# AUDIOLOGICAL FINDINGS IN AUTISTTCS - A REVIEW

**REG NO.M9803**

**An Independent Project Submitted as part of the fulfilment of First Year M.Sc, (Speech and Hearing) to the University of Mysore.**

**All India Institute of Speech and Hearing, Mysore 570 006**

**MAY 1999**

**DEDICATED TO**

*The Lord Almighty*
*Lord of my life*
*in whom I have*
*hope, peace, joy*
*and strength*

## CERTIFICATE

This is to certify that the Independent Project entitled : **AUDIOLOGICAL FINDINGS IN AUTISTICS - A REVIEW** is the bonafide work in part fulfillment for the degree of Master of science (Speech and Hearing) of the student with REG.No.9803.

Mysore

May 1999

Dr. (Miss) S. Nikam

Director

All India Institute of

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Mysore 570006

# CERTIFICATE

This is to certify that this Independent Project entitled AUDIOLOGICAL FINDINGS IN AUTISTICS - A REVIEW has been prepared under my supervision and guidance.

Mysore
May, 1999

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# DECLARATION

I hereby declare that the Independent Project entitled AUDIOLOGICAL FINDINGS IN AUTISTICS - A REVIEW is my own study under the guidance of Mr.Animesh Barman, Lecturer in Audiology, Department of Audiology, All India Institute of Speech and Hearing, Mysore, has not been submitted earlier to any University for any other diploma or degree.

Mysore
May 1999

Reg. No. 9803

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# INTRODUCTION

Perhaps the most fascinating, the most mysterious, the most telling-fascinating of all developmental brain disorders - Autism typically has its impact on absolutely every aspect of a child's perception of an interaction with the surrounding world.

Mysterious because of the complexity of the many interacting brain systems that it perturbs, telling because it strikes at the social, cognitive and linguistic abilities that seem, at least on the surface so essential to one's humanity.

**Diagnostic Terminology**

The syndrome of the autism was first identified by Leo Kanner in 1943 when he described a group of children having "autistic disturbances of affective contact". In 1944, he adopted the term "early infantile autism".

**Age of onset** - Obvious appearance of symptoms occurs before 30 months of age.

## Incidence/Prevelance

Autism and its associated behaviors have been estimated to occur as many as 1 in 500 individuals. Incidence of 5 in 10,000 have been reported by Ritvo and Freeman (1978).

Autism is four times more prevalent in boys than girls and knows no racial, ethnic or social boundaries.

Rutter (1967) noticed a male to female ratio of 4.25:1 amongst the children been at Mauldsley. substantiated by the Middle Sex Survey (Wing, 1967).

Gillberg (1980, 1984) in his studies found prevalence of infantile autism and other childhood psychoses of 4.0/10,000 in the urban industrial area of Goteborg in the country Bohuslan and a higher prevalence of 6.6/10,000 in the later stud}' when both urban and rural areas of Goteborg were considered.

## Behavioural Characteristics

**1)** ***Disturbances of relating*** *:* Behaviors that indicate disturbances of relating are due to arrests or developmental delays in personality formation.

Experiments conducted under well controlled laboratory conditions suggests that disturbed relatedness in autism may be secondary to disturbances of perception (Hermelin and O'Conner, 1970).

2) ***Disturbances of Developmental Rates*** : Autistic children show deviations from the normal sequential motor, language and social mile stones (Bender et al. 1952 and Fish, 1960).

3) ***Disturbances*** *of Motitity* : Disturbances of motility may appear intermittently in some autistic children and continuously in others (Sorosky et al. 1968; Hurt et al. 1965).

4) ***Disturbances*** *of Speech* ***and Language*** : Speech and language developed may be totally delayed (muteness); or fixations may occur along the normal course of development (Kanner, 1943; Bendere, 1947; Wolff and Chess. 1965). Echolalia is a common feature and is accompanied by reversal of pronouns (Kanner, 1943).

5) ***Disturbances*** *of* ***Perception*** *:* Disturbances of perception are most likely due to an underlying neuropatho-physiological process that is common to all autistics. It results in faulty modulation of external sensory input (Ornitz et al., 1968), distortion of an internal sensory input to make feedback from motor responses (Hermelin, et al. 1970).

Failure of adequate modulation of sensory input constitutes a striking and unique aspect of autism (Omitz et al. 1968; Ornitz, 1971).

All sensory modalities are affected and the faulty modulation of sensory input may be manifest as either a lack of responsiveness or an exaggerated reaction to sensory stimuli (Goldfarb, 1961, 1963). This faulty modulation of sensory input is an intrinsic feature of the autistic syndrome.

Many autistic children appear to be impaired in their ability to use the distal receptors of sight and hearing and *give* the impression of being deaf or blind or both.

Behaviourally, it appears as hyporesponsive or hyperresponsive states that alternate in the same child (Goldfarb. 1963). When hyporeactivity to auditory stimuli occurs, the autistic does not react to either verbal commands or sounds. There may be no startle response to very loud sudden noises (Anthony, 1958) and delayed attention to other sounds (Coden, 1975). In the light of the above the autistic child may be suspected to have a hearing impairment.

Importance of assessing the hearing capacity of the autistic child :

The evaluation of hearing is one of the important aspect in the identification and differential diagnosis of autistic children. There are several primary reasons for considering the functional hearing of the autistic child.

Two of these reasons axe inherent in the diagnostic criteria of autism developed by Pendre-short namely (1) acts as a deaf and (2) prefers to indicate needs by gestures (Lewis, 1978). Since hearing is so important to the natural development of speech and language, it is important to determine functional hearing in autistic children.

There is evidence of auditory deficits : i.e. reduced auditory sensitivity auditory processing deficits and/or attention related problems as indexed by both behavioral and electrophysiological measures reported in literature (Sohmer and Student 1978; Robier, et al. 1983;Courchesneet al. 1984;Rumsey et al. 1984; Jure etal. 1991; Steffanburg, 1991; Ciesielski, et al. 1990; Lincoln et al. 1992; Kemner et al. 1995).

The auditory evaluation of autistics needs knowledge, skill and practise of the audiologist. this re\iew has been undertaken aiming (1) at pro\iding information on the audiological findings in autistic subjects (2) at highlighting the difficulty in testing autistic subjects (3) describing the various tests test battery that have been used in the evaluation of autistic subjects (4) at arriving at a reliable test/test battery (5) and for further research purpose.

A brief overview of the availed literature has been presented in the following chapters.

# METHODOLOGY

This project has been aimed at giving an overview about the audiological findings in autistics.

Though the speech and language disturbances in autism have met the concern of the speech and language pathologist, only recently has the syndrome of autism drawn attention into the field of audiology hence only limited and variable information is available in this area.

An effort has been made to review literature from 1968-1998.

Several journals were scanned but many of the journals did not have any information. A few journals related to neurophysiology and neurobiology were also included as a neurophysiological and neurobiological basis has been postulated for the disorder of autism.

The journals that were scanned have been classified into two categories, i.e. Category 1- Journals that were scanned but no information found. Category 2 : Journal from which information has been found.

Category 1

1) Australian Journal of Human Disorders of Communication

2) Brain

3) British Journal of Audiology

4) British Journal of Disorders of Communication

5) Cortex

6) Ear and Hearing

7) European Journal of Communication Disorders

8) Exceptional Children

9) Hearing Research

10) Hearing Journal

11) Human Communication Disorders.

12) Journal of Acoustical Society of America

13) Journal of Auditory Research

14) Journal of Child Psychology and Child Psychiatry

15) Journal of Child Language

16) Journal of Communication Disorders

17) Journal of Mental Deficiency Research

18) Journal of Speech and Hearing Disorders.

19) New England Journal of Medicine

20) Perceptual Motor Skills

21) Psychological Bulletin

22) Scandinavian Audiology

23) Seminars in Hearing

24) Seminars in Speech and Language

25) Volta Review

*Category 2*

1. American Journal of Psychiatry
2. Audiology
3. Biological Psychiatry
4. Brain and Language

5. Developmental Medicine and Child Neurology
6. Electroencephalography and Clinical Neurophysiology
7. International Journal of Psychophysiology
8. Journal of Speech and Hearing Research
9. Neuropsychologia
10. New England Journal of Medicine

Information from these articles are classified chronologically under various columns in different chapters, depending on the tests used to assess auditory ability. Following are the chapters :

Chapter 1 : ABR findings in autistics

Chapter 2 : ERP findings in autistics

Chapter 3 : Auditory processing in autistics

Following are the various columns under which the articles are tabulated; according to chronological order

.Column 1 - Author/year

Column 2 - Purpose of the study

Column 3 - Diagnostic Criteria / IQ

Column 4 - Subject variables

Column 5 - Tests/Instrumentation'Parameters

Column 6 - Procedure

Column 7 - Results

Column 8 - Remarks.

Effort was made to analyse all the articles to (1) determine if there are audiological deficits in autism and if present what are the various findings. (2) To find reliable test/test battery in evaluating autistic children if they have audiological processing and/or attention deficits.

## AUDITORY BRAIN STEM RESPONSE FINDINGS AUTISTICS

| Author/year | Purpose of the study | Diagnostic Criteria/IQ | Subject variables Experimental Group | Control Group | Te st/ Instrumentation /Parameters |
|---|---|---|---|---|---|
| 1. | 2. | 3. | 4. | | |
| Courchesne, etal. (1985) | To examine the functioning of the brainstem auditory pathway in non-retarded autistic individuals by recording event-related brain potentials generated by the auditory pathway. | DSM-III (1980) Nonverbal IQ scores: 70 + | Non-retarded autistics<br>N:13<br>Mean age:(years)<br>19.8<br>Age range: (years)<br>14-28 | Normal<br><br>14<br><br>19.4<br><br>14-28 | 1msec.click stimuli presented through earphones.<br><br>Bandpass setting -.150-3000 Hz.<br><br>Averaging was done for 1500 responses. |

| Procedure | Results | Remarks |
| --- | --- | --- |
| 6 | 7 | 8 |
| Presentation rates : 7,37, and 67 times/sec on different runs.<br>Intensity levels : 70, 50, and 30 dBHL | All autistics and normal control subjects showed normal auditory brainstem ERP responses across the conditions of rate of stimulation intensity, ear of stimulation. | This study gives a clue that there is unlikely tobe a disorder in the auditory brainstem pathways that generate ERP components andthat autism is not dependent upon disorder in the auditory brainstem pathways. |
| Monaural stimulation was done for both ears. | Absolute latencies of waves I, II, in and V and interpeak intervals I-III, III-V and I-V differed between subject groups. | |
| Rarefaction clicks were given except for 70dBHL level. | Wave I-Vamplitudes did not differ between groups. | The neural systems responsible for autism in the non-retarded individuals may include other systems within the brainstem as well as systens outside the brainstem. |
| Recording were done at Cz, Al & A2. | | |

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| Gillberg, etal. (1987) | To collect comprehensive neurobiological data on a group of autistic and autistic -like children. | DSM-m IQs measured on Griffiths' scale and wise Scores 60+ (Normal/ near normal IQs.) | Autistic N: 17(14M 3F)and 3 other males with Asperger syndrome (AS). | Examination of ears and ABR done as part of a batten" of evaluations. |

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| ABR : Results outside 3 SD variations around the mean of normal children were included to indicate abnormality. | 4 16 children examined showed abnormal ABR.<br>1/3 AS and 2 IA showed prolonged brainstem tansmission time.<br><br>1 LA showed prolonged inter-aural time difference.<br><br>3/4 IA and one fragile X abnormality showed prolonged brainstem transmission time. | None of the autistics were detected due to suspicion of organic factors.<br><br>The number of cases of 'non-organic' autism even among children with relatively higher IQ, reduces when a test battery appraoch of neuro-biological assessment including ABR, CAT scan, EEG etc. are used.<br><br>Future research might show that even IA without mental retardation is a heterogeneous group of conditions with varied aetiology. |

3SD: Standard deviation.

IA: Infqntile Autism.

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| Jure et al. (1991) | To describe the drnical features that characterized autistic children with multiple disability - with different etiologies like eneephalopathic insult congenital rubella, bacterial meningities, microcephaly, epilepsy, hard and soft neurological signs. | DSM III-R (American Psychiatric Association, 1987) | Autistic N:46 [30m, 16 f) Mean age:5 years 6 months. | Puretone audiometry was done and AERs were also recorded as part of a test batten'. |

| Procedure | Results | Remarks |
|---|---|---|
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| Sensitivity of hearing impairment was categorized as mild (25 to 44) dB, moderate (45 to 69) dB or profound (> 90 dB), average threshold for 0.5,1.0 and 2.0 kHz in the better ear. | Diagnosis of hearing impairment and autism as made in 46 children :<br>Diagnosis of hearing loss and autism was made at 2 years, hearing loss alone at 2 years, autism alone at 4 years.<br>In 19/46 children, both the disorders, diagnosed within 18 months of each other.<br>In 21/46, hearing loss was diagnosed 18 months before autism.<br>* One boy was diagnosed with mild progressive hearing loss at 12 years.<br>8 children showed moderate loss. 14 severely impaired, and 23 profound hearing loss.<br>* 5 children's hearing loss with mental deficiency was overlooked as lack of language reaction to sound were attributed to autism. | Reliable hearing test, like ABR impedance audiometry should be done repeatedly in all children with inadequate language when mental deficiency or autistic behaviours are present, for differentiating hearing loss from autism. |

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| Ornitz, etal. (1974) | To study the recovery cycle of the average auditory evoked response of autistic children during sleep. | Not specified | Autistics Normals<br>N:28 23<br>Mean age (months):<br>50.4 48.4<br>Age range (months):<br>30-68 22-67 | Clicks generated by a Grass S4 stimulator using a 1.0 msec, pulse, delivered through a loud speaker.<br><br>800-2200 responses were summed to single clicks & paired clicks for Stage 2 sleep.<br><br>500-1200 responses were summed for REM sleep. |

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| Presentation level of clicks was 60 dB above normal hearing threshold.<br><br>Recordings were done and latencies and amplitude of wave N2 to single click response (Rl) and responses to paired clicks (R2) were measured.<br><br>Peak latencies and peak to peak (P2-N2) amplitudes of wave N2 of both Rl and R2 were measured.<br><br>Recovery ratios (R2/Rl)of wave N2 were computed for within pair stimulus separations of 250,160, 80 & 40msec. | There were no significant differences between the autistic and the normal groups in terms of recovery ratios (R2/R1) in either Stage 2 or REM sleep at within pair- stimulations of 250, 160, 80 and 40 msec.<br><br>Disordered modulation of sensory input in autistic children is either not reflected in the recovery process or is not apparent during sleep. | Recovery cycle of the most prominent wave N2 of AER during sleep is not a measure of the disability of pathological reactions of autistic children to sensory stimuli. |

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| Rumsey, etal. (1984) | To examine ABR in pervasive developmental disordered(PDD) subjects. | DSM-III(APA 1980) Neurological evaluation, case history along with direct exami-nation were used to deter -mine diag-nosis. | PDD N:25 (23 M, 2 F) Age range (years) 5-40 | Normals matched for Number age, sex | PTA for frequencies (250-8000) Hz. Thresholds estimated for spondaic words, supra-threshold speech using NU-6 list. * |

* Acoustic immittance and reflexometry done.
ABR : Amplaid Mark V auditory evoked potential unit (Audiostimulator AS-500, Physiological Amplifier PHA-501, pre-amplifier 601, TDH-49 headphones) used. Stimuli: Monaural filtered (bandpass 200Hz) click train of rarefaction and alternating polarity. Amplified data graphically recorded by Tektronics 4061 hard copy unit.

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| ABR: Potential recorded differentially between ipsilateral earlobe and vertex surface electrodes with contralateral earlobe acting as ground.<br><br>Stimulus rate : 11/sec. duration 100 ms.,, ISI 90.9 sec. at peak equivalent sound pressure of 110 dB=80 dBnHL.<br><br>Waves I, in, V identified for each run by 2 experienced independent raters using a 5 point scale level of confidence. | 20/25 PDD (80%) subjects showed normal puretone thresholds. (20 dB or less). 4 showed mild bilateral hearing impairment (25-40) dB. One could not be evaluated on behavioural testing.<br><br>Tympanometry: 16 subjects (64%) showed normal results. 6(24%) showed abnormal results in one or both ears.<br><br>Acoustic Reflex: Bilaterally normal in 16 subjects (64%)<br>Absent in 5 ears (secondary to ME pathology).<br>Absent in 4 ears in presence of normal ME functions. | These results fail to replicate previous studies, like Sohmer and Student (1978), who reported prolonged brainstem transmission timeincluded neurological cases. This study excluded subjects with identifiable neurological syndromes and disorders. The fact that shortened and prolonged transmission times seen in this study argues against an interpretation of specific brainstem pathology. |

ISI : Inter- stimulus -interval•

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| | ABR: No significant group differences were seen in absolute wave I or V latencies for click phase. PDD group showed significantly shorter wave III latencies for alternating clicks. Significant group differences in transmission times were as seen in I-III interval for both click phases and I-V interval for rarefaction click only. PDD showed significantly shorter I-III transmission time than normals. PDD group showed a significantly shorter mean I-V transmission time in rarefaction conditions, 5 PDD subjects (20% of PDD group) and 1 normal control showed at least 1 abnormal transmission time. 1 subject showed one or more prolonged transmission times while 4 autistics showed one or more shortened transmission times. | |

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| Sohmer& Student (1977) | Torecord the auditory nerve and brainstem response in infant and children with various types of psycho-pathology, inorder to search for electrophysiological signs of underlying brain lesions. | Criteria common to Kanner (1943) & Creak (1963).<br>IQs estimated 40+ | Autistics: N:13<br>Age range (years) 4-12<br>Normals N:18<br>5-10 years<br>MBD* N:16<br>3-11 yrs.<br>Psycho-motor retardation N:10<br>2-5 yrs. | ABR: Click auditory stimuli.<br>Filtered bandwith: (250-5000) Hz<br>1024 responses averaged. |

* Minimal Brain Damage.

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| Prsentation rate : 10 or 20/sec. with maximum intensity level at 75dBHL.<br><br>Monoaural stimulation done for bothears. Recordings for experimental groups done on sedation vs. recordings done in control group during awake state.<br><br>Electrical activity recorded betweenearlobe clip and scalp vertex disc electrodes. | ABR; 4/13 aun'stics showed profound cochlear loss.<br><br>9/13 autistic s showed normal wavefoms 2/10 psychomotor retards showed absence of waves IV and V (8/10 showed normal waveforms).<br><br>Absolute latencies of wave I increased in the experimental groups as follows: Normals < autistics <MBIXpsycho motor retardation.<br><br>Brainstem transmission time (I-V) for all experimental groups were significantly different from normal controls. | It is not clear whether these groups lie along a continuum with respect to these responses or whether they are distinct groups.<br><br>The abnormal deviant responses present electrophysiological evidence for the presence of functional or structural brain damage. |

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| Steffanburg, (1991) | To judge underlying brain pathology in autism by a host of in vivo clinical and laboratory examinations of a representative, population based group of children with distinctly defined infantile autism/autistic disorders (AD) and autistic like conditions (ALC) | DSMIIIR(AMA 1987). DSMIII(APA) and descriptions of Rutter(1978) Coleman and Gillberg(1985). | Autistic disorder AD N:35 (30M, 5F) Age range(years) 2-12 | Autistic like conditions (ALC) 17(9M, 8F) 3-12 | A battery of neuropsychiatric and neurobiologic assessment were done. Audiometry and ABR done as part of neurobiological assessment test battery. |

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| Thirty eight of the children in the combined AD/ALC group were given comprehensive audiologic evaluation for behavioral thresholds.<br><br>AD and ALC groups were examined withABR<br><br>- | Behavioural thresholds:<br>AD group: 5 subjects (4 M, IF) showed moderate hearing deficits.<br>ALC group: 3 showed hearing deficits.<br><br>1 (male) was totally deaf. 1 showed severe hearing deficit. l(female)showed moderate hearing deficit.<br>Hearing deficits were postulatexto be of neurogenic origin<br><br>Four children were recommended hearing aids.<br><br>ABR: 8/21 AD and 2/11 ALC children showed clear abnormalities.<br><br>6 showed prolonged brainstem transmi- ssion time, 3 had abnormally low amplitude of wave V and 2 showed pathologicalinteraural time difference one of whom also had low amplitude wave V. | This study, througha battery of neuropsychiatric and neurobiologic examination arrives at the organicity and multiple etiologies in autism.<br><br>Autism and autistic like condi- tions are neurobiologjcally very similar.<br><br>Audiological evaluation including ABR also contributes to the implication that autism and autistic like conditions should be now accepted as a central nervous sysem affliction. |

## EVENT RELATED POTENTIAL FINDINGS IN AUTISTICS

| 1. | 2. | 3. | 4. | | 5. |
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| Buchwald, et al. (1992) | To find the middle auditory evoked responses in autistic subjects. | ICDS:Russell, etal. (1989) and DSM-ni(1980) | Autistic<br>N.ll<br>(males)<br>Mean age(years)<br>25.7<br>Age range (years)<br>17-39 | Normals<br>N:ll<br>(8M,3F)<br><br>23.4<br><br>20-30 | Click stimuli (0.1 msec duration) delivered binaurally through Sony Nude earphones. Response averaging was done in 250 trial blocks. |

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| Presentation rates: 0.5,1, 5,8 and 10/sec. were used.<br><br>Presentation level: 55 dB HL<br><br>Recordings done at Cz referenced to linked mastoid electrodes through one amplifier and referenced to linked sterno-vertebral electrodes thr ough a second amplifier. | Pa component was present in both control and autistic groups.<br><br>PI component in autistic subjects : reduced.<br><br>1/11 autistic subjects showed P1 normal (50-65) msec. 2/11 showed earlier positive peaks (40-50) msec. 8/11 showed no clearly defined middle latency component following Pa. Pa in both groups,not affected by increased rate of stimulation. At slow rates, autistic P1<normal controls. | Autistic Pa suggests normal function of the auditory cortex.<br><br>Lack of decrement of autistic P1 to rapid click rates shows an abnormally fast recovery cycle. |
| | At rates further than one/sec, nofurther reduction in amplitudes in autistic vs. reduction / disappearance of amplitudes in controls. Significant difference in PI amplitude between autistic and controls indicates dysfunction within the generator system. | |

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| Ciesielski, et al. (1990) | To study ERP and behavioural measures of selective attention in non-retarded autistic normal individuals during auditory and visual focussed selective attention tasks. | DSM-IIIR (1987) IQ assessed on WAIS-R Autistics showed average IQ | Autistics Normal<br>N:10 N:13<br>(males) (12M, IF)<br>Mean age (years)<br>20 23<br>Age range (years)<br>18-26 !7-26 | ERP: Stimuli were two tones of 1kHz and 2 kHz triangle waves, presented binaurally through Sennhaiser HIM 14 headphones against white noise. Green and red color flashes of 16 cd/m2 against 3cd/m2 were also presented. Amplification of wave-forms by Grass amplifier set at bandpass of (0.1 - 50) Hz. Analysis of wave forms by computer. |

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| Electrode placement: Scalp location of (FPz, Fz, Cz, Pz,Oz, F7, F8, F3, P3, & P4) of the international 10-20 system. All electrodes were referenced to linked mastoid electrodes. Nd (100-700) msec. atFz, visual N270 and P400 at Fz & Pz, auditoryNc(400-650)msec. atFz, P3b at Fz were measured<br><br>Presentation level of auditory stimuli was 72 dB SPL against 60 dB white noise.<br><br>Stimulus assignment: 10(rare) high sounds, 30 (frequent) green | ERP : Auditory and visual standards (attend ed standards minus unattended standards): Auditory Nd, Nc, absent in autistic<br><br>Nosignificant differences in latencies and amplitudes of N270 and P400 between groups.<br><br>Auditory and visual rares: Attention related difference waves to auditory and visual rares (NC) was smaller in autistics compared to normals. P3b was significantly diminished in autistics.<br>ERP abnormalities were greater for auditory modality in autism. | Dissociation between attentional performance and the ERP components provide strong evidence that autistics have different neurophysiology compared to normals. |

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| flashes were presented for half subjects.<br><br>Blocks of 30 (frequent) high sounds, 10 (rare) low sounds, 30 (frequent) red flashes and 10 (rare) green flashes were presented for next half.<br><br>Experimental conditions:<br>(1) focussed auditory attention condition:<br>(2) focussed visual attention condition:<br>subject required to press button only to the rare auditory and visual stimuli (targets) rspectively. | | |

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| Ciesielski, et al. (1995) | To determine the pattern of brain activity in high functioning autistic subjects in a cross modal divided attention paradigm. | DSM-m-R IQs within normal range onWAIS-R. | Autistics<br>N:8<br>(5M,3F)<br>Age range (years)<br>15-31 | Normals<br>N.8<br>(5M,3F)<br><br>16-33 | ERP: Auditory stimuli presented binaurally over Rastronics E-A-R Tone 3 A headphones. Recording by ERP instruments, amplified by Grass amplifier set with 60 Hz. notch filtered at effective band pass (0.1 to 50) Hz half amplitude digitized at 195 Hz. |

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| Behavioural measures of accuracy and reaction time (RT) were obtained.<br><br>ERP : Scalp locations (Fz,Cz, Oz, F7, F8, F3, F4,P3 and P4 of International 10-20 system) used for electrode placement. Left ear lobe served as reference.<br><br>Stimuli: Sequences of two visual and two auditory stimuliwere randomly ordered; green and red flashes, 1 kHz, and 2kHz tones. All stimuli were presented in blocks of 80 and 50 msec. duration with ISI between 500 and 1500 msec. Each block consisted of 10 (rare) | On behavioural measures : control group showed similar false alarm rates under focussed and divided conditions while autistics showed higher false alarm rates under focussed than divided Autistics also showed lower signal detection measure, d (sensitivity).<br><br>Auditory: Nde & Ndl: autistic group showed > negative Ndl to ignored than divided attention condition.<br><br>SNW: No modulations seen in autistic group vs. highest amplitude in focussed attention, intermediate in divided attention, and lowest in ignored condition as seen in normals. | More pronounced positive ERPs for visual than auditory modality indicate a higher performance in the visual modality. ERP research into visual processing and positive ERP components in addition to auditory ERP components may help identify cognitive areas preserved or specifically developed in autism. |

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| highsounds, 30 (frequent) low sounds, 10 (rare) red flashes and 30 (frequent) green flashes. Data was obtained in 3-task conditions:<br>(1) focussed visual (FV),<br>(2) focussed auditory (FA),<br>(3) Divided auditory /visual.<br><br>Auditory Nde,Ndl (300-600) msec, SNW (440-660) msec, P3b (270-500) msec, visual N270(80-290) msec, P400 (250-420) msec, were analysed. | SNW failed to show effects of cross-modal divided attention in autistics, thus, indicating voluntary information processing may result from abnormalities on the level of a central modality, independent, ditributor of attention sources.<br><br>P3b: Amplitude greater in focussed than ignored condition in both the groups. Significant effect of task was seen in the visual modality, a less strong but significant effect was seen in the auditory modality for autism.<br><br>Visual: N270 and P400: N270 did not show attention related modulations but P400 showed greter modulations in focussed and divided conditions than ignored condition in both groups. | |

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| Courchesne, et al (1984) | To compare the ERP evoked by novel and non-novel sounds in a variation orienting response paradigm. | Diagnosis for infantile autism: through history/ face-to-face observations. IQ assessed on Wechsler Intelligence Scales. Mean (IQ) Verbal: 71 Nonverbal: 93. | Autistics N:7 Normals N:7 Both group were age matched within one year of each other. Age range (years) 13-25 | ERP: Beckman non-polarizable electrodes were used for recording. Amplification done with bandpass setting of 150 and 500 cycles per second. Analysis done using ERP instrument. |

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| Electrode placement: Fz, Cz, Pz, according to International 10-20 system, referenced to right mastoid.<br><br>Stimuli: consisted of sounds 'me', 'you', and novel bizarre sounds and presentation, in block of 50.<br>Two condition of'listen' and 'task' were present:<br><br>'Listen condition[1]:3-6 blocks were presented with 90% sounds me', 10% 'you'. Subj ects instructed to listen &were not told what would be heard.<br><br>Task condition: First task block: you' targets occurred 10% of the time and 'me' sounds 90% of the time. | No significant group differences were observed for P1 and N1 amplitude. Group differences seen in terms of reduced amplitudes in autistics for A/Pcz/300, P3b, A/Ncz/800 suggesting less signal processing in autistics. Larger latency for SW to targets seen in autistics. Novel probes evoked larger amplitudes for all above mentioned potentials in both groups. Autistics showed selective lack of enhancement of P3b to task-relevant,target stimuli which could indicate neurophysiological abnormality in P300 generator sites. | In this study certain ERP components are found to be similar in both groups especially with regard to novel information processing: indicating that certain neural substrates in autistics are similar to normal controls.<br><br>Longitudinal studies of ERP components in non-retarded autistics and retarded autistics, and comparing them with normal controls would help finding differences in sequences of abnormalities between these two sub-groups. |

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| remaining (6-9) blocks: 'you' targets were presented 10% of the time, me' sounds were presented of the time Remaining | | |
| 10% were novel sounds. In each block all sounds were randomly ordered.<br><br>Nl (70-160)msec, P2 (140-240)msec, A/Pcz/300 (250-350) msec, measured at Cz and P3b (280-420) msec, at Pz, SW. Following P3b at Cz or Pz and A/Ncz/800 (600-1000) msec, at Cz were analysed. | | |

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| Dawson, et al. (1989) | To compare hemispheric assymmetry of averaged evoked potentials to speech stimuli in autistic & dysphasic children. | Diagnostic evaluation and administration of childhood Autism Rating Scale (CAR-S). All subjects met DSM-III criteria.<br><br>IQ scores based on standardized intelligence testing showed mean of 71.<br><br>Language was also assessed using PPVT, NSST-R, NSST-E & sub-test from Wechsler Intelligence Scales. | Dysphasics / Normals<br>N:10 / N:10<br>Mean age (years)<br>10 / 10.2<br>Age range (years)<br>6-15 / 8-13<br><br>Autistics:<br>N:10<br>10.2 years<br>8-13years | PTA: Puretone audiometric screening was done for all subjects.<br><br>Auditory Cortical Evoked Potentials: Stimuli: Computer generated square pulse of 300/ sec. Signal bandwith, filtered (0.5-70) Hz. using 2 pole filter.<br><br>Averaging done by Nicolet Pathfinder II Evoked Response System. 50 responses averaged. |

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| Electrode placement:<br>Cz (vertex) between C3 & T5 (left hemisphere) and midway between C4 & T6 (right hemisphere). Linked ear electrodes served as reference and FPz ground.<br><br>Stimuli: Auditory stimuli(80% clicks, 10% speech stimuli Da' and 10% musical chord stimuli) were presented binaurally. Subjects were required to listen and raise hand upon hearing the sound Da'.<br><br>Latencies & amplitudes of P1, N1, P2, N2 & P3 were studied. Peaks were identified by 3 raters indepen-dently according toa 5 point confi-dence rating. | Normal group: Significant hemis-pheric assymmetries was seen for component (Left > Right).<br>Autistic group: Significant hemispheric assymmetries were seen for N1 latency (right>left hemispheric activity tospeech related cortical potentials).<br>Dysphasics: No significant hemispheric differences.<br><br>In Autistics: Poor language abilities were associated with increased right hemisphere Nl amplitude & shorter right hemisphere Nl latency (superior language abilities were associated with decreased right hemisphere activity). Language ability was not associated with left hemisphere evoked measures for autistic subjects. | Over activation of the right hemisphere may be interfering with normal, left hemisphere language processing in autism and this abnormality in cortical activation may subside as language improves (Dawson,1987,1988; Dawson &Lew,l989;Kinsbourne, 1987).<br><br>hi order to determine whether atypical patterns of hemispheric activity to functions such as language, comparison with a wide variety of task stimuli and behavioural measures are needed. |

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| Kemner, et al. (1995) | To study auditory event related brain potentials in autistic children and three different control groups.<br><br>Abnormal lateralization pattern of ERPs, manifestation of MMN were studied. If present, whether differences between autistics and normals were specific to the autistic group. | DSM-III for infantile autism-(299.00)<br><br>ADDH (314.01)<br>Dyslexia (315.00)<br><br>Diagnostic evaluations: child psychiatric and psychological obser-vation & neurological observation.<br>Tests used for autistic grouprChildhood Autism Rating Scale (CARS) & Wing-scale.<br>IQs were determined onWISC-RN.<br>Autistic group showed borderline IQ. | Autistics<br>NJ20<br>(16M.,4F)<br>Mean age<br>9.8 | Normals<br>N:20<br><br>(years)<br>10.6<br><br>ADDH<br>N:20<br>9.9 years<br><br>Dyslectics<br>N:20<br>10 years | N1,MMN,P3: Speech stimuli generated by a speech chip used: presented through earphones.<br>Amplification & filtering by Elema Universal Filters.<br>Low pass filter setting of 30 Hz. Signals sent to PDP11/23 computer for online analysis. |

ADDH : Attention deficit disorder with hyperactivity.

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| Scalp locations of electrodes F3,Fz, F4,C3,Cz,C4,P3,Pz, P4, 01, Oz,O2 according to 10-20 system. Linked ear lobe electrodes (reference) & FPZ (ground).<br><br>Oddball task were used with 3 different stimuli.<br><br>80% frequent stimuli (standard) : Phoneme oy'.<br><br>10% infrequent stimuli (deviants) :Phoneme'ay[1].<br><br>10% infrequent stimuli (novels): complex sound: bbrrzzz. | No significant difference in absolute amplitudes were found between autistics & control groups for N1.<br><br>No signs of abnormal processing of MMN in autistics.<br><br>Difference with respect to controls seen for P3 to task relevant stimuli.<br><br>It has been speculated that the occipital lobe of autistics develope abnormally in terms of auditory sensitivity to auditory, task relevant stimuli. | This study indicates that it is possible to use occipital cortex in processing of auditory stimuli in case it has not normally developed. Findings seem highly specific to autistic group. No indication of abnormal ERP lateralization. |

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| Stimuli were presented under active and passive conditions.<br><br>Total no.of stimuli: 140; 14 standards followed by a deviant stimuli.<br><br>Other infrequent stimuli (deviants & novels)were semirandomized with IS Is between 4 and 6 sees).<br><br>Duration of standards and deviant stimuli (novels) were 300ms and 360ms.<br><br>Presentation level: 67 dB.<br>ERP peaks were scores relative to 100 ms. pre stimulus level.<br><br>Nl (50-120) msecs, P3(300-700) msecs. and MMN (scored as a difference wave between infrequent stimuli & immediately preceeding standards in latency window (150-325)msec)were studied. | | |

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| Martineau, et al. (1992) | To evaluate auditory evoked response amplitude & variability in an auditory-visual association paradigm in autistic children. | DSM-III-R(1987) On the psycho-motor developmental scale Brunet-Lezuie Mean verbal DQ:40 Mean non-verbal DQ:50 | Autistic N:17 (11M,6F) Mean age (years) 5.3 Age range (years) 2.6-8.3 | Normals N : 17 Matched for age & sex | Tone burst stimuli was presented through speakers. PBP 11/24 computer was used to average 20 responses for AERs. |

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| Recordings were done from Cz & Oz electrodes loci.<br><br>Reference electrodes were placed on earlobes.<br><br>AERs were recorded for tone burst stimuli(750 Hz tone burst, 100 msec. duration, 20 msec, rise time)with distance of ear from source, 35 cm horizontally and flash of light presented 30 cm from subjects face.<br><br>Prsentation level of tone burst was 50 dB SPL.<br><br>AERs were recorded on 2 consecutive days. | Cz and Qz rsponses were smaller in autistics.<br><br>SNR (Signal to noise ratio) was used as an "index of associative abilities". Variance of the ratio values > in the autistics. Dispersion of ratio values differentiated 3 subgroups of autism. Subgroup I (5 children) showed high SNR responses at Oz for (SI). Subgroup II (8 children) showed absence of response at Oz for (S1). Subgroup III (4 children) showed absence of response at both Oz & Cz.<br><br>Results indicate different patterns of ability to form cross-modal associations. | Subgroup III showed greater index of ability suggesting that autistic children attend to one selected stimulus at a time referred to as' stimulus over selectivity". The differences observed in the ability to form cross-modal associations can be related to differences in the main psycho-physiological functions such as attention, intention, motility, association, contact and communication. |

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| Day 1: weaktone burst (SI) was presented alone in first 60 trials, i.e. (SI, dayl,l-60) A strong flash of light was presented 800 msec, aftertrials 61- 180: (SL1, day 1).<br><br>Day 2: Strong flash was presented after (SII) in trials 1-120: (SLII, day2). The weak tone burst was then presented alone in trials 121-180: (S2,day2).<br><br>Inter-trial intervals varied randomly between 4 and 12 sec. | Subgroup I: hyper-responsiveness to single stimuli and global inhibition during complex stimuli.<br>Subgroup II: showed similar abilities to normal children, indicating presence of cross-modal association process in some autistic children.<br>Subgroup III: showed greater index of ability in cross modal association.<br><br>hi terms of disturbed attention:<br>Subgroup I > Subgroup II > Subgroup III | |

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| Oades, et al. (1988) | Tofind if there are difference in event related potentials in an attention demanding auditory choice reaction time task between autistics and normal controls. | DSM<br>IQ was measured: Leiter & British Ability Scale (B AS) tests.<br>Mean IQ for autistics: 90 | Autistics<br>N:7<br>(6M, IF)<br>Mean age (years)<br>11.33 | Normals<br>9<br>(8M,1F)<br>Matched forage. | Puretone audiometric and Immittance screening was done.<br><br>ERP: Computer generated pseudo-random sequences of 3 puretones were given through (TDH-49P) earphones.<br><br>Grass P51 IK amplifier with upper and lower half-amplitude cutoff of 30 and 0.01 Hz was used. Notch filter of 50Hz was used at an EEG amplification of (5x $10^4$ ).<br><br>On line analysis of data was done by 11/73 computer. |

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| ERP: Prsentation level:<br>3 pure tones (500 Hz, 1000 Hz & 2000 Hz) of 10msec. rise-time 100msec. plateau, 10 msec, fell time, was presented at 50 dB SL against a background white noise of 20dB SL (withintertrial interval of minimum 500msees & maximum 1300msecs.)inan auditory choice reaction time task.<br><br>Tones were presented in 140 trial-blocks lasting 4 minutes in both passive & active conditions.<br><br>ERP recordings: EEG was recorded from tin electrodes located in frontal (Fz)., central (Cz), parietal (Pz) and lateral sites (F3, F4, P3, P4). Forehead electrode served as ground, referenced to linked earlobes. | Autistics showed shorter reaction times (J3) and (d') indicative of impulsivity and overselectivity.<br>ERP in autistics : varied scalp distribution for maximum ERP peak amplitudes were seen.<br>Nl latencies were shorter and P3 latencies longer than for control groups.<br>Nl amplitudes were longer(to non targets ) attributable to increased responsiveness.<br>P3 amplitudes were smaller (to targets) compared to normals.<br><br>Slow wave (S W): Early average negativity (SW1,0-400ms, Fz) and late average positivity (SW2,650 900 ms, Pz) were not significantly different in both groups. | P3 not maximizing at Pz could be indicative of delayed development of P3.<br>Clearer frontal Nl and lateralized responses at parietal sites might be reflective of greater neural synchronies within these two areas.<br><br>The evidence for unusual activation in both hemispheres of autistic children seems to indicate a dysjunctive coordination of cerebral activity between the 2 hemispheres with respect to earlier and late stages of information processing. |

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| Data Analysis : Peak measures of (latency, amplitude) were computed from voltages averaged with respect to 100msec. pre-stimulus epoch.<br>N1( 120-240); N2 (240-400);<br>PI (50-150);P2 (150-300),<br>P3 (300-600), P4 (600-900),<br>SW (650-900) msec.were analysed.<br><br>Reaction time, signal detection measures : criteria ($_1B$) and sensitivity ($d^1$) were also measured. | Lateralization of ERP:<br>After target and non-target stimuli, N1 latency ws longer and P3 amplitude was larger in the right hemisphere for autistics. | |

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| Ornitz, et al. (1968) | To compare AERs in normals and autistic children during Stage 2 and REM sleep. Amplitudes and latencies of wave N2 were compared during these different sleep stages. | Clinical descriptions of Ornitz & Ritvo( 1968) and Kanner(1943, 1949). | Autistic N:23 Normal N:26<br>Age range (years)<br>Autistic 1.10-8 Normal 1.7-12 | Click stimuli with 1.0 msec. pulse duration was generated by a Grass S4 stimulator.<br><br>Stimulus : amplified by a loud speaker 5 ft above the head of subject's bed.<br><br>Grass-16 channel electro-encephalograph with filter setting l-35c/sec. used for AER recording.<br><br>AER averaging: 100 responses were averaged with Enhancetron model 800. |

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| Presentation level: 80-90 dB above normal hearing threshold.<br><br>Recording of AER was done Cz-Ol andCz-O2. | On comparison of AER during Stage 2 and REM sleep in normals and autistics, mean latency of N2 were almost identical. On comparing means of the ratios of , amplitude during REM sleep and Stage 2 sleep, that was a relative increase in N2 in REM sleep in autistics as compared to normals (more significant in males). There was an inhibition of N2 wave during eye movement burst phases ofREM sleep. | N2 wave of AER in man is measure of change of state and is normally inhibited during vestibular mediated occular activity of REM sleep. This. inhibition is overridden in autistics. Hence, vestibular dysfunction in these children may be related to central nervous system dysfunction in adequate regulation of the secondary elaboration of information, received over afferent pathways (as indexed by N2). |

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| Strandburg, etal. (1993) | To study the performance & ERP pattens of high functioning autistic adults on linguistic and non-linguistic information processing tasks. | DSM-m<br>Mean IQ on WAIS scale: 95.5 | Autistic Normals<br>N:13 13<br>(12M,1F)i (12M,1F)<br>Mean age (years)<br>24.4 26.2<br>Age range (years)<br>17-38 18-39 | Behavioural tasks : Of a behavioral task battery (SPAN, CPT and IRT), Idiom Recognition Task (IRT) was used to probe language processing.<br><br>ERP: ERP recordings done; tin electrodes with impedance < 5 ohms at 30Hz. Amplification was done 14,000 times, with filter setting (0.1 - 30) Hz data was digitized, stored & analyzed online. |

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| International 10-20 system leads referenced to linked earlobes (Pz, Cz andFz on the midline; 01, P3, T5, C3, T3, F3, F7 and FP1 over left hemisphere; and homologous locations over the right hemisphere) were used.<br><br>Stimulus presentation: 160 common words used to construct 40 meaningful literal (L), 40 meaningful idiomatic (I) and 80 nonsense (N) two word phrases. Words were between 3 & 8 characters long and were presented 100msec. with an interstimulus interval of 500 msec. I, L and N were presented randomly with inter phrase interval of 4.0 sec. Subjects wereindicate meaningful of phrase. Raction time (RT) was also measured. | CNV: Austitic CNV > control group. (not statistically significant).<br><br>N400 : In both groups, N400 was largest for (N) and smallest for (I). The 2 groups did not differ significantly in N400 when (N) was compared to (L), but differred significantly when (I) was compared to (L) i.e. there was significant increase in amount of N400 generated from (I) to (L) in the autistics.<br><br>Results indicate that autistics have significantly more difficulty judging the meaningfulness of2-word idiomatic phrases, but do not differ from normals in their ability to identify literal or nonsense phrases. | hi this study autistics show less depth of processing of idioms. They may have attached some semantic meaning due to •familiarity but did not process for alternative literal meanings. Performance on the information processing task which do not require linguistic cues was entirely normal. Deficits are apparent thus, only in the processing of language (comprehension of figurative language): 2 core feature of autism. ERP differences reflect difference in the cognitive processing of those idioms recognized as familiar and meaningful in the autistics. |

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| CNV: was obtained, amplitude measured at Cz. CNV fields were common for all 3 tasks.<br><br>N400: Peak amplitude and latency were measured at (F3, Fz. F4, C3, Cz, C4, P3, Pz and P4). | | |

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| Robier, et al. (1983) | To study auditory brainstem response and cortical auditory evoked potentials in difficult to test children. | Behavioral summarized evaluation (BSE) according to DSxM-III(APA) was used to quantify the behavioral problems.<br><br>Suspected deafness, h\pothyroidism, & Laundau's Syndrome formed the diagnosis in some children in addition to behavioral problems. | Autistic<br>N:24<br>Mean age (years)<br>6.6<br>Age range (years)<br>2-14 | Otoscopic & tympano-metric impedance tests done.<br><br>BER: Alternating click stimuli duration 100 / sec. was delivered through TDH-39 earphones. Electrodes were connected to Nicolet amplifier, bandwidth (150-3000) Hz. Averaging was done for 12 minutes. |

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| | | | | Cortical AEP: Filtered click 100 msec.duration was delivered by an Audiostim Alvar Electronic apparatus Signals were amplified |
| | | | | by Alvar Electronic a-c amplifier bandwidth (0.1-100 Hz 30dB par octave). Averaging was done by Digital mopev 4-Alvar Electronic analyser. |

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| BER: Electrode placement (vertex, mastoid).<br><br>Stimulus rate :30/sec. Presentation level started with 100 dBnHL and decrements in 10 dB steps presented monaurally.<br>Absolutely latency differences were studied. | BER: The children were divided into 3 categories based on absent BERs, lenthening of latencies & normal BERs.<br>One child (originally suspected to be deaf) who showed normal BER threshold but I-V interwave latency prolonged and absent cortical AEP showed a typical autistic syndrome.<br>18 children with normal BERs were divided into 3 subgroups. | A battery of tests including BERA and AEP revealed autism.<br>Association of 2 techniques combined with clinical data helped in correcting initial diagnosis. |
| AEP:Electrode placement vertex (Cz). Rt and Lt ear-lobes (common reference), PFz (ground). | Subgroupl:5/10 suspected of behavioural disorders, were finally diagnosed autistic.<br>2 others suspected deaf, showed an autistic syndrome. | |
| AEP : recorded with stimulus level at 80 dBnHL.<br><br>Pl(30-50)ms,Nl (80-100)<br>P2 (130-180) ms were studied. | Subgroupl : 2/4 suspected for behavioral disorder who's AEPs were normal but diphasic, showed some autistic features.<br>One suspected deaf, showed an autistic sydrome. ** | ** Subgroup III: 1/4 suspected for behavioral disorders, whose AEPs were unidentifiable showed autistic syndrome. |

**AUDITORY PROCESSING EV AUTISTICS**

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| Lincoln, et al. (1992) | To evaluate the short term auditory memory and rapid acoustic processing skills of adolescents & young adults with development receptive language disorder of autism to determine whether either or both of these skills are deficient. | DSM-III(APA 1980) &DSM-III-R (APA 1987) were met-for subjects with autism and DRLD*. Mean Weschler Verbal, Performance and Full Scale IQ scores showed borderline IQ for both autistics and DRLD. Battery of selected language tests like PPVT-R&CELF were administered to further document speech & language impairment. | Autism: N:10 (9M.1F) — Normals: 15 (12M,3F)<br>Mean age (years): Autism 24.4 — Normals 19.9<br>Age range (years): Autism 18-31 — Normals 17-29<br>DRLD<br>N:9<br>(6M,3F)<br>17.7 years<br>15-20 years | Computer generated tone sequences of 100 Hz and 300 Hz were used. Subjects responses recorded by computer and analysed. |

•Developmental Receptive Language Disorder (DRLD)

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| Phase 1:Subject was trained for press response button for tone 1 and tone 2, and later for random presentations. Subject further had to respond for 10 consecutive trials correct or 18/24 trials correct to achieve criteria.<br><br>Phase II: Pairs of stimuli were presented in longer sequences (1-1,1-2,2-2,2-1) with pairs of random tones separated by 500 msec. ISI, i.e. SlowTwo;s(S2).<br>Twelve trials of S2 were followed by two tone sequences of shorter ISIs between tones in a pair (randomly intermixed ISIs of 0, 15,20,60 & 150 msec).i.e.Fast twos (F2) were presented randomly. Further increases in tones per sequence (three to seven) with 500msec.or shorter duration ISIs. | All subjects were able to distinguish between the two stimuli and met 60% or better criterion for S2,F2,S3 and F3.<br><br>Two subjects with autism and-DRLD failed to reachthe 60% crtierion at S4. Only 20/34 reached the 60% criterion at S5 & only 17 subjects reached the 60% criterion at S6. All groups produced more errors as the number of tones per sequence increased, and all groups had more difficulty on faster rates than on slower rates. | DRLD individuals have auditory processing deficits into adolescence and young adulthood (short term memory for tone sequences presented rapidly (0-150 msec. ISIs) or relatively slow (500msp ISIs).<br><br>Autistics had relatively less and insignificant deficits. |

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| Ten tones per sequence level were presented for slow or fast rate for 3 item sequence (S3 and F3), for 4,5,6 & 7 (S4 & F4), (S5 & F5) (S6 & F6) ((S7 & F7). 60% correct response criterion was maintained for slow rate before advancing to next level. | | |

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| Wetherby, et al. (1981) | To determine whether empirical measures of central auditory processing for dichotic stimuli might be indicative of problems underlying deviant linguistic systems of echolalic autistic individuals. | Subjects were diagnosed according to U.S. National Society for Autistic Children criteria (Ritvo & Freeman, 1978). IQ not specified. | Autistics N:6 (5M,1F) Age range (years) 8-24 | Battery of audiological tests was administered.<br><br>Monaural hearing tests: Speech Reception Threshold (SRT) & Word Discrimination Scores (WDS).<br><br>Dichotic hearing tests: Staggered Spondaic Word (SSW) Test & Competing Environment Sound (CET) Test |

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| | | | | Commercially available tape-recorded test stimuli were presented through TDH-39 earphones via high quality tape player Viking 433 and diagnostic audiometer (Maico MA-24). |

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| Monaural hearing tests:<br>SRT (using CIDW-1 spondaic word test) was obtained using descending method (5 dB decrement) and WDS (using recorded CID W-22 monosyllabic word test) with presentation level 40 dB above SRT.<br><br>Dichotic tests: SSW& CES test lists were presented 50dB above SRT. Corrected (C-SSW) and adjusted SS W (A-SSW) scores were obtained.<br><br>CES scores were converted to % error scores.<br><br>Good test-retest reliability was present. | Monaural hearing tests : Indicated ' normal hearing sensitivty for speech & word discrimination for all subjects.<br><br>Dichotic tests : 2/6 subjects showed unilateral depressed SSW scores . (C-SSW moderately & A-SSW mildly depressed).<br><br>CES scoinswere good in both subjects bilaterally.<br>Results suggest a dysfunction in the contralateral posterior temporal lobe of the affected ear, excluding the auditory reception area and extending anteriorly to the fronto-temporal region, consistent with level of language comprehension & extreme lack of spontaneous speech. | SSW results indicate cortical dysfunction in anterior motor speech area (Broca's area) in 2 subjects and in/or near posterior auditory association area (Wernicke's area) in 2 others who were highly echolalic.<br><br>These autistics showed language disturbances similar to Broca's and Wernicke's aphasics.<br><br>Measures of central auditory function taken in conjunction with measures of auditory/ vestibular brainstem nuclei and thalamic function may help us to know whether the cortical dysfunction is a primary etiology of the symptoms of autism or a secondary effect of underlying brainstem or thalamic dysfunction. |

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| | One subject showed bilateral depressed scores on SS W (greater errors in competing condition) and CES scores were depressed in the right ear, suggestive of central auditory dysfunction in the left posterior temporal region, possibly extending deeply tothe corpus callosum/ anterior commissure. Diagnosis is consistent with severe language comprehension problem and incessant echolalia.<br><br>Another subject showed depressed right SS W scores (competing condition) with improved scores on subsequent test administration over a year of intensive language treatment. | Application of the SS W test in differentiating subgroups of echolalic autistics (anterior vs. posterior dysfunction) may lead to more effective language intervention procedures. |

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| | Results are suggestive of improvement in posterior and anterior functioning related to improved langauge functioning. Two other subjects who had completed extensive treatment showed normal SS W and CES scores consistent with normal langauge behaviour. | |

# SUMMARY AND CONCLUSION

The mysterious syndrome of autism was identified by LeoKanner in 1943 and termed as infantile autism' in 1944.

Though infantile autism came into the concern of the speech-language pathologist regarding the disturbances of speech and language, not much attention has been paid to auditory behaviour, hearing sensitivity or auditory processing abilities in this clinical population.

Observation of the autistic child's spontaneous reactions to auditory stimuli reveal that autistic children exhibit auditory perceptual problems, varying from a non-reaction to some noises and a catastrophic reaction to others.

Literature has revealed attempts,that have been made to evaluate the hearing abilities of the autistic child using behavioral observation audiometry, puretone audiometry and immittance (Rumsey, et al. 1984; Jure et al. 1991; Steffanburg, 1991).

Efforts have failed to assess the hearing sensitivity using behvioural measures due to the autistic child's lack of responsiveness, demotivation, attention related problems etc. Literature has further revealed the usage of electrophysiological measures like ABR, for threshold tracking and site of lesion as early as the 70's and 80's (Sohmer and Student, 1978; Robier, et al. 1983) however, contradictory findings have been reported : prolonged transmission time (Sohmer and Student, 1978; Robier, et al. 1983; Gillberg, et al. 1987; Steffenburg, 1991), shortened transmission time (Rumsey, et al l984) and normal transmission time (Courchesne, et al. 1984).

Thus conclusive interpretation of specific brain-stem pathology is still questionable. Further, event-related potentials have been used to evaluate the audiological processing deficits/and or abnormal attention in autistics. Conclusive evidence of abnormal event-related potentials can be drawn from literature.

Event related potentials have given information as to the nature and timing of abnormalities in neural processing that underlie abnormal behaviour in autism.

Long latency evoked potentials (endogenous reponses) seem particularly affected suggesting that much of the processing in autism occurs at later stages of perceptual and attentional procesing.

Ciesielski, et al. (1990) found no auditory Nd or Nc in autism, demonstrating that attentional abnormality in autism is not limited to exogenous events.

Greater than normal Nl amplitude in response to rare, non-target stimuli but a small P3 particularly to target stimuli (Oades et al.1988) seems to indicate more responsiveness to objective features of the stimuli rather to meaningfulness or context suggesting alack of top down modulation of brain response, in cognitive terms an impairment involuntary attention and executive function.

Failure of modulation of P3 to differences of sensory modality have been reported. Kemner, et al. (1995) reported larger P3 to auditory stimulus at occipital sites suggestive of occipital areas of the cortex subserving visual processing, becoming activated, indicating failure to restrict activation to regions that subserve relevant modality.

Difficulty in uncoupling the processing of separate modalities was reported by Martineau, et al. (1992) i.e. occipital P3 response established by cross-modal association of stimuli is not maintained in people with autism and he also correlated this with abnormality of social behaviour.

Reduction of P3 amplitude as reported by (Courchesne, et al. 1984; Oades, et al. 1988; Ciesielski, et al. 1990; Kemner, et al. 1995) is suggestive of capacity for normal attentional function in the autistic brain which may be interferred with or abnormally modulated by some other process.

Absent or reversed assymmetry of cortical responses have been found in autism.

Ciesielski, et al. (1995) found divided vs. focussed attention in autism has a greater effect on the frontal slow negative wave and the parietal P3b in the right hemisphere than the left.

Dawson, et al. (1986) found Nl potential evoked by attended phonetic stimuli larger in the right than left hemisphere contrary to normal subjects. This reversed pattern and language ability correlates with the right-left differences in Nl peak latency which is suggestive of increased right hemisphere activation for language processing.

Literature has also revealed auditory processing deficits in terms of short term auditory memory and rapid acoustic processing (Lincoln,et al. 1992).

Central auditory tests have shown dysfunction inanterior and posterior temporal areas of the brain consistent with language deficits in autism (Wetherby, et al.1981).

A test battery approach including neurophysiologic or neurobiologic evaluation including tests like auditory brainstem evoked response audiometry and event related potentials helps in differential diagnosis of hearing loss and autism. Combining these techniques with clinical data have helped in correcting initial diagnosis.

The number of non-organic cases of autism reduces when a test battery is used.

Thus, behavioral, neurophysiological and/or auditory processing tests are able to point to brain pathology as the cause of autism (recent trends have postulated aetiology with reference to brain locus).

Thus, in the light of the literature reviewed, it can be concluded that a wide test battery including and electrophysiological investigation using ABR and event related potentials is the most appropriate approach to the evaluation of auditory and/or attention related deficits in the clinical population of Autism. Since knowledge, skill and practise is very essential on the part of the audiologist in evaluation of this mysterious syndrome, and as limited research has been done in this area, it calls for our attenion to go ahead, take a step forward, to probe into this area which would definitely have promising results in store!

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