult     3 years     Adult     3 years       19-30 years     Adult     3 years     Adult     Septement       1993     1989     1989     1989     1983	1	Dicotic	<del>_</del>			<u>&gt;</u>
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Alt     Author       Author	Sub	}	Not mentioned	benottnem fow	Male & Female	
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Author John A. John A. Ferraro & Roxann Ferguson Ferguson Gorga et al et al et al et al Aler G.	A	Experiment	>	>	<u> </u>	>
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		Author	John A. Ferraro & Roxann Ferguson	+-1 ai		Aler ( Alder
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	Latency difference	>	7	>	
able	Tone burst/ pips	22.3/860		23.3/560	
s variable	CTTCK8		098/3.2		<u>&gt;</u>
stimulus	DCochG				
and sti	MLR				
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variables	Hearing normal/ abnormal	to notoiqsug szoi pnitseed	Action is a construction of the second of th	1sm10N	ei ilumite bedittes AgA ioi
ect	-croce-ocono- Socto-econo-	development Delayed speech			
fqns	xəs	୳ୖଽଡ଼ୄୢୢ	91 GM	4708	benottnem toN
	÷	2 months to 20years	40 - 60 years	24 - 47 years	benoitinem fou
Articles	Case study	ABR and Puretone ABR and Puretone	SRS & ABR in Cochlear inentisqmi	Low ievel Low frequency ABA	The choice of ASA for ilumite Strements
Art	жрегітелс		> .	>	۱
	на С Ц	6861	6861	6861	6861
	1 <b>1</b>				Þ.
	Author	Fjermedal O. and Einar Lankli	Vishakha W. Rawool	Oddbjorn Fjermedal & Einar Lankli	Michael P Gorga & Aaron R. Thornton

	Symmetey			3 6'
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	difference Lifference	7	7	
sble	Tone burst/ pips		· _ · · · _ · · · · · · · · · · · · · ·	
veriable	c TTCK <sup>2</sup>	298/0Z	>	<u></u>
stimulus	DUDODE		·····	······································
and sti	ыл		,	
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	Author	Robert A Dobie and Michael, J. Wilson.	Daniel.M Schwartz, et al.	
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lab			ubject var	lapie.	
variable		Ad	ult	Inf	ant
		Normal	Abnormal	Normal	Abnormal
Stimuli	1. Brainstem evoked response.	41	26	13	10
ت	2. Middle latency response	14	5	3	
and	<ol> <li>Electrocochleo- graphy</li> </ol>	3	3	2	1
	4. Monoaural	36	25	12	12
ion	5. Dichotic	17	8	2	2.5
rat	6. Clicks	41	27	13	8.5
nist	7. Tone pips	5	2	0	1
Administration	3* Tone burst	8	2	2	3

Percentage of articles studied in different variables.

## CONCLUSIONS

Electrophysiological response systems manifest themselves as recorded changes in the electrical properties of body structures, as a result of direct or indirect auditory stimulation. The articles which have been studied so far reflect the following conclusions:

- Around 95% of the articles are experimental studies and others are reviews.
- 58% experimental studies have been conducted on adult normals and 34% studies have been onducted on abnormal adult subjects.
- 3. In 30-35% articles, the exact age and sex of the subjects have not been mentioned.
- Normal infants and children have been studied in 18% of articles where as, abnormal infants and children have been studied in 14% of articles.
- 5. In 90% of the articles clicks of different frequencies have been used. The rate of clicks varied from 9/sec. to 64 clicks per sec. This shows that clicks are the most valid and reliable stimuli for electrophysiological tests.
- 6. BSER was recorded from subjects in 90% of the studies which shows that a majority of the research still centers around BSER. It is found to be useful in differential diagnosis

of cochlear & retrocochlear lesions sensori-neural from conductive lesions both in adults and children. This has been found to be useful in diagnosis of the multiplyhandi capped to find out organic lesions and detection of hearing in non-cooperative subject..

- 7. Though more interest is seen in MLR, it is basically centered around normal Mults (14% articles on normall adults, 3% on normal infant, 5% on abnormal adults and 3% on abnormal infante) in establishing norms.
- 8. Other stimuli such as tone pips and tone bursts have been used. 8% and 15% respectively in articles, which shows that these are loosing their effectiveness in electrophyslological tests.
- 9. The stimuli were presented monoaurally in 85% of studies where as it was presented dichotically in 28% of the experimental studies.
- 10. The clinical use of electrophysiological tests are not restricted to measurement of auditory threshold. Detailed analysis of EcoehG responses show consistent varieties, in several types of heating impairment. It may also be used to monitor the electrophysiological changes which occur within the cochlea after some event such as the infusion of a drug.

Finally one must remember that each class of auditory electrical response has its own theoretical and practical

advantages for electrical response audiometry (ERA) choices must be made according to particular objectives and with respect to possible limiting conditions. Results of the ERA cannot stand alone and they mast be interpreted in the context of other clinical information.

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