NETAJI SUBHAS OPEN UNIVERSITY

B. Ed. Spl. Ed. (M.R./H.I./V.I.)-ODL

ASSESSMENT AND IDENTIFICATION OF NEEDS HEARING IMPAIRMENT

C-12 (H.I.)

B. Ed. Spl. Ed. (M. R. / H. I. / V. I)-
ODL Programme

AREA - C

C-12 : ASSESSMENT AND IDENTIFICATION OF NEEDS [HEARING IMPAIRMENT]

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ASSESSMENT AND IDENTIFICATION OF NEEDS

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The Self Instructional Material (SIM) is prepared keeping conformity with the B.Ed.Spl. Edn.(MR/HI/VI) - ODL Programme as prepared and circulated by the Rehabilitation Council of India, New Delhi and adopted by NSOU from the 2015-2017 academic session.

Dr. Ashit Baran Aich
Registrar (Actg.)

Netaji Subhas Open University

From the Vice-Chancellor's Desk

Dear Students, from this Academic Session (2015-17) the Curriculum and Course Structure of B. Ed.- Special Education have been thoroughly revised as per the stipulations which featured in the Memorandum of Understanding (MoU) between the Rehabilitation Council of India (RCI) and the National Council for Teacher Education (NCTE). The newly designed course structure and syllabus is comprehensive and futuristic has, therefore, been contextualized and adopted by NSOU from the present academic session, following the directives of the aforesaid national statutory authorities.

Consequent upon the introduction of new syllabus the revision of Self Instructional Material (SIM) becomes imperative. The new syllabus was circulated by RCI for introduction in the month of June, 2015 while the new session begins in the month of July. So the difficulties of preparing the SIMs within such a short time can easily be understood. However, the School of Education of NSOU took up the challenge and put the best minds together in preparing SIM without compromising the standard and quality of such an academic package. It required many rigorous steps before printing and circulation of the entire academic package to our dear learners. Every intervening step was meticulously and methodically followed for ensuring quality in such a time bound manner.

The SIMs are prepared by eminent subject experts and edited by the senior members of the faculty specializing in the discipline concerned. Printing of the SIMs has been done with utmost care and attention. Students are the primary beneficiaries of these materials so developed. Therefore, you must go through the contents seriously and take your queries, if any, to the Counselors during Personal Contact Programs (PCPs) for clarifications. In comparison to F2F mode, the onus is on the learners in the ODL mode. So please change your mind accordingly and shrug off your old mindset of teacher dependence and spoon feeding habits immediately.

I would further urge you to go for other Open Educational Resources (OERs) - available on websites, for better understanding and gaining comprehensive mastery over the subject. From this year NSOU is also providing ICT enabled support services to the students enrolled under this University. So, in addition to the printed SIMs, the e-contents are also provided to the students to facilitate the usage and ensure more flexibility at the user end. The other ICT based support systems will be there for the benefit of the learners.

So please make the most of it and do your best in the examinations. However, any suggestion or constructive criticism regarding the SIMs and its improvement is welcome. 1 must acknowledge the contribution of all the content writers, editors and background minds at the SoE, NSOU for their respective efforts, expertise and hard work in producing the SIMs within a very short time.

Professor (Dr.) Subha Sankar Sarkar
Vice-Chancellor, NSOU

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Netaji Subhas Open University

AREA - C
C-12 : ASSESSMENT AND IDENTIFICATION OF NEEDS

C-12 ❐ Assessment and Identification of Needs

Unit - 1 ❐ Early Identification of Hearing Loss : Needs & Strategies

1.1 Needs for Early Intervention

Hearing loss is a silent, hidden handicap in children. Children especially infants and toddlers cannot tell us what they are not hearing well, hence it's hidden. If undetected and untreated, this can lead to delayed in speech and language development, social and emotional problems and academic failure, therefore it's called a handicap. Detection of hearing loss as early as possible and as young as the new-born period can be applied for effective treatment which significantly reduces the handicap of hearing loss. However, since parents are unaware that an accurate hearing test can be received by any child even a new born infant, identification of a child's hearing loss is delayed.

During 1989 the United States federal government accepted a new commitment aimed at the reduction of the harmful effects of childhood hearing loss.

Research studies have demonstrated that early intervention with hearing impaired children results in improved language development, increased academic success and increased lifetime earnings. Since hearing impaired children who received early intervention require less costly special education services later, hence it is also economically beneficial.

Fitch et al (1982) state that the greater value of such programs may lie in the identification of increased numbers of children with mild to moderate conductive losses that are amenable to treatment.

Communication is learned in early infancy (Bloom & Lahey, 1978) which is essential forgrowth and language but the child's need for language and communication should not pressure parents into making hasty choices between program options.

In 1969 National Committee was formed of representatives from the Academy of Paediatrics, the Academy of Ophthalmology and Otolaryngology and the American Speech and Hearing Association charged with making recommendations for new born infant hearing screening.

The committee at that time addressed itself to the use of behavioural observation hearing screening tests that had been developed and described by Downs and Sterritt (1964) and Downs and Hemenway (1969).

More importance was given by the committee for the development of a high risk register for deafness. Richards and Robert (1967) stated that a high risk register to be efficient should identify a disease that is 14 times more prevalent in the register than in the general population.

Concept of high risk assumes identification of a small group of children who have a history of physical condition and identifies them as possessing a high chance of having the target handicap.

The high risk register were further recommended for a buttressed by a National Maternal and Child Health Conference that delineated Guidelines for Early Screening (Conference of Hearing Screening Services for Preschool Children, 1977). The conference reaffirmed the Joint Committee program and some supplementary suggestions were made. They are:

a) Audiological follow ups of the high risk infants shall be made as soon as possible but certainly by 7 months.

b) The mother child relationship shall be safeguarded by education and careful information in the first 4 months.

c) Informed consent shall be obtained.

d) Information shall be provided on what to look for in later infancy.

e) The development and implementation of adequate identification and diagnostic procedures related to hearing impairment be undertaken by public health agencies.

The Joint Committee on Infant Hearing met again in 1982 and in 1990 to propose new position statements relevant to practices of identifying the hearing impaired neonate and infant.

The Joint Committee on Infant Hearing (1990) represented the American Speech Language Hearing Association (ASHA), American Academy of Paediatrics, the American Academy of Otolaryngology Head and Neck Surgery, the Council on Education of the Dear and the directors of Speech and Hearing Programs in state Health and welfare agencies.

Recent research and new legislation suggest the need for expansion and clarification of the 1982 criteria. The 1990 statement expands the risk criteria and makes recommendations for the identification and management of hearing impaired neonates and infants. It has been recognized by the committee that the recommended protocols may not be appropriate for all institutions so modifications in screening approaches

may be necessary for accommodation of specific needs of a given facility.

In the development" of a screening program, factors such as cost and availability of equipment, personnel and follow up services are important for considerations.

Risk Criteria :

Neonates (birth-28 days)

The risk factors for the identification of those neonates who are at risk for sensorineural hearing impairment include the following:

1. Family history of congenital of delayed onset childhood sensorineural impairment.
2. Congenital infection known or suspected to be associated with sensorineural hearing impairment such as toxoplasmosis, syphilis, rubella, cytomegalovirus and herpes.
3. Craniofacial anomalies including morphologic abnormalities of the pinna and ear canal.
4. Birth weight less than 1500 grams
5. Hyperbilirubinemia at a level exceeding indication for exchange transfusion.
6. Ototoxic medication including but not limited to the aminoglycosides used for more than 5 days and loop diuretics used in combination with aminoglycosides.
7. Bacterial meningitis
8. Severe depression at birth may include infants with Apgar scores of 0-3 at 5 minutes or those who fail to initiate spontaneous respiration by 10 minutes of those with hypotonia persisting to 2 hours of age.
9. Prolonged mechanical ventilation for a duration equal to or greater than 10 days.
10. Stigmata or other findings associated with a syndrome known to include sensorineural hearing loss.

Risk Criteria-

Infants (29 days-2 years): The factors that identify those infants who are at risk for sensorineural hearing impairment include the following:

1. Parent /caregiver concern regarding hearing speech language and /or developmental delay.

2. Bacterial meningitis
3. Neonatal risk factors that may be associated with progressive sensorineural hearing loss (e.g cytomegalovirus prolonged mechanical ventilation and inherited disorders)
4. Head trauma especially with either longitudinal or transverse fracture of the temporal bone.
5. Stigmata of other findings associated with syndromes known to include sensorineural hearing loss
6. Ototoxic medications including but not limited to the aminoglycosides used for more than 5 days (e.g gentamicin, tobramycin, kanamycin, streptomycin) and loop diuretics used in combination with aminoglycosides.
7. Children with neurodegenerative disorders such as neurofibromatosis myoclonic epilepsy , Friedrich's ataxia, Huntington chorea, Werdnig-Hoffmann disease,
8. Childhood infectious diseases known to be associated with sensorineural hearing loss (e.g., mumps, measles).

JCIH met again in 1994, 2000, 2007 to propose new position statements. According to JCIH (2007) families of infants with all degrees of hearing loss should be offered early intervention. EHDI should be linked to the recognised point of entry for infants with a confirmed hearing loss, and be intervened by professionals with expertise in hearing loss including educators of the deaf and speech language professionals. Appropriate interventions offered include both home based and centre based options. A comprehensive guidelines for early hearing detection and intervention programs has been stated by recent JCIH 2013 to meet the needs of children who are deaf or hard of hearing for establishing strong early intervention systems with appropriate expertise

Three groups of people must work together.

a) Parents are in the best position to identify their child's hearing difficulties. Our job can be improvised by making the parents aware of the danger signals and of the available sources that are applicable for them.
b) Physicians are needed to be more responsive regarding the parent's concerns about their child's hearing.
c) Initiation of high risk screening programs can help state agencies. Research indicates that up to 75% of infants born deaf or with hearing impairments can be identified by such pro grams.

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1.2 Overview to Behavioural and Objective Techniques in Screening Hearing Loss

Hearing loss is not a visible disability, and even normal hearing children may not begin talking upto 2 years of age. Thus if hearing loss is not detected through newborn hearing screening programs, it often goes undetected after 18 months of age, especially in children who have no medical ailments and/or other disabilities.

In concert with recommendations of the Joint Committee of Infant Hearing (JCIH-2000) and the National Institute of Deafness and other Communication Disorder (NIDCD-1997) early hearing detection and intervention programs must use screening measures that demonstrate certain response and measurement characteristics. These are as follows:-

1) The response should be capable of being measured reliably under a wide variety of conditions.

2) The response should have predictive value i.e it should be present in nearly all normal -hearing infants and abnormal in nearly all infants with hearing loss.

3) A screening procedure should use objective criteria to define both the method for a technically correct screening test and the guideline for a **"pass versus refer" outcome.**

4) The procedure should achieve a **low referral rate for follow-upto** , prevent unnecessary costs and parental anxiety.

Types of hearing screening procedures

A variety of procedures are presently used in hearing screening programs for children from infancy through high school. Not a single procedure is effective by itself in identifying all hearing loses.

1) **Developmental checklist :-**

It has been used to obtain information from parents or other caregivers regarding the auditory behaviours of children. It is useful to obtain functional information regarding auditory and oral development, especially for very young children or children who are difficult to assess.

Northern and Downs (1974)

At 0 to 4 months - When he was sleeping quiet, did sudden noise awaken him momentarily ? did he cry at very loud noise?

At 4 to 7 months - Did he begin to turn towards sound that was out of his sight? Did he keep on making babbling noises of a large variety at 5 and 6 months?

At 7 to 9 months - Did he turn to find the source of sounds out of his vision? Did he gurgle or coo to voices or sounds that he could not see? Did he make sounds with rising and falling infections?

At 9 to 13 months - Did he turn and find a sound anywhere behind him? Did he begin to imitate some sounds what specific sounds did he say ?

At 13 to 24 months- Did he hear you when you called from another room? Did his voice sound normal?

2 HIGH RISK RESISTER: -

Professional ladership in infant hearing and early detection has been largely provided by the Joint Committee infant hearing (JCIH)

They provided historical risk factors for hearing loss as follows 1972

1. Fmily history
2. Hyper bilurubinemia requiring exchange.
3. Conginital infection (TORCH -toxoplasmosis. Other includes syphilis, rubella, cytomegalovirus, herpes simplex)
4. Craniofacial anomalies (Defects)
5. Birth weight less than 1500 grm 1982 6. Bacterial meningitis
7. Apgar score of <3 at 5 minutes 1990
8. Ototoxic medications including, but not limited to the amino glycosides used for more than 5 days.
9. Prolonged mechanical ventilation for 10 days or more
10. Associated with syndrome

1994 a change to Apgar score of 0 to 4 at 5 minutes

1994 b ototoxic medication, including but not limited to , the amino glycosides, used in multiple courses

1994 c mechanical ventilation lasting 5 days bbor longer

JCIH 2000 indicators for use in neonates (birth through age 28 days) where universal hearing screen is not yet available .

1. An illness or condition requiring admission of 48 hours or longer to NICU
2. Stigmata or other findings associated with a syndrome known to include a snsory-nural and or conductive hearing loss
3. Family history or permanent childhood sensory- neural hearing loss
4. 4. Craniofacial abnormities ,including those with morphologic abnormalities of pinna and ear canal
5. In utero infection such as cytomegalovirus ,herpes,toxoplasmosis , or rubella

3) AUDITORY BRAINSTEM RESPONSE

ABR and Automated auditory brainstem response (AABR ex ALGO -1 plus) are electrophysiological procedures used for hearing screening , based upon brainsterm response to sound.

When used as a screening procedure ABR primarily detect hearing losses that are greater than 30dB in the frequency range 1000 to 4000 Hz with a sensitivity 100% and specificity 96 to 98%.

ABR may be used to detect auditory neuropathy or neural condition disorders in newborns. Because ABR are reflective of auditory nerve and brainstem function, these infants can have an abnormal ABR screening result even when peripheral hearing is normal.

ABR MEASUREMENT PARAMETERS -

Guidelines for stimulus and acquisition parameters in newborn auditory screening with ABR are summarized below -

Parameter	Automated ABR System (screening) ALGO-l device	Conventional ABR system
Stimulus		

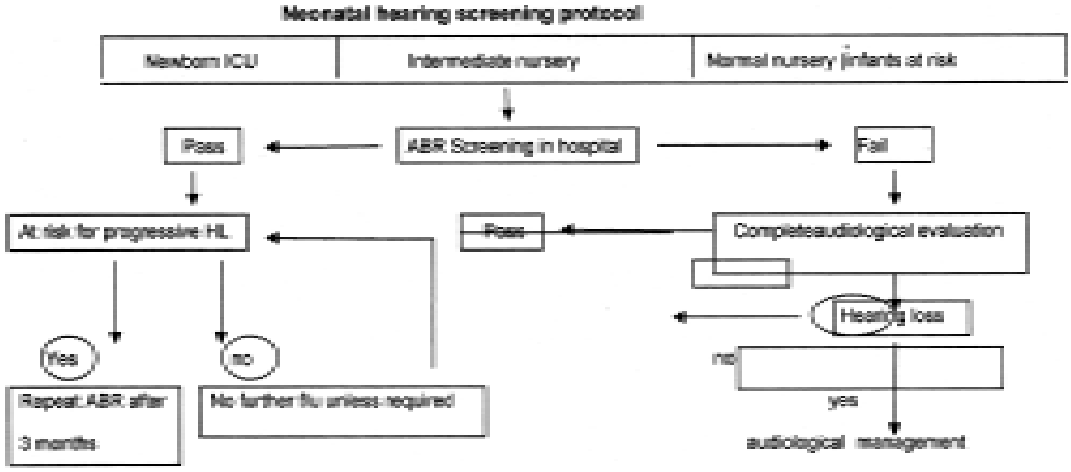
Transducer	Special design	Infants tubephone
Type	Filtered click	Click /frequency specific tone brust stimuli
Duration	0.1 msec	0.1 msec
Rate	37/sec	37. I/sec
Polarity	Alternating	Rarefraction
Intensity	35dBnHL	35dBnHL
Ear	Monaural ,each	Monaural ,each
ACQIS1TTON		
Gain		100,000
Artifact reject	Yes	yes
Analysis time	20sec	ISsec
Filter settings		
High pass	50Hz	^5!l5
Low pass	1400Hz	ISOOHz
60Hz notch		no
Number of sweeps	500 to 1500	Variable 2000 /4000/upto 6000
Electrode placement		
Inverting	Fz	Fz
Noninverting	Back to the neck	Back to the neck
Ground	Fpz	Fpz

International test protocol for screening using ABR

The first component of test protocol is the method of determining which infants will be screened.

A primary objective of chart review is to identify which infants are at risk by careful inspection of available medical records.

The frequency with which chart reviews should be done depends on the volume of births and admission to the ICU and intermediate nursery for the hospital.



4) Otoacoustic emissions-Otoacoustic emissions are sounds that originate from the cochlea more precisely it generated by electromotile vibration fprestin) of the OHCs and propagate through the middle ear and into the ear canal, where they can be measured using a sensitive microphone.

Use of otoacoustic emissions (OAEs), a relatively recent technology for screening, involves measuring the integrity of the outer hair cells of the cochlea.

Transient evoked otoacoustic emission (TEOAE) and distortion product otoacoustic emission (DPOAE) both are used as effective measures in N1CU and well-baby population but the DPOAEs has lower fail rates than TEOAEs (Rhodes et al 1999).

Both types of measurement are frequency specific; TEOAEs in the frequency range of 500 to 5000Hz and DPOAEs in the 1000 to SOOOHz range. (Gorge et al 1993, Probest et al 1987)

TEOAEs generally detect hearing loss at levels of 30dBHI_ or above, while DPOAEs are reported to detect hearing Iossof40dBHL or above (Gorge etal 1993, Probest et al 1987).

Abnormal middle ear conditions usually results in absent of OAEs.

5) **Acoustic Immittance**

Guidelines for screening were adopted by the American-Speech-Language-Hearing Association in 1997 that detailed Immittance procedural recommendation. In addition, the American Academy of Audiology wrote a position statement in 1992, "Audiologic Guidelines for the diagnosis and treatment of Otitis Media in children," which was

submitted as the academy's formal recommendation for the development of the clinical practice guideline "Otitis Media with effusion in young children" (U.S. department of health and human service 1994)

Acoustic Immittance measurements have historically consisted of three procedures: tympanometric peak pressure, static admittance,and the acoustic reflex. Current screening for middle ear disorders consist primarily of the gradient (i.e.tympanometric width) and static admittance (tympanogram peak). Consideration should also be given to canal volume in the interpretation.

Pass and referral criteria must be established with consideration of the age and risk factors of the target population and with consideration of local medical tr Cannot be used to determine hearing sensitivity treatment philosophies.

Reffral criteria from the most recent ASHA guidelines(1997) are summarized in table-

<table>
<tr><td colspan="3">Equivalent ear canal volume for children 1 to 7 yrs of age</td></tr>
<tr><td>90% range for ears with and without tubes 5th percentile-95th percentile referral criteria</td><td>Pre- tube
0.3-0.9cm3</td><td>Post -tube
1.0-5.5 cm3</td></tr>
<tr><td colspan="3">Ear canal volume Vec>1.0cm3 and accompanied by flat tympanogram; do not refer if tube is in place or if TM perforation is under management of a physician</td></tr>
<tr><td colspan="3">Recommended initial tympanometric screening test criteria</td></tr>
<tr><td>Infants</td><td colspan="2">Ytm<0.2mmho or TW>235dapd (Ytm=peak admittance)</td></tr>
<tr><td>1 year to school age</td><td colspan="2">Ytm<0.3mmho or TW>200dapd</td></tr>
<tr><td>6 years and older</td><td colspan="2">Ytm<0.4mmho (when using +-400 dapa for comprehensation)</td></tr>
</table>

6) Visual reinforcement audiometry

Liden and kankkonen (1961) first coined the term'Visual reinforcement audiometry"(VRA). This procedure as currently used employes lighted transparent toys which are flashed on simultaneously with the presentation of the auditory signal during a conditioning period. During the testing phase the light is flashed immediately following a response.Matkin (1974) reported that VRA is successful with 90% of both normal- hearing and hearing impaired children between the ages of 12 and 36 months.In

sound field,the loudspeakers on each side of the child produces the signals and the lights for localization.

7) Behavioral observation audiometry

Behavioral observation as a screening technique may be considered more of a functional measure of hearing ability because it requires the infant or child to respond to avariety of noise stimuli.In BOA,an infants response is observed to a variety of moderate to high intensity stimuli,such as calibrated noisemakers,to observe startle,eye-widening,localization,or cessation of activity. As a screening tool, this procedure would likely have a high false-negative rate.Potentially missing many children with significant hearing loss.

There fore,this procedure can no longer be recommended as a solitary screening tool.

8) Conditioned play audiometry(CPA)

In CPA, children learn to engage in an activity-putting rings an spindle,dropping or stacking blocks, putting together simple puzzles-each time hear the test signals.

These activities are assumed to be interesting to children,are within their motor capability,and reoresent a specific behavior that is used to denote a response to a stimulus. The chalange in play audiometry is teaching the child to wait,listen and only respond with the play activity when the auditory signal is presented.Audiologicliterature suggests that CPA is widely accepted among clinician who practice pediatric audiology(Thomson et al 1989).

PROCEDURE	TARGET POPULATION	ADVANTAGES	DISADVANTAGES
Developmental	Birth 3 years; other difficulty to-assess population data about child's sensitivity of hearing	-Quick and easy to administer -provides functional	'-Does not correlate with actual hearing sensitivity
High risk register	Birth 2 years	-Quick and easy to administer -identifies infants to who require monitoring of hearing due to risk factors.	-only identifies 50% of hearing loss, -may require time consuming chart review.
History	All ages	Identifies medical, familial and other	Cannot be used to determine hearing

		developmental information that may affect hearing ability	sensitivity.
Visual inspection of the ear	All ages	Identifies structural abnormalities, ear canal drainage	Cannot be used to determine hearing sensitivity
ABR	All ages	-Requires minimal training -identifies high-frequency losses above 30dBHL -predicts hearing threshold	_Expensive -May require sedation for children who cannot sit still for long periods. -Not frequency specific. -Difficult to interpret if central nervous system pathology present.
OAEs	Newborns, infants and toddlers, difficult to assess population	-identifies loses greater than 30dBHL (TEOA) Or 40dBHL(DPOAE) -minimal cooperation required -does not require sedation Frequency specific.	-Expensive -Measure only to cochlea -Cannot predict hearing threshold.
Pure tone screening	2.5years to adult	Identifies children who require further assessment, -results are generally reliable.	Not useful with children who have developmental problems. Require very quiet environment.
Acoustic immittance	6months or older middle ear function, -automated units are quick and easy administer, -minimal cooperation required	Valid indicator of	-Does not assess hearing sensitivity, -follow up protocols are controversial.
Behavioral observation	3months to 2 years; special population	-provides reasonably valid response to low level stimuli. -provides functional data about child's use of hearing.	Requires child cooperation may need repeated test session to obtain to sufficient data to estimate hearing sensitivity.

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1.3 Team Members Involved in Hearing Screening and Their Role

Hearing loss is a hidden disability. It is hidden because children are not able to tell whether they are hearing or not. Some adults also do not want people to know about their hearing loss so they hide their problems. Hearing loss should be detected and identified as early as possible so that small children should not go undetected and miss their critical age. Critical age is considered 0-5years .During this period all aspects of development occurs like physical,motor,speech and language development, social and psychological development. This critical age has to be taken into account and has to be maximally used for the child's adequate development. By detecting hearing loss as early as possible, even as young as newborn infants effective rehabilitation can be undergone.

Hearing Loss in children is a serious concern as it interferes with the development of language. Language is a unique gift of nature for humans. The longer it takes for a hearing loss to go undetected the outcome becomes worse. Adequate speech and language therapy should be provided after amplification so as to develop proper speech and language skills. Our primary goal is that the child should develop communication skills. Many research studies have demonstrated that early intervention with hearing impairment children results in improved language development, increased academic success and increased quality of life.

Early Identification and Intervention of hearing loss is a team work and requires a group of professionals who should work rigorously towards the rehabilitation of the client. Reduced or defective hearing sensitivity causes a lot of communication problems. The effects of hearing loss is devastating as it causes many problems in the individual which includes total lack of communication leading to a variety of social and emotional discrepancies.

The rehabilitation team should include the following members who should work hand in hand for the successful intervention of the hearing impaired indivisual.The team includes :

- The health professional on whom parents depend for the general health care of the child, it is probably a **pediatrician,** who treats only children, or a family

practice physician, who treats adults as well as children in the family. This professional will not be able to help parents with the hearing loss itself. However he/she may treat inflammations and infections of the ear and upper respiratory system that can affect hearing, as well as other conditions that children may encounter.

- **The audiologist** must have a license to practice audiology. He/She specializes in the study of hearing disorders. An audiologist identifies the hearing loss, measures it, and aids in the habilitation of the deaf and/or hard of hearing person, by recommending appropriate hearing aids. Periodic hearing screening during the early childhood years increases the likelihood that children lost to follow-up from newborn screening, along with children presenting with post neonatal hearing loss, will receive the timely diagnostic and intervention services needed during the critical language learning years.
- **An ENT surgeon or otorhinolaryngologist** is a physician who specializes in diseases of the ear, nose, and throat. An E.N.T surgeon must examine a child to rule out any medical complications before parents purchase a hearing aid. An ENT should check every child periodically.
- **The service coordinator** is responsible for coordinating all services for the child and will serve as the person for parents to contact when seeking to obtain necessary services and assistance. The service coordinator is also required to assist parents in identifying and locating available services and service providers, and to inform parents (and families) of the availability of rehabilitation services.
- **A speech and language pathologist** specializes in the diagnosis and habilitation of speech and language problems. This team member may meet with a child on a regular basis to work on the fine points of speech and language development and speech correction. He/She will explain how parents can help with the child's speech and language development.
- **The teacher of the deaf or hard of hearing** should be certified by the State Department of Education to teach students who are deaf or hard of hearing. Parents should begin talking to these special teachers, from programs in their area, even if the child is only an infant. This person can help parents get started immediately with communication and language development, even if the hearing

aids have not yet arrived. Most areas have programs for infants and toddlers and their parents. Teachers in these programs will become one of the most valuable members of the team, providing home visits and one-on-one early intervention for parents and children

- **PARENTS** are the most important team members as because they will stay with the child throughout even if the professionals would leave. They are the most important people who will decide on the child's rehabilitation procedures. Parents are the best people who will identify a child's hearing difficulties. Some parents do not accept that their child has hearing loss. They have emotions like shock and denial. It is the professional's role to counsel these parents to overcome this problem. Parents together with help from the professionals will help decide the child's rehabilitation procedures and the hearing impaired child's future. Thus parents play very important role in the rehabilitation process.

1.4 Use of Checklist and Behavioral Observation in Early Identification of Hearing Loss by School Teacher (Congenital and Acquired)

Structure

1.6.1-Identifying Hearing Loss

1.6.2-Behavior Observation

1.6.3-CheckIists

1.6.4-Check list of School Teachers Students Behaviour Observation Hearing Loss. (Congenital and Acquired)

1.6.4-1-STEP-A Observe Auditory Behaviours.

- **Additional information**
- **Appearance of the ears and**
- **Auditory and hearing behaviours of the Student's**

1.6.4-2-STEP-B Reviewing Medical and Educational Records.

B.I-Congenital factors

B.2-Acquired factors.

1.6.4-3-STEP-C: Interviewing the Family

1.6.4-4-STEP-D; Meeting with Family.

1.6.5-5-STEP-E: Referral for Medical Follow- Up

1.6.6-6-STEP-F-: Follow-Up Meeting to Discuss Medical Findings

1.6.1-Identifying Hearing Loss

Children with hearing impairments that can be challenging to educate and serve. Most learning comes through auditory channels and when these avenues are impaired incidental and direct learning is reduced. While the impact of the hearing impairment may not always be the primary impediment to learning it is a factor that has significant impact on a child's ability to learn by affecting their access to the physical, social, and

instructional environment. Use of appropriate modifications and instructional strategies can significantly increase access and ultimately development and achievement. Hearing help us our listening capacity of the sound knowledge in around of the world. Because our hearing mechanism is known as an auditory sensory pathway with the help of sensory pathway we receive and perceive the sound knowledge of the world. If affects that path way its call auditory impairment's. Children with auditory impairments may be having difficulty in hearing in both and one ear. Our hearing is a main sensory pathway through which speech and verbal communication develop. If child cannot hear perfectly so therefore he/she cannot speak individual and speak to others perfectly. So early detection of hearing impairment is important to child's overall development. Hearing loss is one of the most commonly unidentified and misdiagnosed conditions in early childhood because hearing impairment is a hidden problem and even when it is present in a child at birth, it cannot be suspected immediately as it is not seen overly. Only when the child grows up and fails to start speaking do the parents/caregivers realize that the child has a problem in hearing. That's why checklist is an essential part parents, caregivers and school teachers. Because Hearing screening checklists have been used to obtain the report of the parents, caregivers and school teachers to know about the auditory behavior pattern of their children. So therefore checklist most important tools of parents, caregivers and school teachers. Behavior observation or auditory behavior of children is being classified in different age level regard hearing status.

1.6.2-Behavior Observation

Human development in the first 3 years of life occurs with rapid changes in cognitive development, language, motor skills, and social/emotional skills. This foundation is so important that infant's caregivers must be aware of each child's developmental progress. In a child care setting, knowledge of a child's development is accomplished through the key processes of **auditory** behavior observation, developmental screening, and ongoing assessment. The child care consultant can play an important role in helping infant caregivers understand the definitions, key concepts, and processes that can support understanding the developmental progress of infants.

For behaviour observation to be meaningful and useful it must be objective and factual. The objective is Consultants can help caregivers understand they must document

only what they see and hear when recording information about a child. So actual behavior observations should include actions, language, gestures, facial expressions and creations.

Behavioral Observation Technique continues to be used even though they do not provide ear specific results for screening but is hearing screening checklists have been used to obtain the report of the school teachers, parents and caregivers regarding the auditory behavior of their children. The principle of this procedure change child's behavior after presentation of sound stimulus in different sound knowledge in around of the world.

1.6.3-Checklists

Checklists can be a great tool to monitor a child's hearing, speech, and language development. The different variety of checklist used for documenting children's development are beyond the scope of this module and the following checklist is basic standardized methods can be implemented with instruction to parents, caregivers and school teachers is behaviour observation or auditory behaviour checklist of children.

1.6.4 Check List of School Teacher's Student's Behavioural Observation Hearing Loss. (Congenital and Acquired)

1.6.4-1-STEP-A observe auditory behaviors

If you suspect that your student has hearing loss you should document those behaviors that lead you to believe that this is true. Below is a list of behaviors or characteristics typical of children who hearing loss. Check off those behaviors that are suspect, describe them if you think further explanation is needed and add any information you think pertinent to their sensory functioning and behaviors. So check lists of schools teacher's of student's behavioral observation hearing loss can be classified in **1) Additional information 2) Appearance of the ears and 3) Auditory and hearing behaviors of the Student's**

- **Additional information:** If you think further explanation is needed and add any information you think pertinent to their sensory functioning and behaviors. Write your information.....
- Appearance of the **Ears**

SLNO	2) Appearance of the Ears	Yes	No
1	Cleft lip or palate		
2	Malformations of head and neck		
3	Malformations of ears		
4	Frequent ear aches or infection		
5	Discharge from ears		

- **Auditory and hearing behaviors of the Student's**

SLNO	3) Auditory and hearing behaviors of the Student's	Yes	No
1	Makes few or inconsistent responses to sound		
2	Does not look at visual materials when asked to by someone		
3	Does not startle or react to unexpected or new sounds		
4	Does not respond to caregiver's calling name/not soothed by caregiver's voice		
5	Shows a preference for certain types of sound (high or low frequency, louder or softer sounds)		
6	Has limited vocalizations does not try to imitate		
7	Has difficulty attending to auditory stimuli for a reasonable length of time		
8	Does not turn to or localize voices or sounds		
9	Abnormalities in voice, intonation, articulation		
10	Pulls on or covers ears		
11	Breathes through mouth		
12	Angles head to one side so as to favor one ear		

1.6.4-2-STEP-B Reviewing Medical and Educational Records

In reviewing a student's records you should be looking main sources of information about the medical. The information about the medical records is B.lCongenital factors **B.2** Acquired factors.

Congenital factors	**Acquired factors**
● Heredity ● Viral infection during pregnancy, e.g. rubella infection ● Congenital defects such as anomalies ● of the ear, nose or throat	● Excessive earwax ● Eardrum perforation ● Middle ear effusion or infection ● Otosclerosis or ear ossicle dislocation ● Sequelae of childhood diseases such as

● Pre mature birth, birth asphyxia, excessive bilirubin etc	measles and meningitis ● Head or ear trauma ● Prolonged exposure to loud noise ● Medication that may lead to hearing damage

Now the details discus about the congenital factors and acquired factors. Congenital means born with the hearing loss and acquired means hearing loss means could hear when he or she was born but developed hearing loss later in life. Acquired hearing loss also can be described by the age at which it starts. If hearing loss starts before the age when children usually begin talking, it is called "p/-e-lingual", which means "before speaking". If hearing loss starts after the age when children begin talking; it is called *post* lingual which means after speaking. So congenital factors and acquired factors depend upon some criteria these are:

1) Hereditary Syndromes and disorders(Syndrome/Condition)

2) Prenatal History(History of maternal infection/exposure during pregnancy)

3) Natal History(Prematurity)

4) Post Natal History(Prematurity)

5) "Red" Flag Terms(Medical Terms associated with Hearing Loss)

1) Hereditary Syndromes and disorders(Syndrorne/Condition)

1	CHARGE Syndrome/Association	YES	NO
2	Down Syndrome		
3	Trisomy 13		
4	Usher Syndrome		
5	Alstrom Syndrome		
6	Goldenhar, Hurler, Norrie, Waardenburg Syndromes		
7	Other genetic syndromes or defects		

2) Prenatal History(History of maternui infection/exposure during pregnancy)

1	Rubella	Yes	NO
2	CMV (cytomegalovirus)		
3	Toxoplasmosis		
4	Herpes		
5	Syphilis		
6	Prenatal infant exposure to drugs or alcohol		
7	Cleft Lip or Palate		

3) Natal History(Prematurity)

1	Birth weight < than 1500 grams (3.31bs)	YES	NO
2	Prematurity		
3	Pretenn birth, exposed to oxygen		
4	On ventilator longer than 5 days		
5	Elevated bilirubin requiring transfusion		
6	Low Apgar scores (1-4 at 1 minute or 0-6 at 5 minutes)		

4) Post Natal History(Prematurity)

1	Meningitis or encephalitis	YES	NO
2	Hydrocephalus/hydrocephaly		
3	Cerebral palsy or other neurological disorders		
4	Brain disorders, brain tumours or malformations of the brain.		
5	Loss of oxygen to the brain		
6	Severe head trauma		
7	Prolonged fever		
8	Child received “mycin” or other known ototoxic medications		

5) "Red" Flag Terms (Medical Terms associated **with Hearing Loss)**

1	Anoxia, asphyxia, hypoxia	YES	NO
2	Atresia		
3	Cerebral hemhorrage		
4	Cerebral palsy		
5	Ischemia		
6	Meningitis		
7	Peri ventricular damage		
8	Fetal Alcohol Syndrome		

1.6.4-3-STEP-C: Interviewing the Family

Families uho have children with hearing impairment usually accurate reports of their child's use of hearing. They have more opportunities to see their child as well as a more diverse set of circumstances in which to see them. They also have the history of their child over the years in which to observe change. Interviewing parents with a set of discrete and open-ended questions will give a much broader view of the child and help to identify any issues with hearing. A checklist about questions to ask parents about their child's hearing. These questions are best asked face to face but, if not possible, then a telephone interview will suffice .These questions should not be treated as a form to send home as the impersonal nature of this approach will not yield useful information.

SL NO	QUESTIONS TO ASK THE FAMILY ABOUT TH E1R CHILD'S HEARING	Comments/Observations
1	What have *you* been told by medical professionals (such as the paediatrician or family care physician) about your child's hearing?	
2	Has your child had ear infections, if so how often?	
3	Is your child frequently congested? Do they have frequent colds?	
4	What is your impression of your child's hearing?	
5	What sounds get your child's attention?	

6	What does \ our child do when you call their name?	
7	How does your child react to sudden loud noises? (telephone, car, vacuum)	
8	What kinds of things do you think your child sees, and in what activities does he/she use their vision?	
9	Does your child seem to respond differently when the television or radio is on?	
10	Does your child appear to enjoy toys with sound/ noise?	
11	Does your child enjoy you talking or singing to them?	
12	What words does your child seem to understand?	
Additional Comments:		

I.6.4-4-STEP-D: Meeting with the family

If through the first three steps of the identification process it becomes likely that your student may have a hearing impairment a meeting with the family should be requested to discuss the results of your observations and investigation. There is no cut and dry threshold of determination but if both the educational team and the parent have suspicions, and the student's behaviour and medical history support this, then a referral to the appropriate medical professional should be made. The meeting to review this tool should include a discussion of your findings and thoughts as well as helping the parents find medical professionals they can access to have their child tested and. if appropriate, diagnosed. For students suspected of having a hearing loss, a referral to an Audiologist is in order below given the checklist

SL NO	QUESTIONS TO ASK THE FAMILY ABOUT TH E1R CHILD'S HEARING	**Comments/Observations**
1	What kinds of hearing tests were conducted?	
2	What did the test results measure and what were the results?	
3	How did the tests go? How did my child react? How confident are you in the results (reliability)?	

4	When should my child be retested?	
5	What do the results mean for my child's ability to discriminate sounds and understand speech?	
6	Would my child benefit from amplification (hearing aids, FM unit, etc.)?	
7	What would be the best way to get more information my child's hearing and what are m\ next steps?	
8	Is my child's hearing equivalent in both ears? Is there a "better ear" that will assist him/her in accessing speech or environmental sounds better?	
9	Do you suspect that my child has a progressive loss? Will his hearing be worse in the future?	
10	Is it possible for us to listen to the sounds that my child hears?	
11	If my child gets hearing aids what type is recommended? Why is that style better for him/ her than others?	
12	With hearing aids, when will he/she need to get new molds?	
13	Is my child a candidate for a cochlear implant? Why or why not?	
14	When should my child be retested?	
15	How does ihe information from the test results help my child's educational team?	
Additional Comments:		

1.6.5-5- STEP-E: Referral for Medical Follow - Up

Medical appointments are not always an easy experience for parents and helping them to prepare for the appointment will make it more productive for them and ultimately for the educational team, as there is a better chance of getting information that is useful in diagnosing and serving the child. Giving the parents questions to ask the doctor can

be extremely helpful in preparing the parcnis and questions for audiologists. These, as well as specific questions the parents or team ha\e, should be formulated beforehand so the parent has them on hand for the medical appointment.

1.6.6-G-S i EP-F: Follow-Up Meeting to Discuss Medical Findings

After the child has gone to their medical appointment for hearing a follow-up meeting should be scheduled lo assist the parents in understanding the results. If hearing impairment has been identified the next step is to make a referral for an evaluation by a teacher of the deaf. These individuals will evaluate the child and make a recommendation for services that will be put on the IEP with appropriate goals and accommodations.

1.5 Referral Based on Signs and Symptoms of Hearing Loss

Hearing impairment is the inability of an individual to hear sounds adequately. This may be due to improper development, damage or disease to any part of the hearing mechanism. Since deafness is an invisible impairment, often signs and symptoms of hearing loss might help in diagnosis and adequate referral. The various professionals working as a team in management of hearing loss is as follows:

Roles and Responsibilities of Audiologists

Audiologists play a central role in the identification, assessment, diagnosis, and re/habilitation of patients with permanent/sudden hearing loss. Professional roles and activities in audiology include clinical/education services, prevention and advocacy, and education, administration, and research.

Appropriate roles for audiologists include:

- providing prevention information, promoting hearing wellness, and monitoring the acoustic environment;
- educating other professionals on the needs of children with permanent childhood hearing loss and the role of audiologists in diagnosing and managing permanent childhood hearing loss;
- identifying permanent childhood hearing loss, including early detection and screening program development, management, quality assessment, and service coordination:
- conducting a comprehensive assessment, using behavioral, electroacoustic and/or electrophysiologic methods to assess hearing, auditory function, balance, and related systems;
- referring the patient to other professionals as needed to facilitate access to comprehensive services

SPEECH LANGUAGE PATHOLOGIST

The *speech-language pathologist (SLP)* is defined as the professional who engages in professional practice in the areas of communication and swallowing across the life span. Speech-language pathologists (SLPs) play a role in the screening, assessment,

and re/habilitation of children with permanent childhood hearing loss. Professional roles and activities in speech-language pathology include clinical/educational services, prevention and advocacy, education, administration, and research.

OTOLARYNGOLOGIST

Medical specialist who deals with diagnosis and treatment of diseases of the ear, larynx, and upper respiratory tract are called Otolaryngologist. Individuals with history of sudden hearing loss, ear pain or other medical conditions are treated with medicine and surgical intervention. Individuals with profound sensirineural hearing loss and restricted gain from hearing aids might undertake cochlear implantation.

ROLES AND RESPONSIBILITIES OF PSYCHOLOGIST

A psychologist and psychiatrist, helps to address some of the potential psychological effects of hearing loss. They help to rule out any intellectual deficits associated with or without hearing loss. Hearing loss can induce observable psychological effects at various points in development. The potential psychological effects of hearing loss are different for children and adults, which leads to difficult inter and intra personal conflicts leading to psychosomatic disorders. Hence proper guidance and counseling is often pertinent.

SPECIAL EDUCTORS

Rehabilitation council if India aims to promote and facilitate full and equal enjoyment of rights of children who have hearing impairment. The special educators specializing in HEARING Impairment helps to develop knowledge, skills and desirable attitudes to facilitate the differently abled children to blossom to their fullest by providing a barrier free environment. The national goal of Universalization of Elementary Education (UEE) and Education for All (SARVA Shikshya Abhayan) is designed for contributing towards achievement of Millennium Development Goals (MDG) by way of preparing the teacher trainees to meet the challenges of all round development of these children.

VOCATIONAL GUIDANCE AND COUNSELLING

Career guidance for persons with disabilities is an important step in habilitating the persons with disability. The trained and educated social worker professionals identify the potentials of the individuals. With comprehensive assessments and understanding of the persons abilities they help them to pursue their chosen occupational opportunities.

Signs and Symptoms Of Hearing Loss	Other associated symptoms	Severity	Referrals
• Distinguishing soft/distant speech • Responding to subtle cues in conversation • Rapid-paced information/transitions • Distinguishing grammatical markers (possessive, plural, verb tense forms, etc.) • Fatigues more easily; presents with immature behavior	Dizziness, Ear pain, ear, blockage, ear sensation, discharge (watery, purulent, blood, foul smelling), abnormal sensation of sound.	Minimal or Slight Hearing Loss (16-25 dB HL)	AUDIOLOGIST/OTOLARYNGOLOGIST
• Compared to peers with normal hearing-(this) greater risk for academic failure • Localizing source of sound and filtering speech in noise • Distinguishing and understanding speech in classroom environment (even when presented in the "good ear") • Distractible/less attentive and easily frustrated • Not as confident and more dependent on others as compared to peers with normal hearing	Dizziness, Ear pain, ear, blockage, ear sensation, discharge (watery, purulent, blood, foul smelling) abnormal sensation of sound.	Unilateral Hearing Loss	AUDIOLOGIST/ OTOLARYNGOLOGIST/ SPEECH LANGUAGE PATHOLOGIST
• Can possibly miss 25-40% of speech signal Without use of audiologic management • Cannot "overhear" others' conversations therefore misses passive learning opportunities • 30-40 dB HL can miss 50% of classroom discussion • Cannot hear soft/distant voices and described as "daydreaming" or "not trying" • Fatigues more easily due to	Dizziness, Ear pain, ear, blockage, sensation, discharge (watery, purulent, blood, foul smelling) abnormal sensation of sound.	Mild Hearing Loss (25-40 dB HL)	AUDIOLOGIST SPEECH LANGUAGE PATHOLOGIST/OTOLARYNGOLOGIST/ SPECIAL EDUCATORS

effort taken to hear • Unmanaged hearing loss can result in lagging behind at least 1 grade level			
• 50-75% of information missed in classroom situations • Articulation and syntax deficits as well as limited receptive and expressive vocabulary • Demonstrate immature behavior • Deficits in communication and social skills • If untreated by 4th grade these students are at least 2 grades below level	Dizziness, Ear pain, ear, blockage, ear sensation, discharge (watery, purulent, blood, foul smelling) abnormal sensation of sound.	Moderate Hearing Loss 140-55 (dB HL)	AUDIOLOGIST/ SPEECH LANGUAGE PATHOLOGIST PSYCHOLOGISTE DUCATIONAL GUIDANCE AND COUNSELLING/ VOCATIONAL; GUIDANCE STATE GOVERNEMNT HOSPITAL FOR DISABILITY CERTIFICATE,
• Unamplified-100% of classroom information is missed, cannot detect sound, cannot localize sound, cannot distinguish between environmental and speech sounds • Academic deficits • Language delays (including syntax deficits) • Poor speech intelligibility • Deficits in social skills	Dizziness, Ear pain, ear, Blockage, ear sensation, discharge (watery, purulent, blood, foul smelling) abnormal sensation of sound.	Moderately-Severe Hearing Loss (55-70 dB HL)	AUDIOLOGIST/ SPEECH LANGUAGE PATHOLOGIST PSYCHOLOGISTE DUCATIONAL GUIDANCE AND COUNSELLING/ VOCATIONAL; GUIDANCE STATE GOVERNEMNT HOSPITAL FOR DISABILITY CERTIFICATE,
• With amplification can detect speech and environmental sounds • Requires technology to hear conversational speech • Significant academic, language and social skills deficits • Appears inattentive as looks to peers often to model what child should be doing • Requires auditory language intervention to learn to communicate with others	Dizziness, Ear pain, ear, blockage, sensation, discharge (watery, purulent, blood, foul smelling) abnormal sensation	Severe Hearing Loss (70-90 dB HL)	AUDIOLOGIST/ SPEECH LANGUAGE PATHOLOGIST PSYCHOLOGISTE DUCATIONAL GUIDANCE AND COUNSELLING/ VOCATIONAL; GUIDANCE STATE GOVERNEMNT

	of sound.		HOSPITAL FOR DISABILITY CERTIFICATE,
• Cannot detect speech vs. environmental sounds without amplification • Verbal expression will not develop without the use technology • Without use of technology or alternative modes of communication, child will not use a functional communication system to successfully communicate, primitive gestures will remain as primary mode of communication and learning will not occur	H/O Dizziness, Ear pain, ear, blockage, ear sensation, discharge (watery, purulent, blood, foul smelling) abnormal sensation of sound.	Profound Hearing Loss (90+ dB HL)	AUDIOLOGIST/SPEECH LANGUAGE PATHOLOGIST PSYCHOLOGIST/EDUCATIONAL GUIDANCE AND COUNSELLING/ VOCATIONAL; GUIDANCE STATE GOVERNEMNT HOSPITAL FOR DISABILITY CERTIFICATE, SIGN LANGUAGE.
• Sudden inability to hear. • Selective inattention, refusal to go to school • Emotional and behavioral disorders	None	Functional hearing loss	AUDIOLOGIST, PSYCHOLOGIST

Partly adapted from: Cole, Elizabeth, and Carol Flexer. *Classroom Accommodations for Students with Hearing Impairment.* San Diego, CA: Plural Publishing, Inc., 2007.

Unit - 2 ❑ Assessment and Identification of Needs

Structure

2.1 Introduction

The hearing mechanism in humans is an interesting and intricate process. An intact hearing system helps to acquire adequate speech, language and communication skills. This further helps in educational, psychological and social development of an individual. Any deficit in the hearing mechanism causes varied amount of effect on an individual depending on the extent of deficit. The most important of these are hearing impairment that is inability to hear. The deficit can be by birth or can be acquired due to any ailment, accident etc. The deficit can take place in the external ear, middle ear or inner ear. For e.g, there can be wax accumulation in the external ear, there can be infection in the middle ear or there can be a permanent damage of hair cells in the inner ear. Moreover there can be a combination of these conditions. The resulting hearing impairment can range from minimal loss to total loss of hearing.

An individual with hearing impairment needs early identification, accurate diagnosis and timely rehabilitation in order to lead a healthy life. For this purpose, correct identification and assessment of hearing loss is necessary. There are a number of tests in the field of audiology, which help to assess the hearing capacity of an individual.

Correct selection and administration of these test(S) helps to find the degree of hearing loss and also the site of deficit/damage. Audiology is very closely related to education. The role of special educators in assessment and rehabilitation of hearing disorders is well established. Moreover the results of audiological assessment have important implications for educational assessment and planning the educational management of a hearing impaired child.

In this chapter we will discuss about the various tests, their procedures, their importance, the instruments used, the interpretation of resultsand their implication on educational assessment and management.

2.2 Objectives

At the end of this chapter students will learn about

- Concept of sound, its parameters and units.
- Auditory development in humans
- Various audiological tests- Subjective and Objective used for children
- The audiometer
- Interpretation of results from the tests
- Implications of results and application in educational management of the hearing impaired child

2.3 Audiological Assessment Orientation

Audiology refers to the study of hearing and hearing disorders. Audiology is concerned with the human's response to auditory stimuli which is basically "sound". In order to gain knowledge about the various assessment procedures used in audiology, the basic understanding of "sound" and its properties is essential. As measurement of hearing loss requires accurate and dependable instrumentation, so the knowledge of instrumentation, tests performed with the help of these instruments and the various response patterns is crucial.

2.3.1 Sound

Sound is a form of energy which is generated in the form of vibrationsand is perceived by the hearing mechanism. It can propagate in any medium like air or water.

Sound has two aspects namely physical and psychological. Because hearing disorders represent an inability to respond normally to acoustic stimulation or "sound", it is very important to learn briefly about the physical and psychological aspects of sound.

2.3.2 Physical Correlates of Sound

Sound is produced when a force sets an object into vibration that in turn disturbs the molecular movement of the medium surrounding the object. The disturbance is propagated as a sound wave is heard by the human ear. So the chain is Source ◗ Medium ◗ Object that will vibrate ◗ Hearing mechanism.

2.3.3 Psychological Correlates of Sound

The act of hearing something that is sound is an auditory experience. There are certain psychological attributes attached to the physical properties of sound namely pitch,loudness and timbre. Pitch corresponds to frequency, loudness corresponds to intensity and timbre corresponds to quality of sound.

2.3.4. Basic Attributes of Sound

Physical attributes of sound are frequency, amplitude and phase which are psychologically correlated with pitch, intensity and time. Sound can be a simple single frequency puretone or a combination of many frequencies called a complex tone.

Frequency

The frequency of a sound refers to the number of vibrations that occur in one second and is expressed in Hertz(Hz).Each vibration consists of one cycle of compression and rarefaction. So a pure tone of 1000 Hz means 1000 cycles per second. The period of a sound T,is the reciprocal of frequency.

$T = 1/f$

The range of human hearing is 20 Hz-20 000 Hz. However in basic Puretone Audiometry we test from 250 Hz to 8000 Hz. The length of one cycle called the wavelength decide the frequency of a sound wave. Low frequency sounds have longer wavelengths and high frequencies have shorter wavelength.All the sounds heard by human ear including speech can be categorised as low,mid or high frequency sound. E.ga sound from a Drum is a low frequency sound whereas a bird's chirp or a whistle are categorised as high frequency sounds.

Amplitude

The amplitude of a sound refers to how far an object moves back and forth and the amount of maximum and minimum air pressure created. The larger the movement or

pressure variation the greater the amplitude for any given frequency. The sounds in human environment are categorised as soft, moderate and loud. E.g Rustling of leaves is a soft sound and sound of a cracker is a loud sound.However a term called intensity is used to express amplitude whether to describe sound energy per area or sound pressure. Logarithmic units are used to express amplitude.

Phase

Phase refers to amplitude of a sound at a particular time during the cycle. Phase can be expressed in units of time such as seconds or can be expressed as an angle. Phase can also be used to describe the time relationship between two or more tones occurring simultaneously.

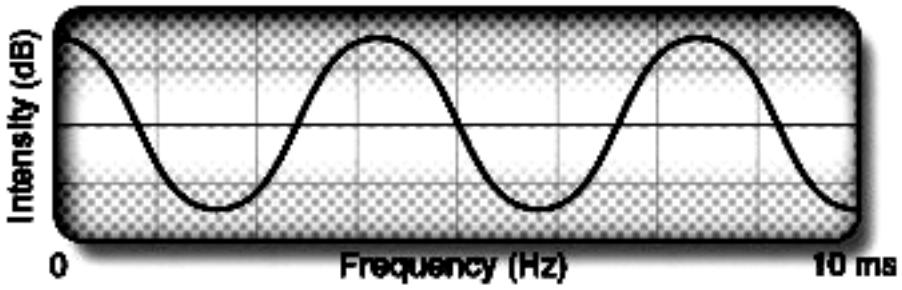
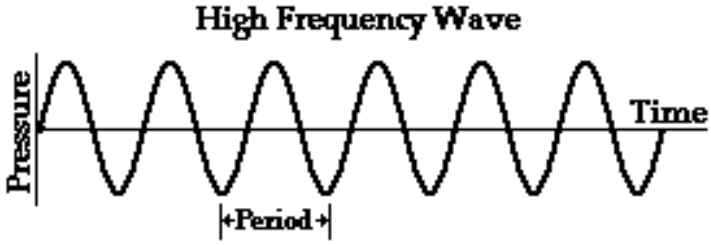


Fig 1. A simple pure tone waveform showing intensity, frequency and time



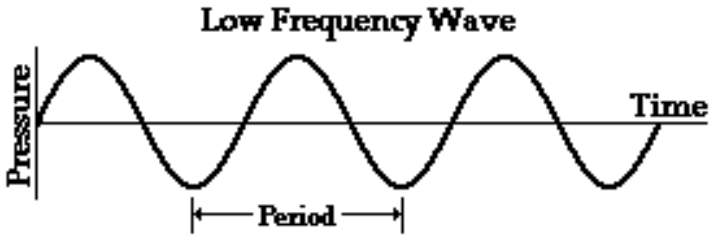


Fig 2: frequency, intensity and phase

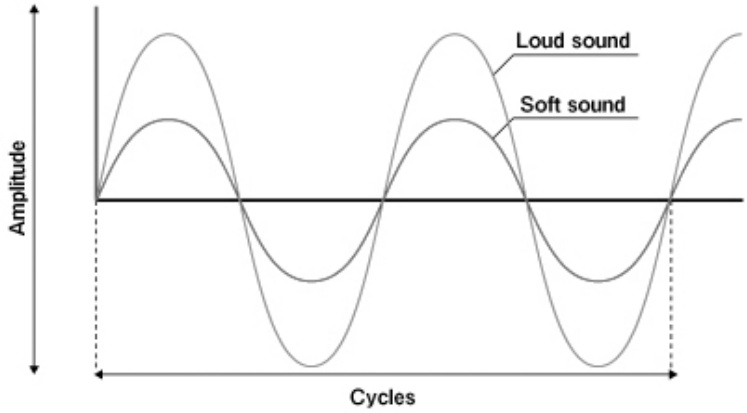


Fig 3: Loud and soft sound

2.3.5 Decibels

Decibel is one-tenth of Bel, which is a relative unit in logarithm. It is the unit of measurement of intensity used in audiology.

Linear scales of intensity or pressure ranges require working with large numbers or scientific notations. To simplify our work, a decibel scale is used. The decibel scale is a logarithmic ratio scale where any measured value is relative to some specified reference value. It can also be stated as a unit for expressing the ratio between two sound pressures or two sound powers.

dB= 10 log(Xmeas/Xref),

WhereXmeas is the sound that is being measured and Xref is the reference sound to which Xmeas is to be compared.

Sound can be measured in sound pressure or sound intensity where Intensity(I) and pressure(P) are related as

$I = P^2$

dBIL=10log(Imeas/Iref)

dBSPL = 20 log (Pmeas/Pref)

CONCEPT OF dBHL VS dBSPL

dBHL

The conventional audiometers used today are set to a standard that the lowest sound intensity that stimulates normal hearing has been variously called 0 hearing loss and 0 hearing level (HL).This was also called audiometric zero. The minimum amount of Sound Pressure Level needed to generate 0 HL is variable across frequencies, due to

sensitivity of ears. E.g 7 dBSPL produces a sensation of 0dBHL at 1 KHz, whereas 13dBSPLis needed to produce 0dBHL at 8KHz.Therefore the hearing dial or the intensity dial of all audiometers was calibrated with reference to normal hearing (audiometric zero)

dBSPL

Sound Pressure Level is an expression of the pressure of a sound. When in the measurement of decibel the reference value (Xref)is the lowest pressure needed to hear (20μPa), it is called dBSound Pressure Level. This value is universally accepted standard reference value (20 μPa).

2.3.6 Auditory Milestones in Typical Children (0-2 Years)

Prenatal Hearing

The human hearing organ that is the cochlea has normal adult function after the 20th week of gestation. There is ample research which shows prenatal hearing. The developmental response to sound in the foetus is primarily reflexive in nature, including startle, generalised body movement, possible cessation of activity and the involuntary eye blink.

NEONATAL HEARING

At birth or soon after birth the infant is able to discriminate his/her's mother's voice. They are also able to discriminate the various segmental and suprasegmental aspects of speech.

The Auditory development can be understood in the following stages

Birth to 4 weeks: Startle response: the infant may startle or jump to loud sounds.Eyes may widen or blink, arms and legs may fling out.Infants may awaken from sleep.

3 to 6 months: Searching Response:Baby will turn head and eyes to look for an interesting sound e.g name call. He or she enjoys sound making toys and music.Begins to coo and gurgle,repeats sounds like bababa

6-10 months:Localisation; baby will start to turn towards the source. He or she can move head towards the side and indirectly below. Responds to familiar voices and familiar sounds e.g mobile ring, name call, doorbell. Makes many different babbling sounds, even when alone. Understands common words such a "no" and "bye bye".

10- 15 months: Response to speech; the infant directly locates the sound source to the side and below. Also starts to localise indirectly above.They start to understand simple speech,play with own voice,imitate simple words and start using meaningful words.

15-18 months: Direct Localisation; can identify the source of all sounds,localises on

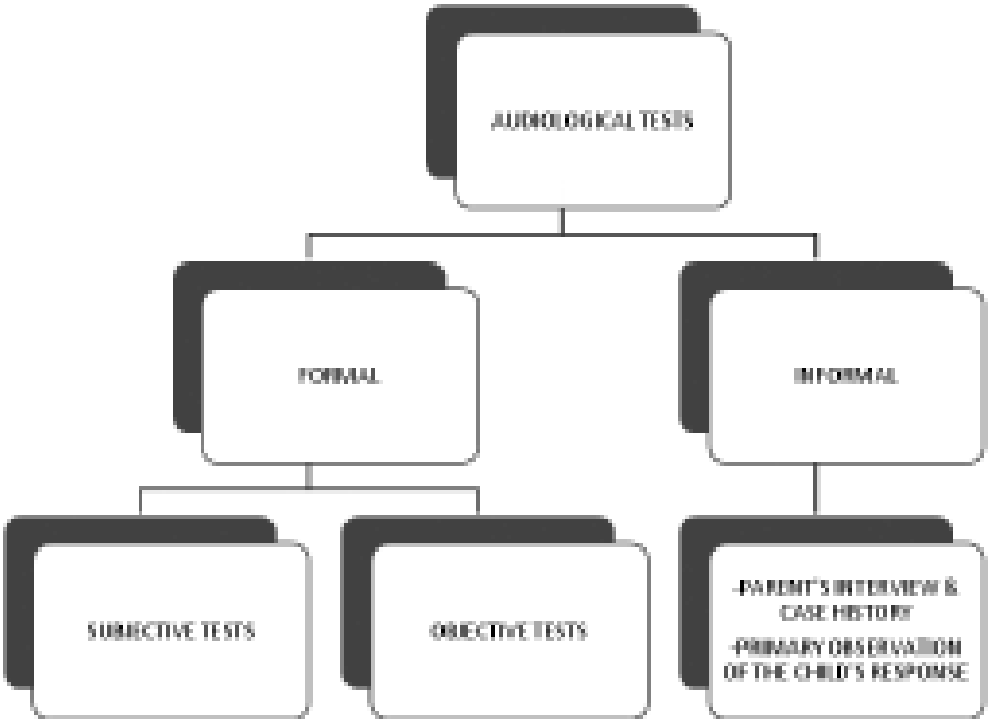
the sides,below and above.By 18 months the infant correctly responds to simple speech,follows simple commands, uses more words in expression, may initiate to join two words.

24 months: the child locates directly a sound at all angles, starts to use phrases and simple sentences. Understands more of adult speech and talking.

2.4 Assessment and Methods of Assessment

2.4.1 Test Battery Approach

Children with hearing loss,acquired or congenital will not demonstrate the typical auditory skills described earlier. Audiological assessment is necessary to correctly identify, diagnose and remediate hearing loss in children. Audiological assessment in children should be characterised by TEST BATTERY APPROACH that is more than one test should be carried out to confirm the detection and diagnosis of hearing loss. The test results should be cross-checked and validated .Parents may need to be advised that the paediatric hearing examination is an ongoing, age-specific activity, so that as the child grows older, more accurate hearing results may be obtained. The various tests used for audiological assessment in children can be classified as



FORMAL HEARING TESTS

All the formal tests make use of instruments which can vary from simple to most sophisticated ones. The tests are characterised by presentation of a sound stimulus such as puretones, speech, warble tones, noise and elicitation of a time locked response from the child to be tested. The tests are performed by an audiologist (Tester) on subjects with or without hearing loss .The tests give a result, which is again interpreted by the tester.The ultimate goal of each test is to establish the auditory/hearing threshold, which is the minimum stimulus level that elicits a response consistently. It is always advocated to use the cross-check principle in paediatric audiometry. According to this principle the results of subjective tests such as BOA (Behavioural Observation Audiometry) should be cross-checked with objective tests such as ABR. All these tests are carried out in sound treated rooms(usually double room set up) which prevent external noise to enter that may interfere with the testing procedure. The instrument used for basic tests are audiometer, immittance audiometer, instrument for electrophysiological tests such as ABR (with software and other accessories), and OAE instrument. The sound stimulus is presented in sound field condition that is via loudspeakers or under closed field condition that is via headphones.These tests can be used for both screening and diagnostic purposes. These tests can be used for school screening programs also. The tests are carried out by an audiologist and an assistant tester is employed if needed.

Prerequisites for Formal Test

1. Case History/Parental Interview
2. Otoscopic examination of ears- to ensure clean ears,no infection/discharge, no ear anomaly

Fig 4: Otoscopic Examination

3.Tuning Fork Test – can be performed by using tuning forks in older and cooperative children to get an idea about probable site of pathology(middle ear or inner ear)

Fig 5: Tuning fork test

4. Selecting and deciding on the tests to be administered- Usually it is important to use a test battery approach in case of infants and children. This is because, it is often difficult to obtain reliable and complete results from any one particular test. So more than one test should be administered depending on the child's age, hearing status, cognitive status and economic status.

e.g For a child aged one year, BOA, IMMITTANCE AUDIOMETRY AND ABR/ASSR can be administered for correct threshold estimation.

2.4.2 Subjective Tests

As the name suggests these tests need participation of the subject.The participation can be active or passive. In these tests the response is recorded after the presentation of a stimulus. The response can be a predefined active one,e.g. raising hand in response to a sound stimulus,or it can be a change in behaviour of the child, e.g. searching for the sound stimulus or startle response which can be noted by the tester.

2.4.3 Orientation to Subjective Tests

These tests can be classified into two major divisions;

1) Techniques used without reinforcement
2) Procedures based on reinforcement of the infant or child's responses

The techniques utilized that do not incorporate reinforcement principles are known as Behavioural Observation Audiometry(BOA).Procedures that use reinforcement to develop repeatable responses are known as conditioned audiometry,such as Visual

Reinforcement Audiometry(VRA)

The first type of techniques are carried out for younger children (upto 12 months), however can be used till 24 months. Conditioning techniques are carried out for older infants and children,between 12-48 months.However the use of behavioural and conditioning procedures with infants and young childrenmay lack sufficient precision to establish valid auditory sensitivity thresholds. An improvement in response behaviour should always be anticipated as the child matures.Auditory evaluation of hearing in children should be considered as completed when earphone thresholds can be obtained for frequencies 250 Hz to 8000 Hz in a test called puretone audiometry.

Let us briefly learn about these tests

2.4.4 Behavioural Observation Audiometry

It is an important clinical test in day to day clinical use. This is mostly used for children upto 6months, but can be used for older children as well, especially those who cannot be conditioned. The use of noisemakers and sound field signals from an audiometer as acoustic stimuli is done in BOA.The major advantages of BOA are efficiency in time required and the lack of need for specialised equipment. The disadvantages of BOA include the fact that it is difficult to eliminate tester bias, the responses of infants quickly reach saturation and a wide variance of responses are noted in infants.Moreover the test does not yields ear specific responses and only gives an idea about degree of hearing loss.This test should ideally be carried out in a quiet background, and sound field condition. The stimulus should be presented in an ascending manner (soft to loud). During the test one audiologist makes a sound, making sure that the child cannot see them, while a second audiologist watches for any change in the child's behaviour (e.g., a "startle" or sudden reflexive movement, eye blinks or cessation of activities). The type of sound is recorded together with its intensity and the nature of the behaviour change. The infant or child can exhibit reflexive response such as startle (younger children/infants below 3 months)or attentive behaviour (above 3 months)such as quieting responses.Children quickly grow accustomed to sounds and may stop showing a response if they hear the same sound often enough. For this reason, it is recommended that repeated "testing" at home is avoided prior to formal BOA testing with the audiologist.

The intensity and frequency of noisemakers can be premeasured for estimation of hearing levels. Puretones,warble tones,speech andnarrow band noise can be used for sound field testing via an audiometer.Handheld paediatric audiometers with intensity and frequency dials/interrupters can also be used.This test can be used for both screening and diagnostic purposes.

Fig 6: BOA

Importance of BOA

1. This test is a true test of hearing unlike electrophysiological tests or objective tests,

   which are not actual tests of hearing. Moreover there are very less chances of the response being affected by instrumental errors or recording artifacts.This test gives information about degree of hearing loss across frequencies.

2. This test can be carried out with passive participation of the child. The child/ infant is the best person to inform about his/her hearing status,that is,it is always very helpful when we can observe the child's actual response to sound stimuli instead of relying on parents' reporting.

3. This test can be carried out in a state of light sleep,as passive participation of the infant/child is needed.

4. This test can also be carried out for difficult to test(for conditioned audiometry)population. E.g children with multiple disability or non-co-operative child.

5. This test is cost effective as not much sophisticated instruments are needed,it is very important to save expenses of the parents.

6. This test can also be performed with the help of noisemakers, if proper instruments are not available.

7. It is an important screening tool.

2.4.5 Reinforcement Audiometry

These tests involve the use of conditioning techniques.The response of the infant or child is conditioned with use of reinforcers.This procedure has been called as operant conditioning. Reinforcer is any entity-verbal praise, an object, food, that increases the likelihood that response will occur again. If a stimulus is given, then a response is obtained and then reinforced, it is likely that the response will occur for many more stimuluspresentations. With more responses available it is possible to obtain thresholds.

Visual Reinforcement Audiometry

It is the use of visual reinforcer in the process of obtaining auditory thresholds. A variety of visual reinforcers can be used. It can be used for children aged 6 months to 2 years. The reinforces can be video-based or made up of animated toys placed in dark Plexiglas boxes located at an angle to each side of the child. The reinforcers should be located approximately level with the child's head at a distance of 1-2 m. Close proximity between speaker and reinforcer is preferred in order to help conditioning when using soundfield stimuli; so in practice adjacent positioning of loudspeaker and reinforcers is recommended. At first, the audiologist lights up the boxes in conjunction with the sound. This "trains" the child to respond by shifting her eyes or turning her head toward the sound source. Once a child understands what to do, the audiologist can "reward" the child by briefly delaying the visual stimuli. The boxes are lit to elicit a head turn associated with a sound source.During the testing phase the light is flashed immediately following the response of the child looking toward the light.

Fig 7: VRA

Importance of VRA

1. It is an important test for children between 6 months to 2 years and gives accurate findings as the child gets motivated for the reinforcement used
2. It is an important test for developmentally delayed children, who cannot cooperate for puretone audiometry.

2.4.6 Conditioned Play Audiometry

As the name suggests use of games or play techniques is done in this procedure to obtain hearing thresholds of the child. This procedure can be used for children from 2 years till 5 years. However for younger children, behavioural observation and parental interview should always guide the threshold estimation.The child is conditioned to a sound stimulus through some play activity such as to place a ring on a stand, put a block in a box upon hearing the sound (either in sound field or through headphones). Initially the tester might demonstrate the activity and the try to engage the child. If interesting toys are used the child can be kept interested for long enough to get lots of testing accomplished. Blocks, puzzles, chips, pebbles, all of which can be dropped into a bucket are good. It is important to have many toys available so when the child becomes tired of a toy,it can be changed quickly. It should be kept in mind that the child may not be cooperative through the total testing time,may need breaks or might need a follow up.However it is always wise to test the speech frequencies first,some testers might do the bone conduction testing first or might use speech signals to generate interest of the child. The child will begin by using both visual and auditory cues. When he can do the task by himself using both visual and auditory cues, visual cue can be removed and auditory alone can be tried. The parents can be instructed to teach conditioning to the child at home with use of noisemakers so that the child can give better responses in the next session.

Fig 8: Conditioned Play Audiometry

Importance of Conditioned Play Audiometry

1. This test prepares the child for puretone audiometry.
2. Frequency wise information on hearing can be obtained. This test gives information about both degree and type of hearing loss.
3. Hearing in both ears can be tested.

2.4.7 Pure Tone Audiometry

Pure tone audiometry is a routine audiometric test used to measure auditory threshold of an individual in a sound proof test room. The instrument used in this measurement is known as the audiometer. This is a subjective investigation, the accuracy of which is dependent on the response of the patient. It can be used for children 5 years and above.Pure tone audiometry provides information about the type of hearing loss and also helps in quantifying frequency specific threshold. This test is generally performed with headphones(FIG 9) for air conduction testing (AC) and bone conduction vibrator(Fig 10) for bone conduction testing (BC).Simple pure tones varying in frequency from 250 Hz to 8000 Hz;and varying in intensity from 0 dBHL to 120 dbHL are used for testing.However the frequency and intensity range depends on the test. For example,in case of BC testing,the measurement is done from 250 Hz to 4000 Hz. The intensity range is also maximum up to 85 dBHL. With the help of a particular pattern/sequence of presenting the puretones,the ear specific threshold across all the test frequencies is established and plotted on an audiogram.The tester should be aware of false responses made by the child and should know how to minimize them.Younger children might need reinforcements,breaks in between testing and often repeated sessions for establishment of reliable thresholds across all the frequencies. The better ear is always tested first, and also masked if required. The AC testing gives information about external, middle and inner ear, whereas the BC testing gives information about inner ear. In case of children, the ultimate goal of assessment should be to obtain puretone audiometry results. The response pattern of the child can be any conditioned response from simple hand raising to keeping blocks in a box.

Fig 9:A) Air conduction testing B) PTA in double room setup

Fig.10: Bone Conduction Testing

Importance of Puretone audiometry

1. The ultimate goal in paediatric evaluation is to obtain puretone thresholds because they give accurate information on type and degree of hearing loss.The information about type of hearing loss is very important for otologists to take decisions about medical treatment. Audiologists can use this information to plan the other tests to be administered.The information about degree of hearing loss is very important for selection of amplification devices, planning speech-language therapy goals and educational placement
2. It givesindependent information about hearing in both ears and the full audiometric frequency range.
3. Regular or periodic assessment of hearing sensitivity by puretone audiometry helps in identifying the changes in hearing sensitivity of subject at regular intervals. This helps in early detection of progressive hearing loss.
4. It helps in determining the amount of benefit from medical and surgical treatment.
5. The pure tone audiometry also helps the audiologist in selection of suitable amplification device and accurate adjustment of the same.The results of puretone audiometry also help to decide about ear to be fitted and also about monoaural vs binaural fitting.
6. The results of pure tone audiometry also help to decide in selection of assistive listening devices,e.g classroom amplification solutions and their adjustment.
7. It provides direction for further management and suggests direction for further investigations.
8. The results of this test help the child to get a handicap certificate,which further helps to get benefits from State and Central Government in job reservations,exemption in tax, travel reservations etc.
9. The results of this test are accepted by agencies to ascertain auditory fitnessfor certain jobs like pilots, policemen,corporate sector etc.

2.4.8 Speech Audiometry

As the name suggests,the stimulus or signal used for this test is speech. Speech audiometry is an additional test,which is done to confirm the results of pure tone audiometry. Moreover it gives an idea about difficulty in real life situation where the most important stimulus to be heard is human speech. A pure tone audiometer is used

for this testing,when the speech is presented live,the tester speaks in the microphone attached to the audiometer which can be heard by the child wearing headphones,or through loudspeakers in the test room. The speech signal can also be recorded and presented using a CD player which can be connected with the audiometer.The speech stimulus can be monosyllables or PB words like /pa/, /cha/, /sha/, word pairs called spondee like /ma-baap//aaj-kaal/the child has to repeat the stimulus upon hearing,or they can write it down. Younger children can also point out picture cards corresponding to the stimulus words or sentences.However the child's receptive vocabulary and cognitive level should be considered while selecting the speech material.There are basically some subtests done under speech audiometry

a) Speech recognition threshold (SRT)-gives us the threshold at which the child can just hear speech clearly and repeat. This is measured in dBHL. It can be correlated with the pure tone audiometric threshold. If there is any discrepancy between the two thresholds, then it can be suspected that either the testing procedure was faulty or the child's response is doubtful.

b) Speech discrimination score/word recognition score (SDS/WRS)-gives us idea about theamount of speech the child can understand or finds intelligible in percentage.eg. WRS is 60% that means out of 100 words, the child can correctly hear 60 words.

c) Ling Six-Sound Test-this test can be carried out without or with the audiometer. Six sounds /a/,/u/,/e/,/i/./m/,/s/.which represent most of the human speech frequencies are used for this test. Detection, identification and discrimination of these sounds is tested.

Importance of Speech Audiometry

1. It validates the result of puretone audiograms.
2. In case of difficult to test population, the child may respond to speech stimulus better than pure tones.
3. Speech discrimination test can be used to differentially diagnose pathologies beyond cochlea,e.g central deafness,where a discrepancy between PTA and SRT/ SDS

2.4.9 Objective Tests

These tests need no active participation from the child. The child's state of arousal,cognitive level or vocabulary do not affect the results of these tests. These tests are time effective and also provide an important tool in the test battery approach. They

also help to cross check the results obtained from subjective tests. The use of these tests give information about functioning of the hearing structures, beyond cochlea.These tests give information about type and degree of hearing loss and the probable site of lesion.However these tests are at an extra expense to the routine hearing tests,so the selection of these should be rightly justified.Many of these are also used for screening purposes in neonatal stage. Moreover these tests are very important for difficult to test population e.g.children with intellectual impairement, non-cooperative child.

2.4.10 Immitance Audiometry

Also known as impedance audiometry,it is an automatic and objective means of assessing the integrity and function of the peripheral hearing mechanism. The impedance audiometer helps to determine tympanic membrane mobility,middle ear pressure,Eustachian tube functioning,continuity and mobility of middle ear ossicles,acoustic reflex threshold(8^{th} and 7^{th} cranial nerve function) and non-organic hearing loss.This test is routinely performed along with puretone audiometry.This test can be carried out in neonates,in sleeping children. However this test cannot be performed if the child is moving,crying or speaking.As a prerequisite it needs clean ear canals and no active infections,pain or discharge from ears. In this test a small probe is inserted into the external auditory canal of the child.The probe has three small holes. One emits a probe tone,the second is an outlet of air pressure system,and the third leads to a pick up microphone that measures the SPL of probe tone in the ear canal cavity.

Fig 11: Impedance Audiometry

There are two subtests of Immitance audiometry

a) Tympanometry-the mobility of tympanic membrane as a function of mechanically varied air pressure in the external ear canal is measured. The introduction of air pressure in the ear canal leads to mobility of the tympanic membrane, this can be recorded as a tympanogram. The movement of the TM depends on the functional status of middle ear. Any abnormality in the middle ear,effects the normal movement of the tympanic membrane. Along with tympanic membrane mobility(compliance), middle ear pressure and ear canal volume are also measured in tympanometry.The tympanogram can be of following types
    1) Type A – normal middle ear function
    2) Type As – Restricted mobility of tympanic membrane(otosclerosis)
    3) Type B – No mobility of tympanic membrane(fluid in middle ear)
    4) Type Ad- Abnormal or excessive mobility of tympanic membrane(ossicular chain discontinuity)
    5) Type C- normal mobility of tympanic membrane with negative middle ear pressure.

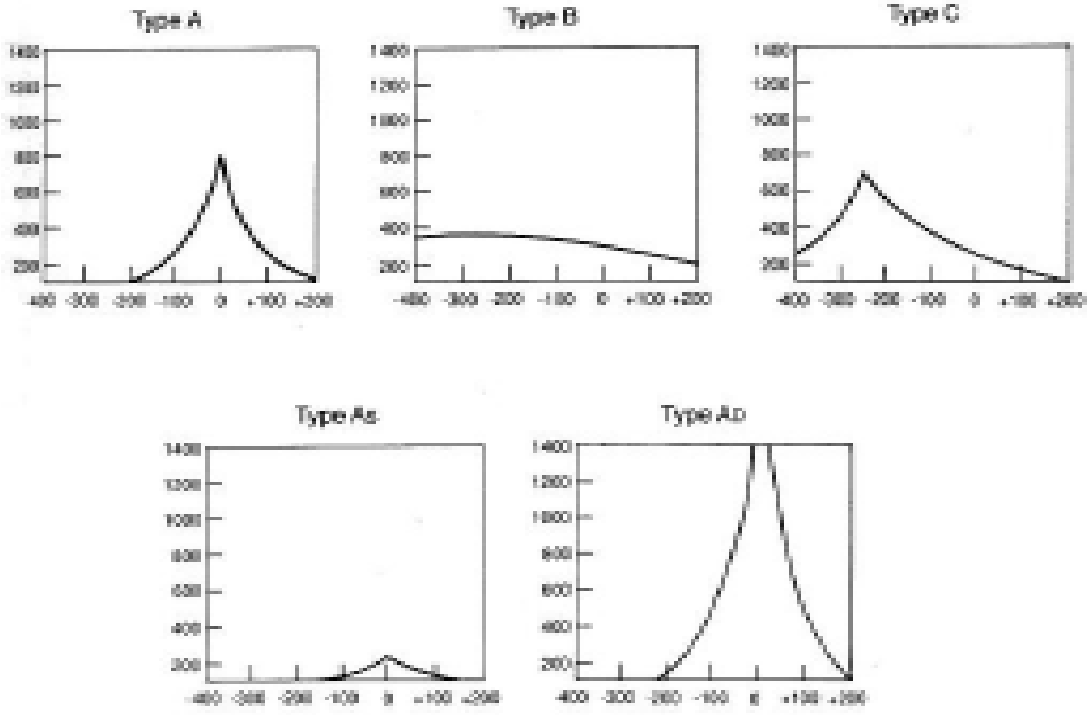


Fig 12: Types of tympanogram

b) Acoustic Reflex Threshold- the acoustic reflex test in the immittance battery is the determination of the signal threshold level at which the stapedial muscle contracts.The lowest signal intensity capable of eliciting the acoustic reflex is the acoustic reflex threshold for the stimulated ear.In normal hearing ears,it is usually between 70 and 100 dBHTL.This means an individual with a puretone threshold of 20 dB, is likely to have ART between 90 and 120 dB (20 +70)The measurement is made both ipsilateral(stimulated ear) and contralaterally(opposite ear) simultaneously.

Importance of Immittance Audiometry

1. It helps to determine the type of hearing loss. Also helps to detect the presence of middle ear pathology and probably the type and stage of disease. This further helps otologists to provide medical treatment.
2. It provides as a useful tool to assess pre-treatment and post treatment condition. E.g a child with Eustachian tube dysfunction will have C type tympanogram, after treatment it becomes A type.
3. It is a quick test and can be used for screening.
4. It is a very important test used to cross-check the results of puretone audiometry.
5. It can provide useful information about hearing in difficult to test population who do not cooperate for conditioned responses.
6. It can be carried out when the child is asleep, needs no active participation.

2.4.11 Brainstem Evoked Response Audiometry

Also known as Auditory Brainstem Evoked response measurements provide information about functioning of peripheral hearing system and hearing upto brainstem level.This objective test helps in hearing assessment and also helps to locate the site of a particular lesion along the auditory pathway. A stimulus called click or tone burst is given through headphones/insert earphones and the response is recorded from the electrodes placed on various positions on the scalp of the child. There is continuous ongoing activity in the brain, an introduction of sound in the auditory path, causes a change in this ongoing activity and this can be recorded in a form of waveform. This testing is best done when the child is calm or asleep. This can be done in new-borns, difficult to test children and also in children suspected with neurologic dysfunction (8th

nerve-tumour,dyssyncronyetc.). This test can also be used for hearing screening programs in NICU.The test is carried out using a BERA instrument. The test also aims to determine the threshold of hearing, however the results obtained are interpreted and deduced in order to get the actual threshold of hearing. The waveform obtained is denominated with certain peaks(I-VI).The lowest intensity upto which peak V can be identified is defined as the threshold obtained from BERA and is usually 15 dB above PTA threshold.

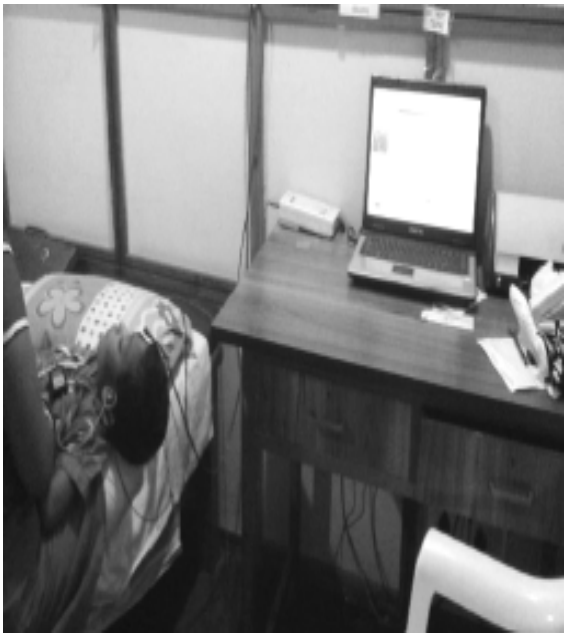


Fig 13: Set up for ABR/ASSR

Importance of BERA

1. It is a very important screening and diagnostic test. It can be used in neonates also.
2. It is an important component of the test battery used to assess young children and difficult to test population. This is because it gives ear specific information about degree of hearing loss.
3. It is also an important test for differentiating between cochlear and nerve pathologies, e.gtumor.
4. It is a very important test as it is not affected by state of arousal, cognition and vocabulary of the child.

2.4.12 Otoacoustic Emmisions

Otoacoustic emission are low level,inaudible sounds produced in the inner ear. Further these can be elicited and recorded from ear canal on introduction of external sound.This is a quick procedures. The instrument consists of a probe assembly, to deliver tone and record responses at the same time from the ear canal. The presence of response indicates intactness of some part of inner ear, however the response can get affected by middle ear pathologies, presence of wax in ear canal etc. Used both as screening and diagnostic purposes.Children who fail in this test are referred for further testing.This test is also used as a part of test battery.Diagnostic tests can be Transient Evoked OAE(TEOAE) or Distortion Product OAE(DPOAE).

Fig 14: OAE

Importance of OAE

1. It is an important test as it is quick, and reliable. It can be used for neonates.It can be used for screening as well as diagnosis of hearing loss.
2. It can detect early signs of sensorineural hearing loss.

Frequency wise responses can be obtained in a special OAE test called DPOAE.

2.4.13 Auditory Steady State Response

The auditory steady-state response (ASSR) can be thought of as an electrophysiologic

response to rapid auditory stimuli. The goal of ASSR is to create an estimated audiogram from which questions regarding hearing, hearing loss, and aural rehabilitation can be answered. Stimulus is modulated pure tone. Has potential to be a faster test than ABR when perfected.Some equipment can test multiple frequencies and both ears simultaneously.Uses same basic set-up and equipment as ABR.ASSR is similar to the Auditory Brainstem Response (ABR) in some respects. For example, ASSR and ABR record bioelectric activity from electrodes arranged in similar recording arrays. ASSR and ABR are both auditory evoked potentials. ASSR and ABR use acoustic stimuli delivered through insert earphones (preferably). ASSR is evoked using repeated sound stimuli presented at a high repetition rate, whereas ABR is evoked using brief sounds presented at a relatively low repetition rate.

Importance of Assr

1. ASSR allows the hearing care professional to create valid audiograms for those unable to participate in traditional behavioral tests.

2.5 Audiometer

The audiologist uses an instrument called AUDIOMETER for many hearing tests like puretone audiometry, BOA etc. There are different types of audiometers that are commercially available. These can be classified as diagnostic, screening, computer-based depending upon their function. Also there are different makes and models available commercially.

2.5.1 Block Diagram

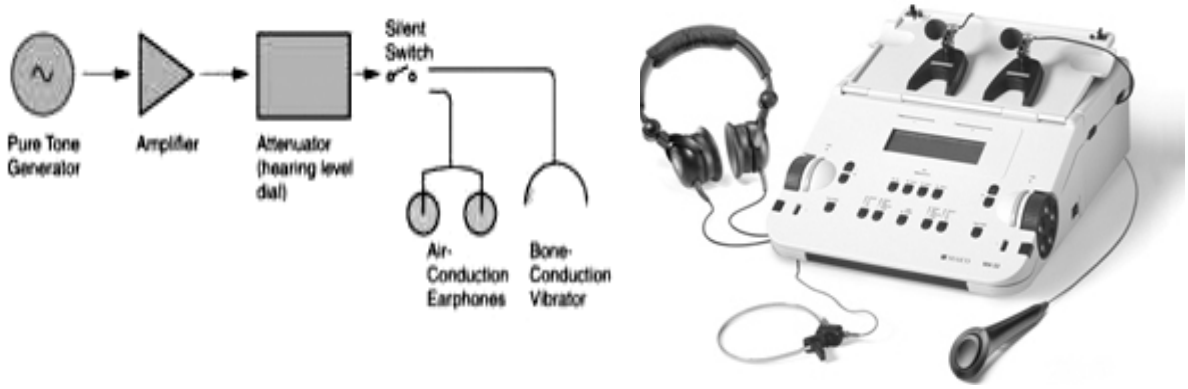


Fig 15: Audiometer

2.5.2 Parts And Their Use

The basic functions of an audiometer are to produce puretones at selected frequencies, change the intensity of the signal, select how the signal is delivered to the ear and direct the signal to a desired ear .For example a tester would select 1000 Hz as the frequency,40dB as the intensity, earphones as the transducer and right ear for the signal presentation.To achieve these functions following parts are required

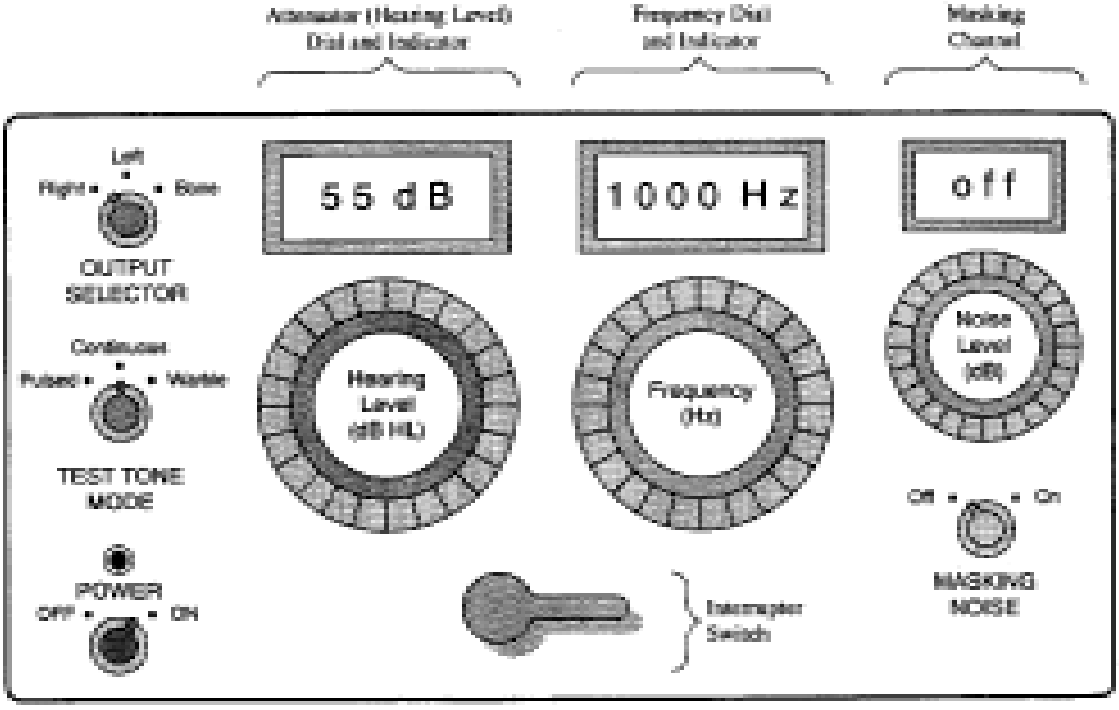


Fig 16: Parts of an Audiometer

1. Pure Tone Oscillator(Frequency dial)- it is the part of the electronic circuit located in the audiometer which generates pure tones at different frequencies like 250 Hz,500 Hz,1000 Hz,2000 Hz,4000 Hz,8000Hz. Some audiometers also provide option to test mid frequencies. It is represented as frequency dial/ switch with markings of various frequencies on the audiometer.
2. Attenuator/Attenuator Dial- This part of the circuit helps to control the sound pressure level or the intensity of the sound.The intensity can be changed in 5

dBsteps from -10dBHL to a maximum output level which varies with the test and frequency.

3. Interrupter Switch – this part of the circuit helps to present the signal to the patient. It is an on-off switch for puretone presentation. It also controls the duration of the signal presented to the patient.
4. Power Switch- This is used to switch the audiometer ON and OFF.A.C main supply of 220 volts or batteries can supply the power.
5. Transducer Selector - This part of the circuit helps to select the transducer through which the signal will be delivered. Transducers are the parts which convert electrical energy into sound energy or vibratory energy.For example Headphones are selected for air conduction testing.The BC vibrator is selected for bone conduction testing.
6. Router switch - this part of the circuit helps to direct the signal to desired location. For example right ear or left ear.
7. Signal Selector Switch-helps to decide the type of signal to be delivered. For example puretone, speech or noise.
8. Masking Dial/Switch: A part of this test makes use of noise to stop participation of a particular ear. The masking switch is used to present the masking noise in some audiometers.
9. V-U Meter- this helps to monitor the output level.
10. Microphone- is used to present speech through headphones or loudspeakers.
11. Patient Response Switch- Optional facility, given in patient's hand. He can press the switch to indicate his response upon hearing the sound, simultaneously a light glows on the audiometer for the tester to understand. Not recommended for young children as they can give false response.

2.5.3 Type of Audiometry

Sound Field Audiometry

Sound field audiometry is a test in which the test stimuli are delivered through a loudspeaker instead of earphones, is commonly used in the clinical evaluation of difficult

to test clients, such as infants, young children, and persons with developmental disabilities, as well as in the assessment of hearing aid benefit for adults and children. The loudspeakers are placed at anangle from the child in the test room,for example 45 °.The type of signal used can be pure tones, modulated tones (warble), noise or speech .The response of the child can be obtained by behavioural observation(BOA, VRA) or conditioned responses (free filed audiometry). An audiogram can be obtained across the audiometric test frequencies.

Fig 17: Sound Field Audiometry

Closed Field Audiometry

The audiometric results obtained in a sound treated room, under headphone condition. More accurate results (thresholds) can be obtained in this condition. Under headphones the thresholds can be obtained frequency wise and ear wise. The stimuli which can be used are pure tones, warble tones or speech. Moreover we can block the participation of either ear by using noise in a special procedure called masking. This yields the true thresholds of each ear.The stimulus can be presented using a variety of transducers names supraaural headphones,circumaural headphones, or insert earphones. Closed field audiometry is suitable for older children (more than 5 years) and adults, who can keep wearing the transducer during the test time.

Fig 18: Transducers for Closed Field Audiometry

Supra Aural HeadphoneCircum Aural Headphone

2.5.4 : Role of Special Educator in Conditioning for Pure Tone Audiometry

Special educators are one of the important team members in the identification and intervention of hearing loss. These professionals are included in the daily routine of a hearing impaired child. A child being conditioned for puretone audiometry, often takes days of practice before delivering the accurate response. Prior to that a regular conditioning practice needs to be carried out. The hearing impaired child spends most of his waking hours in school after being at home, therefore parents and special educators play an important role in conditioning the child for PTA. The concept of classical conditioning or operant conditioning can be implemented in the course of conditioning the child. The special educator can easily communicate with the child and make him/ her understand the whole process as the teacher shares a good rapport with the child. The teacher can make use of certain noisemakers, loud sound generating items to elicit the conditioned response in the child. He can plan to have a daily 15 minutes practice session during classroom hours. He can train the child to give conditioned responses, such as raising hand, keeping a peg etc upon hearing the sound. The teacher can initially

give the sounds with visual cues (in front), then without visual cues (from the back).This practice helps the audiologist to finally carry out the entire testing and get a reliable audiogram.

2.6 : Audiogram

The results of puretone audiometry, are plotted on a graph. This plotting is done at various frequencies and intensity level. The graph is called an audiogram.

2.6.1 Understanding of Audiogram

The figure shows a typical audiogram. The X-axis shows the frequencies and the Y-axis shows the intensity levels across which the testing is carried out. The thresholds are plotted at the junction of frequency and intensity. For example in the figure below, the threshold at 1K(1000 Hz) is 25 dBHL. Each vertical line represents frequency and each horizontal line represent the intensity level. The frequencies are expressed in Hz or KHz from 250 to 8000 Hz (left to right). The intensities are expressed in dBHL, from low to high (top to bottom),-10 dBHL to 120 dBHL. In a typical audiogram the air conduction threshold for both ears is plotted, the bone conduction threshold of better ear is plotted first followed by the other ear. If needed the masked AC and BC thresholds are plotted. A typical audiogram is plotted in figure 19.

Symbols: For plotting audiograms, specific symbols are used for air conduction and bone conduction threshold of each ear. These symbols are internationally standardised. Red colour is used for plotting of right ear and blue for left ear.The thresholds for air conduction are joined by a solid line, but the thresholds for bone conduction are joined by dotted lines. The symbols are shown in figure 20.

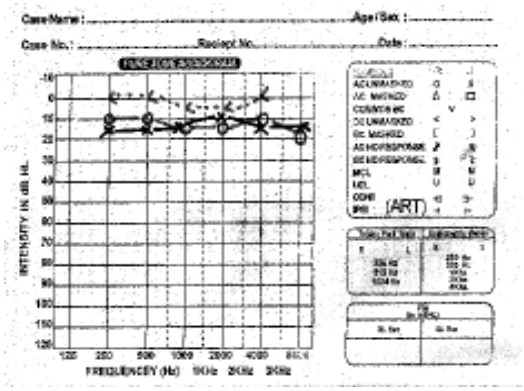


Fig 19: Typical Audiogram

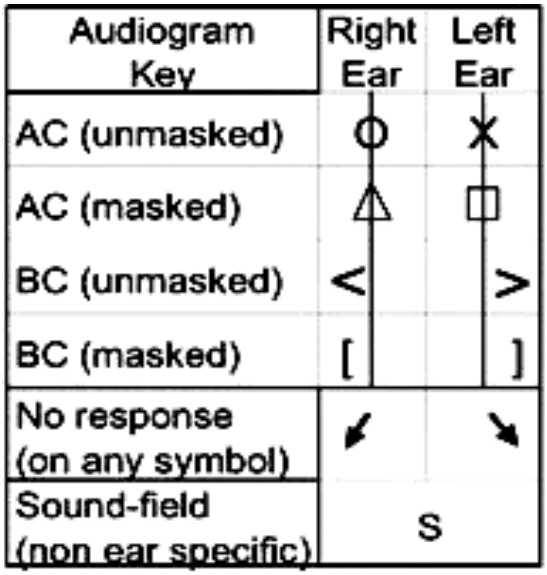


Fig 20: Symbols used on an audiogram

2.6.2 Audiogram Interpretation

Audiogram mainly provides information about type and degree of hearing loss. Also it provides separate information about each ear, which helps in diagnosis, as well as planning appropriate management.The PureTone Average (PTA) provides information about the degree of hearing loss and the difference between air conduction threshold and bone conduction threshold indicate the type of hearing loss.

Degree of hearing loss- for determining the degree of hearing loss (amount of impairment) the pure tone average is calculated. The pure tone threshold of each ear at three frequencies 500 Hz, 1000 Hz and 2000Hz, are summed and divided by three. For example the threshold at 500 Hz, 1000 Hz and 2000 Hz is 50, 60 and 40 dBHL. The PTA is calculated as follows:

$$\frac{50 + 60 + 40}{3} = \quad 150/3 = 50\text{dBHL}$$

The degree of hearing loss in the above example is moderate.

The degree of hearing loss in the above example is moderate.

Table 1 : PTA and Degree of hearing loss

PTA	Degree of Hearing Loss
-10 to 15 dB	Normal Hearing
16-25 dB	Minimal Hearing Loss
26-40 dB	Mild Hearing Loss
41-55 dB	Moderate Hearing Loss
56-70 dB	Moderately Servere Hearing Loss
71-90 dB	Severe Hearing Loss

Type of Hearing loss:

Hearing loss is categorized into different types, depending on what part of the auditory system is damaged. The three types of hearing loss are conductive, sensorineural and mixed hearing loss. For understanding the various types of hearing loss, we need to understand the normal hearing sensitivity.

Normal Hearing Sensitivity: When the thresholds for both AC and BC are within 15 dBHL, also the difference between AC and BC thresholds is less than or equal to 10 dBHL, we can interpret it as normal hearing sensitivity.

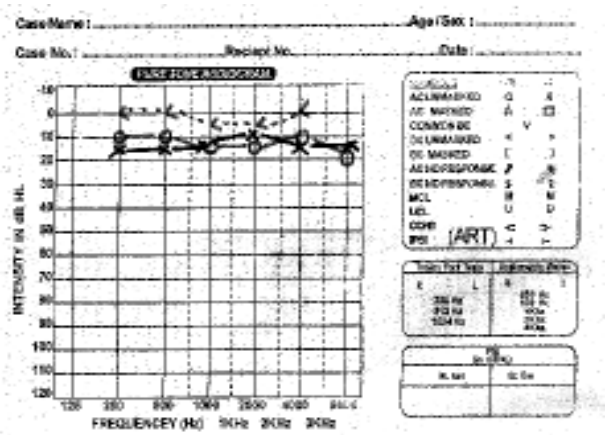


Fig 21: Audiogram showing normal Hearing

Conductive Hearing Loss- When the AC thresholds are abnormal (upto 70 dBHL), BC thresholds are within normal range creating an Air-bone gap (ABG), the audiogram gives an indication of conductive hearing loss. It can be seen for one ear or both ears. Both ears may show the same degree or different degrees. Any deficit or malfunction in external ear and/or middle ear causes a conductive hearing loss.

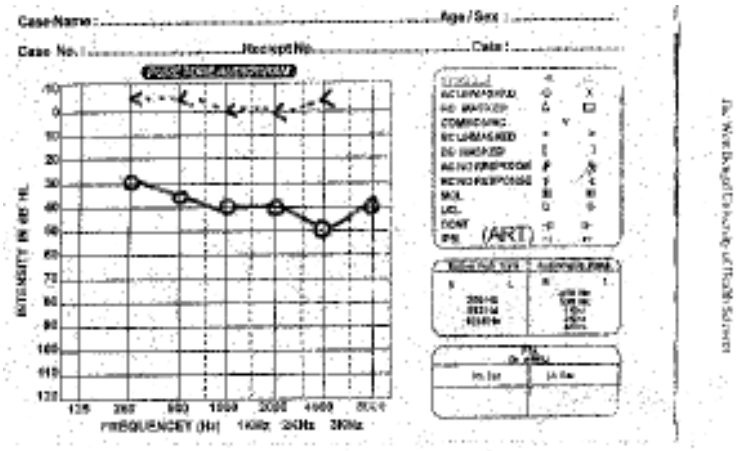


Fig 22: Audiogram showing conductive hearing loss in both ears.

Sensorineural Hearing loss- When both AC and BC thresholds are affected or abnormal, with ABG equal to or less than 10 dBHL, the audiogram indicates sensorineural hearing loss. The defects of inner ear or auditory nerve results in sensorineural hearing loss.

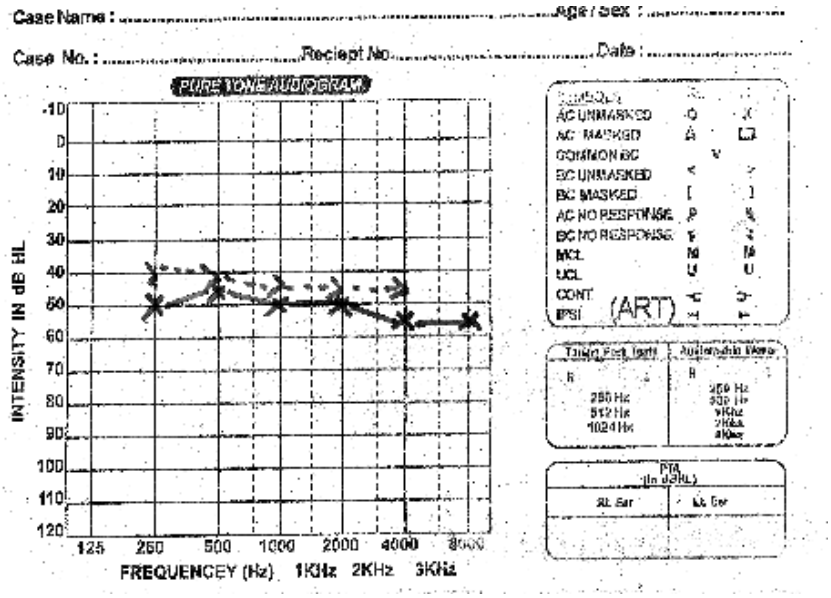


Fig 23: Audiogram showing sensorineural hearing loss

Mixed Hearing Loss – When both AC and BC thresholds are affected, the ABG is more than 10dBHL. The mixed hearing loss occurs when there is involvement of the outer ear and / or middle ear and the inner ear.

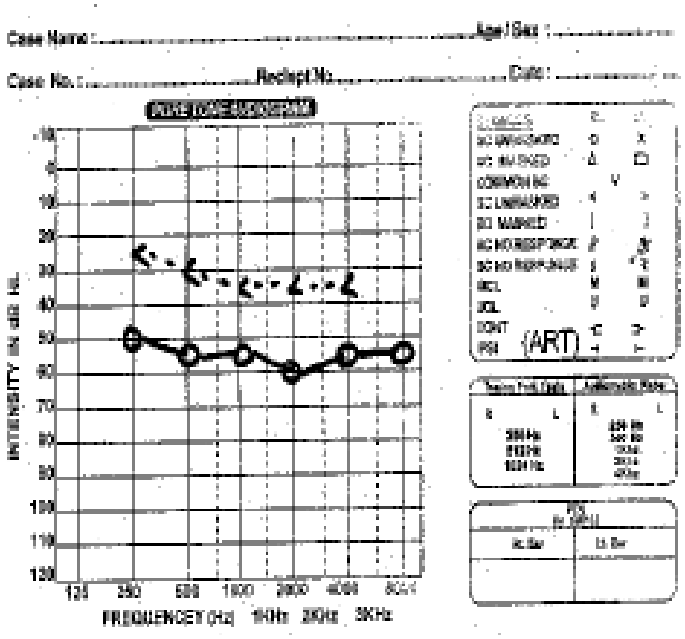


Fig 24:Audiogram Showing Mixed Hearing loss

Configuration of Audiogram

The shape or contour of the audiogram is called its configuration and can be understood from an audiogram. It suggest the underlying pathology. Depending upon the configuration, certain frequencies will be more affected than others. It helps to decide about amplification device and plan the rehabilitation work up. Also helps to predict benefit from amplification and various rehabilitation programs including educational management. Some configurations are as follows:

1. Flat Configuration; all frequencies are equally affected
2. Sloping Configuration: High frequencies are more affected than low frequencies
3. Rising Configuration: Low frequencies are more affected than high frequencies.

2.6. Audiogram Interpretation and Educational Implication

The degree, type and configuration of hearing loss helps to assess the educational needs of the hearing impaired child. The educational needs which can be assessed using

information from audiogram are as follows:

1. Deciding on the schooling option. Depending upon the degree and type of hearing loss selecting the type of school-
    a) Special School placement – this option is for children with more severe hearing loss(bilateral profound hearing loss).Moreover for children who had a late identification and hearing aid fitting with severe to profound hearing loss, special school placement is recommended.
    b) Mainstream school- Hearing impaired children with less severe hearing losses can be included in mainstream schools provided they had an early identification and intervention. It can be further decided depending on their degree and type of hearing loss about the type of mainstreaming to be done- regular school (minimal or mild hearing loss),integrated school, and inclusive school.
    c) Non-formal Education – national open school placement
    d) Some children need special school in early years and then they can move on to mainstream school.(mild to severe degree)
    e) Some children may need special school after primary education.
    f) Some children may need specialized individualized input along with enrolment in mainstream school.
    g) Some children may benefit from mainstream schools and yet require specialized academic support for social studies, science or languages or literacy.(moderate to profound sensorineural hearing loss)
    h) Some children may need some classroom amplification and some may need sign language interpretation in the class.(severe to profound sensorineural/ mixed hearing loss)
    i) Some may need certain concessions and exemptions and the others may not need them.
2. Deciding on the curriculum- Some children may follow the standard educational hierarchy, but some might need a flexible curriculum. For example children with more severe sensorineural hearing loss, might need a flexible curriculum, they often find language and literature subjects difficult as these need more proficiency in speech and language skills.

3. Deciding on the type of evaluation of performance to be administered. For example, conducting written exams over oral exams, using a grading system instead of any examination etc.
4. Deciding about classroom needs- The most important place where the child spends quality time for acquiring education is the classroom. Classrooms for hearing impaired children should be designed and equipped according to their hearing needs.
    a) Seating Arrangement- For instance children with severe to profound sensorineural hearing loss and limited benefit from hearing aids may need preferential seating in the classroom, front seat, close to teacher.Children with milder losses,conductive type may not need this seating arrangement.
    b) Classroom Acoustics- Children with more severe losses and sensorineural type are affected by noise and reverberation. The classroom must be designed to keep them noise and reverberation free.
    c) Installation of classroom amplification devices – All children with hearing impairment benefit from assistive listening devices installed in classrooms. However children with severe to profound hearing loss benefit the most from these devices.For example, FMsystems, loop induction systems.Children with unaidable hearing loss might need installation of alerting devices,such as flash lights to indicate end of period.
5. Deciding on teacher-student ratio – Children with more severe loss need more individualised support. So a lesser ratio is preferred for more severe hearing losses.
6. Deciding upon the communication strategy to be used – unisensory vs multisensory approach. Children with more severe loss will need multisensory approach for teaching, for example use of visual and tactile clues.
7. Deciding upon medium of instruction and communication to the child.
8. Help to design appropriate teaching aids that will excel the child's learning in classroom.
9. Assess the child's hearing every day, with or without hearing aid in the classroom. This can be done by using simple tools like conversation, using Ling Six sound Test.
10. Plan an educational management strategy depending upon the degree, type and configuration of hearing loss.

2.7 Concept of Unaided, Aided Audiograms, Speech Spectrum and its applications

2.7.1 Unaided Vs Aided Audiogram

Audiogram obtained in unaided condition (without amplification device) and in aided condition (with amplification device) is compared to know the actual benefit from amplification. This procedure helps to determine the functional gain. In both the conditions, conditioned (VRA OR PTA) or behavioural responses (BOA) are obtained in sound field environment. The stimulus can be modulated tones (warble), narrow band noise, pure tones.The stimuli are presented via loudspeakers in both unaided and aided conditions. The minimum response level of the child are noted on the same audiogram, to compare the difference in both conditions. The amplification device (e.g hearing aid) is adjusted according to child's hearing thresholds. More recently speech stimuli is used. (Speech perception tests) or real ear measurements are carried out to get more appropriate responses. However measurement of functional gain is still practiced as a routine clinical test. The functional gain can also be estimated by using the results of aided ASSR.

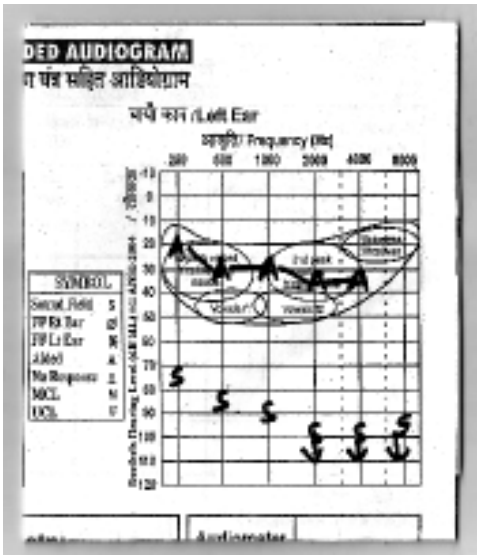


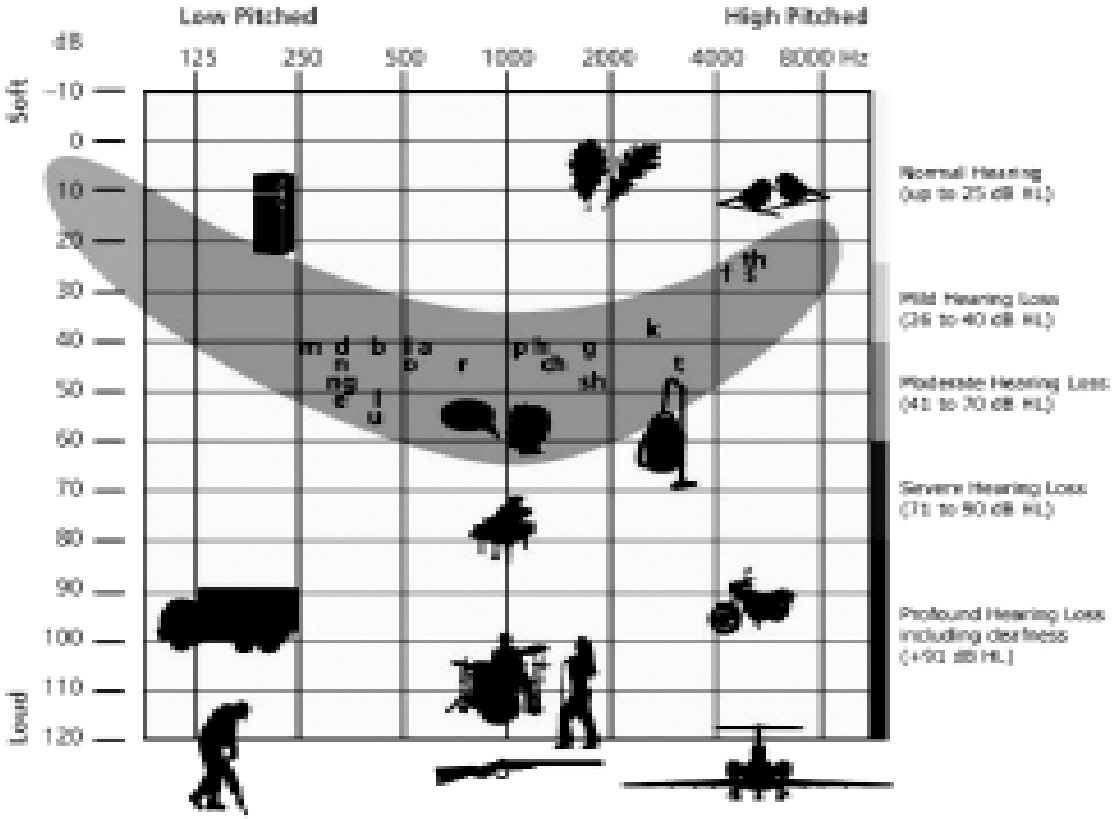
Fig 25: Aided(A) and Unaided (S) responses

Clinical Implication

1. Measurement of functional gain is a very useful tool for young children and infants.

2. Measurement of functional gain is very important and useful for children with associated problems.
3. It gives us an idea about the actual benefit from the amplification device.
4. It suggests about the modification to be made in the current aided hearing, or the device setting.
5. Depending upon the results of functional gain measurements comparison between two hearing aid settings or two different devices can be done. As a result the most appropriate device can be chosen for the child.
6. It is a very effective counselling tool, to explain the parents about hearing aid benefit.
7. Functional gain measurements can be used to select between communication strategies to be used with the child(verbal vs non verbal)
8. The results of functional gain measurement can be used to predict progress in speech language skills and educational skills.

2.7.2 Concept of Speech Spectrum



The speech spectrum also called the speech banana is a representation of different speech sounds on the audiogram depending on their frequency and intensity at typical conversation levels. Most speech sounds are within the 250 to 4000Hz range, with a few high frequency sounds between 4000Hz and 6000Hz.

A plotting of the child's thresholds at each frequency on the speech banana will show the speech sounds which the child is able to hear. Any sound which is below the level of the child's threshold will be heard, and anything above this threshold line will not be heard. A child with a mild loss may not hear f, v and z in the low frequencies and f, s and th in the high frequencies. Thus, children with mild losses develop speech and respond to sounds, and the hearing loss is identified at a later age. These children will often have difficulties with pronunciation of words, depending on the sounds they are unable to hear. Difficulty will be experienced in noisy environments such as the classroom.

A moderate loss will result in missing out on number of consonants in the speech banana, depending on the shape of the loss, while a severe (and greater) loss will result in all speech sounds being missed. However, environmental sounds (like the piano, dog barking, and heavy machinery) will be heard. These children will respond to sound but, without amplification, will not hear sounds clearly.

With amplification the threshold at which sounds are heard will be improved and thus speech sounds will be heard clearly.

2.7.3 Clinical Applications of Speech Spectrum

1. One use of the speech banana is to help visually understand what sounds are not audible. It is an excellent counselling tools for parents to understand why their child seems to hear certain sounds or words but not others. In some cases, audiologists will do aided testing to show what sounds within the speech banana can be heard when using a hearing aid or cochlear implant. When the child's unaided and aided audiogram are plotted on the speech spectrum, it helps us to understand the child's hearing status (environmental and speech sounds). This further helps us to select amplification device, and plan rehabilitation program.
2. For children who are already wearing amplification device, the aided response can be plotted on the speech spectrum, and depending upon the response, the hearing aid can be readjusted, if required.

2.8 Let us sum up

1. Sound is the basic acoustic unit perceived by human ear. It has certain parameters which can be expressed in different units.
2. The auditory development in humans starts before birth and attains almost adult like hearing by 2 years of age.
3. The hearing capacity can be assessed using a variety of tests. These tests can be either objective or subjective depending upon the participation of the child. Usually a test battery approach is used for correct diagnosis of hearing loss.
4. The basic instrument used for testing is an audiometer. The audiometer is capable of generating certain sound signals e.g pure tones, speech etc. The signal generated is presented to the child via transducers like headphone, loudspeaker etc. The selection of transducer depends upon the test to be done.
5. The ultimate goal of assessment is obtaining threshold of hearing with the help of puretone audiometry.
6. The results of pure tone audiometry are plotted on an audiogram. The results can be plotted ear wise. The interpretation of audiogram helps us to understand the probable site of deficit/damage. It also gives information about degree of hearing loss.It helps to plan the rehabilitation process including educational aspect.
7. According to standardised classification the hearing loss might range from minimal to profound degree in either ear or both ears. There can be asymmetric hearing loss in each ear.
8. The hearing loss can be conductive,sensorineural or mixed depending upon the site of deficit/damage.
9. Aided vs unaided audiogram gives us an idea about the child's hearing with and without hearing aid. Also helps to plan the rehabilitation process.
10. Aided and unaided audiogram are plotted on the speech spectrum, which is a representation of all the speech sounds used by humans, depicting their frequencies and intensities. Plotting the aided and unaided audiogram on the speech spectrum gives an idea about the sounds the child can hear with and without hearing aid.

2.9 ‘‘Check your Progress’’

1. What are the physical attributes of sound?

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2. By which age the child starts localising the sound source?

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3. What are the subjective tests of hearing? Briefly describe the procedure for conditioning a child with hearing loss.

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4. What is an audiometer? Name its parts.

   .....

   .....

   .....

5. A child’s Air Conduction threshold are as follows. What is the degree of hearing loss?

   .....

   .....

   .....

250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
85 Db	90 dB	100 dB	120dB	120dB	85dBNR

6. What information you can get from a child's aided audiogram? What is a speech spectrum?

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2.10 References

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   D.SE(HI) Manual

Unit 3 ❑ Assessment of Language & Communication

Structure

3.1.1 Introduction :

Communication is "any act by which one person gives to or receives information about one's needs, desires, perceptions, knowledge, or affective states. Communication may be intentional or unintentional, may involve conventional or unconventional signals, may take linguistic or non-linguistic forms and may occur through spoken or other modes."

Humans convey information through a variety of methods: speaking through telephones, email, blogs, TV, art, hand gestures, facial expressions, body language and even social contexts. Communication can occur instantaneously in closed, intimate settings or over great periods of time in large public forums, like the Internet. However, all forms of communication require the same basic elements: a speaker or sender of information, a message, and an audience or recipient. The sender and recipient must also share a common language or means of understanding each other for communication to be successful.

As such, a study of communication often examines the development and structure of language, including the mathematical languages used in computer programming. The act of communicating draws on several interpersonal and intrapersonal skills. These include speaking, listening, observing, questioning, processing, analyzing and evaluating. Recipients of a message must be able to identify the sender's intent, take into account the message's context, resolve any misunderstandings, accurately decode the information and decide how to act on it. Such skills are essential to learning, forming healthy relationships, creating a sense of community and achieving success in the workplace.

As a field of study, communication spans a broad, rich array of subjects, including sociology, psychology, philosophy, political science, linguistics, history, literature, criticism and rhetoric. Although much of the field's subject matter is theoretical in

nature, communication studies have proven applicable to business, film, theatre, composition, advertising, education, foreign policy and computer science.

In today's globalized, media-driven world, communication studies have become more relevant and exciting than ever. Web developers seek new, inventive ways to draw Internet users to their websites. Public policy writers debate society's most pressing issues. Through linguistics, computer scientists are developing programming languages that may someday allow humans to interact directly with computers.

3.1.2 Objectives :

After completing the unit student-teachers will be able to

- *Explain the concept, types and structure of communication and language.*
- *Acquire knowledge about Developmental milestones in typically growing children.*
- *Understand the clinical as well as environmental Impact of deafness on communication and language.*
- *Acquire knowledge about need for assessment of communication and language.*
- *Understand the various assessment tool related to communication and language.*

3.1.3 Communication : Concepts and types (Linguistic versus Non Linguistic)

The term "communication" has been derived from the Latin "communis," that means "common". Thus "to communicate" means "to make common" or "to make known", "to share" and includes verbal, non-verbal and electronic means of human interaction. This act of making common and known is carried out through exchange of thoughts, ideas or the like. The exchange of thoughts and ideas can be had by gestures, signs, signals, speech or writing. People are said to be in communication when they discuss some matter, or when they talk on telephone, or when they exchange information through letters. Basically, communication is sharing information, whether in writing or orally.

Scholars who study communication analyze the development of communication skills in humans and theorize about how communication can be made more effective. It is the meaningful exchange of information between two or a group of people. Communicative competence designates the capability to install inter subjective interactions, which means that communication is an inherent social interaction.

Schramm (1964) defines communication as “a tool that makes societies possible and distinguish human from other societies”.

Berelson and Steiner (1964) define communication as the transmission of information, ideas, emotions, skills through the use of symbols, words, pictures, figures, and graph.

Theodorson and Theodorson (1969) define communication as “the transmission of information, ideas, attitudes, or emotion from one person or group to another...primarily through symbols.”

Human beings can communicate with each other. We are able to exchange knowledge, beliefs, opinions, wishes, threats, commands, thanks, promises, declarations, feelings - only our imagination sets limits. We can *laugh* to express amusement, happiness, or disrespect, we can *smile* to express amusement, pleasure, approval, or bitter feelings, we can *shriek* to express anger, excitement, or fear, we can *clench our fists* to express determination, anger or a threat, we can *raise our eyebrows* to express surprise or disapproval, and so on, but our system of communication before anything else is language. In this book we shall tell you a lot about language, but as a first step towards a definition we can say that it is a system of communication based upon words and the combination of words into sentences.

Communication by means of language may be referred to as linguistic communication, the other ways mentioned above - laughing, smiling, shrieking, and so on -are types of non-linguistic communication. Most or all non-human species can exchange information, but none of them are known to have a system of communication with a complexity that in any way is comparable to language. Primarily, they communicate with non-linguistic means resembling our smiling, laughing, yelling, clenching of fists, and raising of eyebrows. Chimpanzees, gorillas, and orangutangs can exchange different kinds of information by emitting different kinds of shrieks, composing their faces in numerous ways, and moving their hands or arms in different gestures, but they do not have words and sentences. By moving in certain patters,

bees are apparently able to tell their fellow workers where to find honey, but apparently not very much else. Birds sing different songs, whose main functions are to defend their territory or to attract a mate.

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3.2 ❑ Communication

Structure

3.2.1 Introduction:

Theoretically, communication can be defined as the process involving sending and receiving messages which is important to transmit information, share feelings, etc. between persons and groups. It involves the process of encoding and decoding via which information is encoded by a speaker and decoded through the listener. Linguistically, communication is defined as a rule based mental system of language codes for expressing an understanding thoughts, feelings and ideas.

Communication can be represented in the forms involving either a verbal or a non-verbal mode. Verbal communication involving a set of linguistic codes foral-auditory, visual-graphic) following a set of mental rules is called as oral language. Similarly, non-verbal communication involving use of pantomimes, gestures but not governed by mental rules of spoken language is called as sign language.

3.2.2 Language

Introduction:

Language has been defined from various perspectives depending on the theories that have been proposed to explain the process of language acquisition.

From a social view point, language can be defined as a speech act which includes the reason for speaking (intentions), the situations in which the event occurs (context) and different ways in which one speaks depending on the circumstances (alternation).

From a behavioral view point, language is defined as a learned behavior in which the processes of classical and operant conditioning facilitate the development of language.

From a linguistic framework, language can be represented as a system that consists of symbols (words) governed by mental rules (grammar) which is used to represent the ideas about the world.

From a cognitive framework, language has been defined as a mode that serves to express thought. Language has been defined as a culmination of processes involving sensation, perception, imagery, conceptualization, symbolization and abstraction. Piaget defined language as a fine cognitive act which results into developmental processes including intelligence, social, sensory-motor, emotional and cognition.

3.2.3 Speech:

On the other hand, speech has been defined as the verbal manifestation of language and is the result of overlaid function of different physiological systems involving articulation, phonation, respiration, resonance, and regulation.

Interaction between communication, language and speech: Types of communication:

Basing on mode communication can be of two types

(i) **Verbal communication-** involves use of language and other verbal modalities (paralinguistic cues)

(ii) **Non-verbal communication-** involves use of signs. gestures, sign language, lithography, etc.

Basing on the use of senses, communication can be described as

(i) **Auditory based communication-** involves use of auditory signals. Example- sirens, alarms, telephones, etc.

(ii) **Visual based communication-** involves use of visual signals. Example- reading, writing, gestures, facial expressions, etc.

(iii) **Tactile and olfactory based communication** involves use of tactile and olfactory signals such as hand-shake, kiss, hugging, slapping, different smells, etc.

Basing on developmental stages, communication can be described as :

(i) Perlocutionary stage

- Present from birth and continues throughout life.
- Lack of consciousness and goal directed intentions.
- Communication involves care givers interpretation of infant's behavior.
- It is a one way process in which caregiver infers messages by willing fully interpreting infant's behavior as communicative signals.

  Example : (a) caregivers attention to reflexive and differential cry of infant. child directed speech (b) Social smile, gaze coupling.

(ii) lllocutionary stage

- Develops at 6 months of age
- Represents the emergence of semantic intentions
- Infant's behavior is consciously directed towards influencing other persons to act on some object the concept of cause-effect and means-end relationship emerge, that is, changes have causes, and persons can be the agents of change.
- Infants learn to use gestures in phonetically consistent forms and vocalizations to convey intentions during this period, Not only semantic intention, the overall concept of intentionality emerges during this stage (semantic intentions-protesting, requesting, declarative, existence, non-existence, recurrence, rejection).
- The use of joint reference, i.e., shared focus of infants and caregivers of identifying an object and joint action, i.e., goal oriented motor behavior are routinely performed during an event. The use of proto declaratives and proto imperatives are also seen during this stage.

(iii) Locutionary stage

- This stage is marked by the use of true words along with complex gestures to express intentions.
- This stage is also identified with development of joint attention in an infant.

3.2.4 Components of Language:

Language is a complex combination of several component, rules and systems. Bloom and Lahey (1978) had divided language into three major components-

(i) Form

(ii) Content

(iii) Use

The interaction of form, content and use of language is called as knowledge of language. The knowledge and concept of language is called as language competence. Basing on Chomskian views, performance has been viewed as expressive language and competence as receptive language. Performance has been defined as the ability to use the inbuilt grammer and grammatical rules and competence as the inherent capability to acquire grammatical rules from exposure to it from the environment.

Disorders of language can be due to faulty interaction between these three components of language.

Language form refers to the underlying rule, system, or the grammar of a language. Language form consists of three major components. These are:

(i) Phonology

(ii) Morphology

(iii) Syntax

PHONOLOGY

Phonology refers to the rules that govern the way in which speech sounds are represented in a particular language. Phonology studies the range of speech sounds used by a native speaker while speaking and the way they are produced.

Phonology also governs the way in which speech sounds are categorised in a particular language and the way they are combined to form syllables and words. Example- English has 43 speech sounds, Whereas, Telugu has 47 speech sounds (phonemes).

Phonology can be divided into two components- segmentals and supra-segmentals.

SEGMENTALS

The segmentals refer to the phonemes and syllables found in a language.

PHONEME — any speech sound is called as a phone and the meaningful speech sounds which combine to form syllables and words are called as phonemes. Every language has a limited set of phonemes which combine to form the grammar of that language. All the phonemes that exist in all the languages of the world have

been represented in an International Phonetic Alphabet Inventory (IPA).

The phonemes such as |b|,pl,|o| in combination with other phonemes such as such as *a*\ form syllables |ba|, Ipoj, pal, etc. phonemes have been categorized basically into consonants and vowels and the consonants have been categorized basing on place of articulation and manner of articulation.

Basing on place of articulation consonants are categorised as bilabial, labiodental, dental, alveolar, palatal, velar, glottal and retroflex.

Basing on the manner of articulation consonants are categorized as stops, fricatives, affricates. nasals, laterals, aspirates, unaspirates, voiced, voiceless, trills.

Based on tongue height, vowels have been classified as front, mid and back vowels.

SYLLABLES: A syllable refers to the unit of speech sound composed of a vowel and a consonant or similar combination. Syllable consists of an onset and a rhyme further consists of a nucleus and a coda. Syllables are the smallest units which can be separated in a word

SUPRA- SEGMENTALS;

When syllables are combined in words and phrases, the rhythmic contour of combination of syllables make up the prosody of the language. Features of prosody include the relative stress on one or another syllable in a string. The melodic rise and fall of the intonation of the syllables and pattern of pause time that occurs between segments. The prosodic features of sound are super imposed of the sound segments, that is, phonemes and syllables and thus arte called as supra-segmentals.

MORPHOLOGY:

Morphology refers to the study of internal organization of words. The smallest segment of speech that carries meaning is called as morpheme. Thus morphology consists of word and word inflections. A morpheme can also be represented as the smallest meaning of word that carries meaning. Morphology enables the language user to modify word meanings and produce semantic distinction such as numbers, verb, tense and possession, extended word meanings and derived word classes.

A morpheme can be of two types-fa) Free morpheme- it refers to the smallest meaningful unit in a word which can exist independently and'has its own meaning

For example: "cut" in cutting (b) Bound morpheme- they are grammatical markers that cannot function independently and must be attached to free morphemes or to the

other bound morphemes. For example: “ed”, “ing”, “er”, “un”, “ly”, “s”, etc. With respect to number -cat, cats With respect to tense -talk, talked With respect to possession-Mary, Mary’s With respect to extended word meaning - Respect, Disrespect With respect to derived word classes - beauty, beautiful, etc.

Morphology of a language also includes two types of word classes:

(i) Content words- these are nouns, verbs, adjectives and adverbs. Content words are the building blocks of a sentence which carry meaning. Content words exist independently in a language. Content words referring to objects are called as substantive words (noun) and those words referring to relationships are called relational words (verb). Content words keep adding on throughout a person’s lifetime basing on his experiences and thus are called open class words.

(ii) Function words - it refers to those words that connect the content words in a sentence. These are prepositions, articles, conjunctions, and pronouns. Function words are constant in a person in a language and thus are called as closed class words.

Apart from functions words and content words, Morphology consists of Morphological inflections called as ‘affixes’. Affixes are those morphemes that are added to roots. Roots are those words that cannot be divided. The affixes have been divided into two types:

(i) Prefixes - morphemes added at the beginning of roots.

(ii) Suffixes - morphemes added at the end of roots.

Morphological inflections modulate the meaning of a sentence, i.e., they provide information about the meaning of number and time.

Relation between nouns, verbs, and adjectives along with the morphological inflections constitute the syntax of a language.

SYNTAX:

Syntax refers to the rule system which governs the word order in a sentence. The word order can be described as:

(i) The order in which words should be arranged in a sentence

(ii) The way in which sentence should be organized

(iii) Relationship between words, word classes word types and other parts of the

sentence. Syntax specifies which word combinations are acceptable or grammatical and which are not. Word sequences follow definite word order rules, i.e., the phrase structure rules and transformational rules. Each sentence may contain a noun phrase that includes a noun and a verb respectively. Within noun and verb phrases, certain word classes appear. Example- articles always appear before nouns. Thus. 'The boy' is grammatical and 'Boy the1 is syntactically incorrect.

Hence, according to. McLaughlin. syntax is that part of grammar which specifies rules for sequencing or ordering words to form phrases and sentences. The sequencing of words in a sentence is governed by two types of grammatical rules:

(I) **Linear structure:** A linear structure is formed when two words in combination do not mean anything more than each of the words alone. Example: The meaning of "more cookie" is same as the meaning of 'more' and the meaning of the relation between 'more' and 'cookie' (two of the words convey the same meaning as one word in isolation). The linear structure relations can be described with the formula f(x) where *f is a fixed value which does not change and 'x' is a variable which can assume many values.

(II) **Hierarchical structure:** When the meaning relation of words in combination with one another, is something more than the meaning of the separate words, the syntactic structure can be described as the hierarchal structure. The hierarchal structure defines how words and phrases are arranged in a sentence. "Noam Chomsky categorized hierarchal structure into two types of structure rules:

(a) **Phrase structure rules:** These rules help in sentence organization where units in each sentence are organized in hierarchy. Each of these units can again be further broken down into its constituent parts. In all languages a sentence contains at least a noun and a verb as its basic units. The basic relationship is written as:

(Sentence = Noun Phrase + Verb Phrase)

A noun phrase contains noun and associated words such as articles, adjectives, etc. A verb phrase consists of verb, adverbs, pre-positional phases and possibly a noun phrase as an object of the verb. The phrase structure of sentences can be explained through a sentence tree diagram.

(b) **Transformational rules:** They rearrange the basic structure rules to create

general sentence types such as declarative, interrogative, negative, passive and imperative. Each sentence comprises of two basic structures: Deep structure and Surface structure. The deep structure contains the basic meaning of the sentence and the actual sentence produced is known as the surface structure. The relationship between deep structure and surface structure is determined by transformational rules. By changing, recording and modifying the deep structure elements. These transformational operations create the surface structure. A transformational rule can be represented by a formula.

NP2 + Verb Tense + V (-ed) + by + NPj

For example: The cat was chased by the dog.

Similarly the same sentence can be represented as: NPi + V +

(The dog chased the cat).

Linguistically, every sentence is composed of subject and a predicate. A sentence in which a group of words are centered around people or objects are called noun or noun phrases. Similarly, if a group of words is centered towards actions or relationships in a sentence, they are called as verb or verb phrases.

In a sentence, a noun is always predicted by a determiner called the noun modifier, which qualify, specify, or rank the noun. The determi9ners include pre-articles, articles, demonstratives, possessives, ordinals, quantifiers, comparatives and adjectives. Pronouns such as he/she/they are also used in a sentence instead of noun to convey the same meaning. In a sentence, the predicate is represented as a verb phrase. A verb can take various forms depending on the content and context of the sentence this can be:

(i) Action verbs - Walking, Eating

(ii) Process verbs - Hearing, Seen

(iii) State verbs - Ball, Alone

(iv) Grammatical verbs - is, are, was, were

(v) Lexical verbs - Run, Sit, Write

(vi) Transitive verbs - Heat, Heard

(vii) Intransitive verb - Smiling

A sentence in transformational structure thus can take various forms depending on the content and context of the sentence.

3.2.5 Language Content

Language content refers to the meaning represented by language. Language components can be explained by the following tree diagram.

Denotes an idea or concept or an arbitrary system for dividing reality into categories and units.

These categories and units group similar object, actions, relationship and distinguish dissimilar one. Semantics is concerned with the relationship of language form with objects, events and their relationship, as well as word and word combination.

Word/symbols do not represent reality but rather a concept. A concept is related to a whole class of experiences rather than to a single one. Semantics is the result of the cognitive categorization process (reference between object and events).

Language content or semantics defines the way objects and action relationships are represented. The way objects and action relationships are represented by a person determines the language topic of that person. As experiences differ from others, language topic varies from person to person. However, language content is universal across cultures and languages and helps a person to use language form correctly according to situations. Language content is general, depersonalized and independent of particular context where as language topic is particular, personalized and contextual.

Language content can be categorized as based on representing and understanding of:

(1) Objects

(2) Relation between objects

(3) Relation between events

The understanding of .objects and their meaning can be represented as particular objects or classes of objects.

Second category, i.e., relation between object can be defined the relation of one object to itself or relation of one object to another object.

Third category, i.e., event relations includes relations between two different events or relations within a single event. Object relation refers to dimensional words such as big/little, high/low, etc.; spatial words such as behind, outside/inside, far/near, etc. and kinship words such as son, daughter, grandfather, brother, father, mother, etc. Event relations includes temporal words such as after, before, since, until, etc.

The object, object relations and event relations are related to each other through word orders.

These word orders are called as semantic relations. A children master, semantics during their language learning, the complexity of word order also increases. In English, the semantic relations normally include sentence construction such as:

(1) Agent + Action + Object

(2) Agent + Action + Locative

(3) Agent + Object + Locative

(4) Agent + Action + Object + Locative, etc.

The semantic relations for objects and the relations are expressed in the form of semantic intentions.

3.2.6 Language Use

Language use or pragmatics serves three major functions:

(i) The use of language for attending different goals

(ii) The use information from the context to determine what one must way to achieve the goals

(iii) The use of the interaction between persons to initiate, maintain- and terminate conversations.

Language use/Pragmatics has been described by Bloom and Lahey (1978) on the basis of communication function and communication context. Communication functions involve both personal and social goals that describe the interaction and the balance of control between speakers and hearers. Personal functions are served when one comments on himself, solves a problem or asks a question to gain information. On the other hand, social functions (interpersonal) refer to the behaviors one shows for getting things done.

Socially mediated goals are served when one seeks and maintains the attention of others or gives a direction for someone to act. Pragmatics is also related to the context of spoken message. The idea about context helps for deciding which form of the message will serve the function of the message in different context.

The pragmatic rules governs sequential organization and provenance of conversation, repair of errors, and roll and speech acts. A speech act is a unit of linguistics communication and contains not only the forms of utterance but the meaning and the intention of the speakers as well. Organization and provenance of conversation include turn-taking, initiating, maintaining and closing a conversation, establishing and maintaining topic and making relevant contributions to the conversation. Conversation includes giving and receiving feedback. Conversational role skills include establishing and maintaining role and switching linguistic codes for each role.

Pragmatics also includes the extra-linguistic aspect of language. These refers to the non-verbal features that accompany expressive language and serve to modifv. amplify, fine tune the actual meaning being expressed linguistically. Among the extra-linguistic aspects, pragmatics includes pre-dominantly the par a-linguistic codes used in a language. These para-linguistic codes are also known as supra-segmental aspects or prosody of speech. The supra-segmental aspects modify the meaning of the spoken message as it is produced in different context and includes mainly the stress, rhythm, intonation, pause, juncture, etc.

3.3 ❐ Normal Developmental Milestones of Speech and Language:

- At birth-Birth Cry
- 0-1 months - Reflexive Cry, Vocalization
- 1-2 months - Differential cry, differential vocalization, i.e., caregivers can differentiate between hunger cry, pain cry, pleasure and happy sounds
- 2-3 months - Cooing Stage

  In this period the infant develops the ability to start and stop oral movements and this stage is characterized by laughter and known distress pleasures, like cooing sounds which express happiness. During this time the infant produces consonants like |k| and |g, and vowels like |u|. Though they are not accurate and their resonance is not complete. The child's vocalization contains 2-3 different sounds.

- 4-6 months - Babbling Stage

  During this time infants begin to exhibit marginal babbling which is described as the production of variety of vowels like sounds with occasional vocal tract closure. "Marginal babbling" may contain simple consonant vowel (CV) syllables or vowel consonant (VC) syllables. The vowels resonate more fully in this period, compared to the period between 2-4 months. Thus, the resultant tones in this period are called fully resonant nuclei (FRN). Speech is characterized by prolonged periods of vocalizations and strings of sounds. These sounds are mostly bilabial such as |b, |p| or alveolar |d|.

- 6-7 months - Reduplicated (canonical) babbling

  The infants start to playfully experiment with different sound combinations in this stage. Thus, this stage is known as vocal play. The child produces string sounds such as |p|, |b|, |t|, |d|, |m| and |n|. The infant uses long reduplicated strings of consonants and vowels such as jbabababa, jmamamama.

- 7-9 months

  During this period, the child responses to mother by babbling like vocalization

and child also starts to babble whenever he/she is spoken. This is called as "Directed Babbling". During this period, the child starts to babble to communicate socially with the caregiver. This is called as "Socialized Babbling". In this stage the child also varies the strings of syllables, i.e. , consonants and vowels change from one syllable to another. Hence, this stage is also called as the stage of "Non-reduplicated/Variegated Babbling". Example: |bagada|.

- 9-11 months

  At this stage, the child tries to imitate adult like speech in a meaningful way, i.e.. phonemic sequence, syllabic structure and intonational contours in the child's vocalizations follows that of adult's speech. These non-meaningful sequence of phonemes having intonation and stress patterns that sound appropriate for meaningful speech are called "jargon". Along with jargon, the child also uses proto words which have sound-meaning relation. (Example: **'bhow-bhow'** for dog, 'meow-meow' for cat etc.). These proto words are also called 'Vocables'" or "ideomorphs".

- 12-18 months - First word

  By 12 months of age, the child starts to acquire the first meaningful word. This develops directly with his ability to name different objects. By 18 months of age, most of the children acquire a minimum of 3-4 meaningful words involving the most basic relationships like father, mother and basic needs like milk, water, food, etc. By 18 months of age. normally children may have a word vocabulary of up to 50 to 100 words also along with use of ideomorphs as well as jargon.

Development of Semantics :

The ability to represent something in mind when it is not present (representational thinking) is important for development of language. A child in order to learn the conventional word associated with a concept must be able to represent the phonetic form of that word from past experience and must be able to represent the concept for its use, hence a mental schema or representation of an object or an associated event or the relationship between the event and the object. The development of jargon marks the development of semantics.

- 8-12 months

  At this age, the development of semantics begins and the child starts relating to persons and objects. However, the child is able to comprehend the meaning of objects and events but cannot represent them in expressive language.

- 12-18 months

  The child has a vocabulary of about 35-100 words. Children begin to combined words basing on objects and the relationship with events. Child at this age develops various semantic intentions such as:

(i) Possessions and possessives i.e., relating to own self. Example: mine, my ball, my dress, etc.

(ii) Existence and non-existence i.e., objects being present or being absent permanently,

(iii) Rejection and negation i.e.. the child learns to stop activity if the adult says 'no' or uses the word 'no' to either reject or stop unfavorable activities. (iv) Disappearance/recurrence i.e., objects when taken out of sight, the child intends to see the disappeared objects.

(v) Location - the child looks for objects located in certain places. The child also starts learning new words outside his/her routine conversation and tries to learn the meaning of it by taking cues of the situation. In this stage, nouns constitute 40% of the vocabulary followed by verbs constituting 10%, adjectives 10% and function words 10%. The 30% of the child's vocabulary consists of protowords and other grammatical classes. The child begins to form categorical concepts i.e., mental representation of events, objects and object-event relation.

- 18-24 months

  The average vocabulary of a child is about 200 words. The child starts to comprehend two word relationships such as:

(1) Agent + action

(2) Action + object

(3) Agent + object

(4) Action + location

(5) Object + location

(6) Possessor + possession

(7) Entity + attribute

(8) Demonstrative + entity

The categorical representation increases and the child continues to extend new words to other members of the same category through fast mapping. The child continues to over extend items into a category (over extension error) or under extend Hems into a category (under extension error). Children learn to identify the different reference (object., events and object event relations) based on adult attentional and intentional states. The idea about how the word is organized into categories of objects, events, relations, states and properties develops very fast and thus this stage is called fast mapping. The child basing on increasing linguistic and world knowledge and understanding of disposed context use more varied and richer language.

- 24-30 months

The child starts to understand questions and asks 'wh' questions related to object, people, action and location. Example:

➔ "What is this?"-for object

➔ "Who is he?" - for people

➔ "What is he doing?" - for action

➔ "Where are we?" - for location.

- 30-36 months

"Why" related question start at this age. This improves with the improvement in reasoning skills for both comprehension and expression. More specialized concepts start to develop. In this stage the child acquires concept of preposition hence words like on, in. there, by, here, etc. start to develop.

- 36-42 months

Children start to develop color concepts and can identify basic color like red, green, blue, etc. Children also develop knowledge of kinship i.e., they identified different family members according to their relationship. Children also learnt

concept of opposites and learns to use contrastive words like big/small, etc. A syntax development also occurs alongside; the children learn the concept of words like 'and/or' etc. with which they produce complex sentences.

- 42-48 months

  At this stage, the child starts to learn time concept, understands and expresses when and how and develops the concept of shapes, sequencing and size.

- 4-5 years

  Children develop the knowledge of alphabets and their corresponding phonetic sounds, learns the concept of counting numbers, uses advanced conjunctions like - because, so, when, etc. Children have an expressive vocabulary of around 2000-2200 words at this stage.

- 5-6 years

  Children during this period accumulate receptive vocabulary of around 14000 words, learning around 9 new words per day. It is at this stage, that a child masters the use of spatial words like - in front, behind, under, on' etc, and temporal words like - after, before, since, until, etc.

- 6-7 years

  The child starts to learn to expand meaning of various words and overall semantic development occurs as the child experiences new concept. The child during this period has an expressive vocabulary of around 5000 words.

- 8-9 years

  New words are learnt at school and both expressive and receptive vocabulary is increased. The child uses pronouns like he, she, they appropriately, especially in language composition, statements and conversations. The learns to define words and word definitions include synonyms and categories, the child also understand that some words have multiple meanings and meanings may change according to context and situation. The child also gains knowledge of figurative language.

- 9-12 vears

  The child learns the meaning of abstract words and can explain the semantic

relationship of the words in sentence. Semantic development gets completed by 12 years.

Syntactical Development:

The development of syntax is marked by the production of single word utterances in which a string of utterances consisting of single meaningful words and ideomorphs are used to convev meaning.

Syntax development is generally determined by measuring the MLU. Brown (1973) summarized the development of syntax based on 5 developmental stages. Brown further states that appearance and mastery of 14 grammatical morphemes is central to the development of syntax. These 14 grammatical morphemes are:

1. Present progressive inflection
2. Preposition - in
3. Preposition- on
4. Regular plural inflection
5. Past irregular
6. Possessive inflection
7. Uncontractible copula
8. Articles
9. Regular past tense
10. Regular third person singular
11. Irregular third person singular
12. Uncontractible Auxiliary
13. Contractible copula
14. Contractible auxiliary.

These Brown Stages are as follows:

- Stage I (MLU 1.0-2.0) {12-26 months of age}
  Children acquire the first meaningful word and speech is characterized by the

use of single words and early multi word utterances. Semantic intentions and semantic relations are predominantly present and used by the child. 2 years old toddlers learn simple word orders. The utterances are often telegraphic i.e. they lack appropriate grammatical morphemes. Child uses semantic relations such as :

(i) Agent + action

(ii) Action + object

(iii) Action + Location

(iv) Entity + location

(v) Entity + attribute

(vi) Demonstrative + attribute

∞ Stage II (MLU 2.0-2.5) {27 TO 30 months of age}

In this stage the child acquires and uses all the 14 grammatical morphemes. In this stage, the child learns to use, the subjects more consistently and begin to modify nouns occurring in the object phrases of longer utterances, even when subject phrases are also present "Tommy ate big cookie". The child also uses different words to convey meaning. The characteristic feature of this stage is the development of morphemes.

∞ **Stage III** (MLU 2.5-3.0) (31-34 months of age)

The child acquires basic scheme and constituents consisting of a subject verb and an object Hence, this stage marks the development of sentence form. In this stage, modifiers appear in both subject and object phrases i.e. noun phrases are elaborated. Auxiliary-verbs like tense markers, interrogatives and negatives are predominantly used in this stage. The modulation or elaboration of sentences occurs during this stage.

∞ **Stage IV** (MLU 3.0-3.75) (35-40 months of age)

This stage is marked by emergence of complex sentence forms and embedded sentence elements. For example: "I know what you did." In this T stands for subject; 'know'-verb and 'what you did' represents the embedded element of object.

This stage is marked by the child's ability embed elements of one sentence within another, as well as correct use of different verb classes. The child masters the concept of irregular past tense. Example: 'go?' 'went'.

Use of articles (both definite and indefinite) - example: 'a', 'an', 'the', etc.

As well as use of possessive markers - example: 'David's book'.

- Stage V (MLU 3.75-4.5) (age of 40 months and above)

  In stage V, the child masters the use of all 14 grammatical morphemes including 3r person present tense (3PPT). This stage is marked by the emergence of compound sentences in which the child uses sentence connectors to conjoin two simple sentences. The child also masters the use of verb classes including 'wh' words. By stage V, the acquisition of syntax is almost complete.

Disorders of Speech and Language in The Hearing Impaired

Introduction:

Hearing impairment results from a number of causes and is usually characterized by the type and degree of hearing loss. Type of hearing loss is related to the site of the disorder within the auditory system, and degree of loss is related to the extent that the disorder is infringing on normal function.

Disorders of Language Content:

Hearing impaired individuals ideas of the world, from which the content of-language derives, develop in the same sequence as that of a hearing person, but with a slight delay. A lot of research evidence have been cited and suggest that the deaf child who is learning sign language codes the same semantic notions as the hearing child who is learning to speak. Although the form of communication differs, the content is the same. Even, the acquisition of semantic relations is similar to that of a normal child.

Disorders of Language Use:

The hearing impaired individuals can communicate a wide variety of functions and intents using both verbal and non verbal means and is mostly similar to that of hearing individuals. However, deaf individuals are not able to fully comprehend metaphorical use of language and have a tendency to literally interpret embedded meanings.

Disorders of Language Form:

Hearing impaired individuals know sentence forms and can determine the form class that should be inserted in a frame, but they do not know the use or meaning of specific functor words. Thus, the hearing impaired individuals learn the form of language as it is written, but do not learn language in terms of its content or use. Even in use of content words, hearing impaired individuals have restricted use of relational words.

Specific Effects:

Vocabulary:

Vocabulary develops more slowly in children who have hearing loss.

Children with hearing loss learn concrete words like *cat, jump, five,* and *red* more easily than abstract words like *before, after, equal to, and jealous.*

They also have difficulty with function words like *the, an, are,* and *a.*

The gap between the vocabulary of children with normal hearing and those with hearing loss widens with age.

Children with hearing loss do not catch up without intervention.

Children with hearing loss have difficulty understanding words with multiple meanings.

For example, the word *bank* can mean the edge of a stream or a place where we put money.

Sentence Structure:

Children with hearing loss comprehend and produce shorter and simpler sentences than children with normal hearing.

Children with hearing loss often have difficulty understanding and writing complex sentences, such as those with relative clauses ("The teacher whom I have for math was sick today.") or passive voice ("The ball was thrown by Mary").

Children with hearing loss often cannot hear word endings such as *-s* or *-ed.*

This leads to misunderstandings and misuse of verb tense, pluraiization, nonagreement of subject and verb, and possessives.

Speaking:

Children with hearing loss often cannot hear quiet speech sounds such as "s," "sh," "f," "t," and "k" and therefore do not include them in their speech. Thus, speech may be difficult to understand.

Children with hearing loss may not hear their own voices when they speak. They may speak too loudly or not loud enough.

They may have a speaking pitch that is too high. They may sound like they are mumbling because of poor stress, poor inflection, or poor rate of speaking.

Individuals with Hearing Impairment typically have a great deal of difficulty with articulation, because normal articulation depends to a large extent on hearing the sounds of a language.

Clinical experience and research has shown that hearing impaired and deaf-speakers often have problems with various aspects of speech production, resulting in loss of intelligibility. The kind of distortion in speech can be easily recognized as 'deaf speech'. Speakers may have difficulty producing vowels and consonants and may also be unable to control the suprasegmental aspects of speech.

Segmental Problems

- Vowel problems, particularly neutralization (limitations in horizontal and vertical movements of tongue)
- Consonant errors - omissions and substitutions (voicing, place and manner of articulation errors).

Suprasegmental Problems

Suprasegmental problems are another feature of deaf speech, including inappropriate, excessive or insufficient variations in Fo and intensity.

Prosody-refers to pitch, intonation and rhythm and these aspects are of interest in a hearing impaired speaker. Prosodic errors, stem from situations such as intonation deficiencies caused by poor control of fundamental frequency (i.e. monotonous speech), inappropriate breath control, slow speech rate, abnormal uses of pauses, and abnormal uses of rhythm and stress (Girgin, 999; John&Howarrth, 1965; Lederet al., 1978; Markides, 1970).

Some of the prosodic characteristics of hearing impaired speaker are:

- **Rate and Rhythm**

Hearing impaired children usually have difficulty maintaining suitable rate and rhythm of speaking (excessively slow rate and inappropriate rhythm). The *amount ofphonation time* on syllables is a frequent problem among the hearing impaired; some children should increase their time and others shorten it for improved rhythm, rate and speech intelligibility. Others may have problem of continuous phonation, voicing unvoiced and voiced sounds.

A child's slow rate of speaking may be related to *lack of breath control.* For example, he may need to take a breath every few words and not have enough breath to finish a complete phrase. The total time for the hearing impaired speakers averaged 8-10 sec per sentence and normally hearing speakers averaged 3-4 sec per sentence (Colton and Cooker, 1968). It is suggested that slower speaking rate of deaf speaker's results in perceived hyper nasality and that the hyper nasality is not caused by velopharyngeal dysfunction.

- **Lacks typical intonation**

Incorrect production of intonation contours is a common phonatory problem among the hearing impaired. Intonation is often described as too monotonous or too jumpy, or, either irregular with some rise and fall or monotonous or insufficient or excessive intonation variability.

Monson (1979) tested 3-6 year severely and profoundly hearing-impaired children imitating words. Duration of word and Fo contour of the word was examined. The children's task was to imitate a word with a smoothly falling declarative contour. However, most hearing impaired children did not produce smoothly falling Fo contour. Instead, they produced flat contour or changing contour (Fo may first rise then fall, then be level, then rise all over the course of a single syllable). Also, they did not produce enough variation in Fo to differentiate between declarative vs interrogative utterance. These atypical contour patterns can seriously degrade a speaker's intelligibility.

Abnormal pause behavior/abnormal use of pauses.

Pronovost (1977) stated many deaf individuals are likely to produce separate phonemes and words with *many pauses* as a result of having been taught to articulate speech sounds as precisely as possible.

Increased duration of speech sounds and segments.

Whitehead and Jones (1976) studied vowel duration in three groups of male adults - hearing impaired, deaf group and normally hearing group. They found *longer vowel durations* in hearing impaired and deaf groups. Durational measures on the three groups led the authors to conclude that a hearing impaired population who receives some auditory input can learn the timing system in the same way a normally hearing population does, but a deaf population does not appear to learn these durational differences to the same extent. This suggests the importance of residual hearing. The first two groups sound as if they have more continuous phonation than the normally hearing person.

Academic Achievement:

Children with hearing loss have difficulty with all areas of academic achievement, especially reading and mathematical concepts.

Children with mild to moderate hearing losses, on average, achieve one to four grade levels lower than their peers with normal hearing, unless appropriate management occurs.

Children with severe to profound hearing loss usually achieve skills no higher than the third- or fourth-grade level, unless appropriate educational intervention occurs early.

The gap in academic achievement between children with normal hearing and those with hearing loss usually widens as they progress through school.

The level of achievement is related to parental involvement and the quantity, quality, and timing of the support services children receive.

Social Functioning:

Children with severe to profound hearing losses often report feeling isolated, without friends, and unhappy in school, particularly when their socialization with other children with hearing loss is limited.

These social problems appear to be more frequent in children with mild or moderate hearing loss than in those with a severe to profound loss.

Impact of hearing loss on speech and language development

Hearing Level (dB)	**Degree of Hearing Loss**	**Type**	**Missed Sounds**	**Effect**
16-25	Slight	Conductive / Sensorineural	10% speech signals.	Misses fast paced peer interactions, fatigue in listening.
26-40	Mild	Conductive / Sensorineural	25% - 40% speech signal, distant sounds, unvoiced consonants, plurals and tenses.	Misses 50% of class discussions, has problems in suppressing background noise.
41-55	Moderate	Conductive / Sensorineural	50% - 80% speech signal	Articulation deficit, limited vocabulary, learning dysfunction.
56-70	Moderately Severe	Sensorineural / Mixed	100% of speech information	Delayed language syntax, atonal voice, reduced speech intelligibility
71-90	Server	Sensorineural / Mixed	All speech sounds, can hear loud environmental noises	Speech not developed or deteriorates, learning deficits
> 90	Profound	Sensorineural / Mixed	All speech sounds. only feels vibrations	Speech not developed or deteriorates, learning deficits

3.4 Assessing communication and language: Developmental checklists, scales, standardized tools and assessing language samples using parameters of measurement (Productivity, Complexity, correctness an communicativeness)

Structure

3.4.1 What Is Assessment?

The processes of systematic collection, review, and use of information about educational programs undertaken for the purpose of improving student learning and development is known as assessment. Through the processes of assessment student's learning skill can be understood and also can be improved. In other words the processes of assessment can be defined as processes of systematic gathering, analyzing, and interpreting evidence to determine how well performance matches those expectations and standards; and using the resulting information to document, explain, and improve performance.

3.4.2 Purpose of Assessment

Through the assessment procedure for communication, students are encouraged to be more active in their communication. The ultimate purpose of assessment is to create self-regulated communicators who can leave school able and confident to continue communicating throughout their lives.

3.4.3 Types of assessment

There are two general categories of assessments: formal and informal.

Formal assessments provide data which support the conclusions for the test. These types of formal assessments are also known as standardized measures. Formal tests are usually administered when student's communication skill is below average

his or her age. The data is mathematically computed and summarized. In formal assessment scores are on percentiles, stanines, or standard scores.

Informal assessments are usually based on the content and performance and usually does not provide any data. The example of informal assessment can be a reading task. It indicates how well a student is reading a book. Scores such as 10 correct out of 15, percent of words read correctly, are given in this type of assessment.

Whenever taking about the assessment of communication and language it is important to know about the communication and language in brief. Communication is mainly an active an intentional two way process of exchange of messages. Language is the main vehicle for communication. Language is a set of arbitrary symbols used by a group of people for the purpose of communication.

There are examples of few formal tests:

Name of the test	**Developed by**	**Target population**	**Age**	**Domains**
Scales of Early Communication Skills for Hearing Impaired Children	Jean S. Moog and Ann E. Geers	Children with hearing impairment	2-8 years	Receptive language Expressive language
Childhood Autism Rating Scale	Eric Schopler, Robert J. Reichier, and Barbara Rochen Renner, 1986	Children with autism	chiihood	• Relationship to people • Imitation • Emotional response • Body use • Object use • Adaptation to change • Visual response • Listening response • Taste-smell-touch response and use Fear and nervousness • Verbal communicati on • Non-verbal communicati on

				• Activity level • Level and consistency of intellectual response • General impressions
Apraxia battery for adults	Barbara L. Dabul, 2000	Neuromotor speech Disorder	Adolescents and adults	• Diadochokinesthetic rate • Increasing word length Limbapraxia • Oral apraxia • Latency and utterance time for polysyllabic words • Repeated trials test • Inventory of Articulation characteristics of apraxia
Receptive Expressive Emergent Language Scale 3	Bzoch, League, & Brown, 2003	IThiid7en~	Birth to 3 years	Receptive language Expressive language
Frenchay Dysarthria Assessment	Enderby, 1983	Neuromotor Speech Disorder	12 years to adult	• Reflexes • Respiration • Lips • Palate • Laryngeal • Tongue • Intelligibility Influencing factors

3.4.4 How do I assess?

For the purpose of assessment first demographic data needs to be collected. The name of the client, age and gender of the client should be known. Speech development history is very important to know because without knowing speech developmental

history it is difficult to understand whether the student's speech and language skill is delayed or age appropriate, and if it is delayed from when this process of delay started. Under the developmental history whether the child vocalizes spontaneously and on demand, age of babbling, first word and first sentence should be included. Mode of communication of the child needs to be noted. The child can use verbal communication or nonverbal communication or both. The range, frequency, effectiveness and appropriateness of communication should be assessed. Under each mode of communication i.e., whether verbal communication or nonverbal communication; both comprehension and expression should be assessed. The details about language background and speech and language stimulation should be taken into account.

Identification of communication needs and participation pattern:

The subject of communication, with whom, when (times of day), where (location and position), why, how and about what topic and vocabulary the client communicates need to be known in detail.

We know that sensory skills play very crucial role for speech and language development. Therefore, the status of visual skills whether the vision is normal or corrected, ability to focus and tract, colour blindness is there or not need to be assessed. Similarly, for assessment of auditory skills whether the client is hearing impaired or not, whether temporary hearing loss is there due to illness or not should be checked.

Oral peripheral examination

The structure and functions of all the oral peripheral mechanisms like lips, teeth, tongue, jaw, hard palate, soft palate need to be assessed.

Articulation at phonological level and phonetic level of all the vowels, consonants and blends should be checked. For the production of speech, breath support is necessary. Therefore, breath control and phonation duration need to be assessed. Loudness, pitch and quality of voice should be checked perceptually as well as using perceptual scale for assessment. Suprasegmental aspects are the important parameter for assessment. Among the suprasegmental aspects accent, emphasis, intonation, phrasing and rate of speech are the area of assessment.

Cognition is one of the primary pre-requisite for language development. Therefore, the cognitive skill of the client should be assessed. Among cognitive skills attention,

use of object, means end relationship, object permanence and stage of play development need to be assessed. Imitation skills for gross body movement and speech also should be noted.

Letter recognition, word recognition, reading comprehension, copying, writing to dictation, spontaneous writing ability under reading and writing skills should be checked.

Speech intelligibility of the client should be assessed based on the rating scale. Finally the communication and the language of the client should be pprovisionally diagnosed.

Productivity :

Productivity is the degree to which native speakers use a particular grammatical process for the formation of new structure, especially in word formation. The process of productivity generally concerns with which grammatical form would be used with newly coined word. For example, in standard English the formation of preterite (past form) and past participle forms of verbs by the means of ablaut (for example, run-ran-run) is no longer used. Mostly the form of "ed" is used at the end of the verb (for example, e-mailed) irrespective of any form to indicate the past form and past participle form. Similarly, in case of plural "s" is majorly used. The ending "en" is longer productive, being found in oxen, children because these old forms sound incorrect or irregular to modern ears. The plural form of the word brother has been replaced with brothers in place of brotheren because of its irregular sounding. During the transition from old English to modern English, many strong verbs have completely lost because they sound archaic or they are no longer truly understood.

During the evolution over the last five hundred years or more, English has developed very different in ways from most world languages across history. With a long written past English has preserved many words that might otherwise have been lost or changed. Written language has many conventions for writing polite and formal prose than the spoken language. In other words, written language is often very different from how people normally speak. As English speakers are universally literate, it has become easy for people to bring back into life archaic words and grammar forms. This is often to create a comic or humorously old-fashioned effect. It is with the expectation that these new coining words will be understandable. These processes are rare for languages without a culture of literacy. English has borrowed

extensively many words from the other languages because of technology and trade. For example, the plural form of the word “radius” which is a Latin word, has not decisively settle between “radiuses” and the original Latin “radii”, though the educated people prefer to use the Latin plural form. Based on the same rules (Latin plural) new words have been coined.

Complexity of language :

By comparing two Santo languages, Tolomako and Sakao , these two languages are very similar to each other and equally distinct from English, an English speaker is neither inherently biased as being seen as more easy or difficult.

The complexity of language depends upon the parameters of language like phonology, morphology, syntax. When the two languages are closely related to each other based on these parameters, those two languages are said to be easier.

Correctness:

In prescribed grammar, correctness is the notion that certain words, word forms, syntactic structures follow the standards and conventions (that is the rules) prescribed by traditional grammarians. It is a misleading idea that whether a piece of language is right or wrong. Practically language may be better described as appropriate or acceptable to a given context. As per the classical model, the so -called rules of English are pieces of advice laid down by grammarians. Based on the intention of speaker, some of these rules may be proven as good for clarity of language whereas, others are considered as constraints on living language. In old English there are some rules like a sentence cannot be finished with preposition, cannot be started with and, are some examples of rules which are still followed by some language users but deliberately flouted by some other users. There are two main principles practically creating grammatical rules:

Prescriptive rules describe the attitude that there are some conventional rules and everyone should obey them, on the other hand, descriptive rules describe the attitude of modern linguists that what is said by a natural speaker is normal and these real language should be described by the linguists to create a model of language. In spite of all these views, fundamental rules which make a language unique yet these are so embedded that the rules are rarely raised as an issue by the user or it is difficult to draw the line between good and bad language. Depending upon some factors like time, speaker, medium, audience, situation style, message, these differences usually follow the process of change and therefore flexible hard to define.

Communicativeness:

Communicative Language Teaching is an approach of teaching second language and foreign language. It emphasizes both on means and the ultimate goal of facilitating language. The term communicativeness implies different meaning to different facilitators. To some facilitators, it simply means a great emphasize on the use of target language in the classroom particularly on orality. To other facilitators, communication implies the exchange of unknown information between interlocutors, and finally to other facilitators, as a cultural bond system for making meaning. Despite their variations in opinion, all the module facilitators seem to advocate for a communicate approach.

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3. 5. Identification of Needs Related to Communication and Language

Communication through speech and language is the entity which differentiates humans from other species and this has become their paramount need. Children who find difficulty in talking and understanding what others are saying have speech language communication need. About one in every ten children has a probability of having some kind of speech language communication need1. Hence many children with speech language and communication need will just look like any other child and they may show learning difficulty and problem in socializing leading to poor behavior. Their behavioral problem may again lead to, that they may be misinterpreted, misdiagnosed or missed altogether. The difficulties which they will encounter are;

1. Paying attention while listening to others.
2. Articulation difficulty, problem in movement of oral peripheral structures.
3. Difficulty in understanding use of language that is affected pragmatics.
4. They may have problem in recognizing difference between certain sounds or words.
5. They may have problem in memorizing what they hear due to poor, memory, so it is hard to learn new words and follow instructions.

There are some frequently used words that are used to describe different types of speech language communication need:

1. Speech and language delay
2. Speech and language disorder
3. Specific language impairment
4. Comprehension (or receptive language) difficulty
5. Expressive language difficulty
6. Speech difficulty
7. Social interaction difficulties (sometimes called pragmatic difficulty)
8. Stammering/Stuttering/Dysfluency/Non-fluency
9. Selective mutism

10. Verbal dyspraxia

While identifying a child's need of communication through speech and language, at the beginning, the questions which must be taken into consideration are:

1. Age - How old the child is?
2. What type of difficulty they have including the type of onset? and
3. What is the severity of their problem?

Need of some children are expressed from a very young age, and others need may be identified until they are at school or even more lately until they become a Young adult. Diagnosis can be gradual or it unfolds overtime and can be a difficult process. People who will be at the first to realize that a child or young person has a problem:

1. Parent or family members
2. Any staff at school or nursery
3. A young person themselves

Some children may find no difficulty at the primary levels of their schooling, but find problem on more complicated curriculum, at higher levels and on larger demands on their needs to communicate through speech-language.

The possible warning signs of a young child, that they may have speech language communication need:

1. Does not respond to sound.
2. Regressing in terms of development.
3. Have little interest in communication.
4. Talks slowly than other children of the same age.
5. Has difficulty understanding simple instructions or requests.
6. Unusual speech and language compared to other children of the same age.
7. Problem in tasks like reading, spelling and mathematical problems.
8. Even family members may find difficulty to understand them.
9. Difficulty in making and keeping friends and participating in games.

The possible warning signs of an older child and young people who might have speech - language communication need;

1. They may be slow to answer or to follow an instruction.
2. They may need several repetition and simplification of instructions.
3. They might switch off when someone is talking to them, it seems they are not listening.
4. Their language may sound muddled and they may find difficulty in organizing their thoughts into words.
5. They may find writing or expressing verbally about some basic thing which they have managed, effortful.
6. They may not understand jokes, or complicated language like idioms.
7. They may find problem in joining and maintaining conversations.

A health visitor, a general physician, a teacher or nursery staff and a family member may refer these children to a speech-language therapist. A Speech language therapist will assess and will tell whether the child has speech language communication need and its appropriate intervention.

Unit - 4 ❐ Assessment and Identification of Needs

Structure

4.1 Introduction

Speech is a medium, used to convey message which is in a particular form called language. In other words, language is verbally expressed using speech in humans. Speech and language help in successful communication. Impairment of speech or language cause communication disorders which in turn affect the child's educational, social and personality development.

Speech development starts at an early age and attains adult mastery by the age of 7-9 years. Speech production is an interesting and intricate process. It involves different systems of the human body. These systems are:

1. Respiratory System
2. Phonatory System
3. Articulatory system
4. Resonatory System

The airflow from the respiration process is modified and produced by the other three systems. This is called speech production.As a prerequisite of age appropriate speech development, the intactness of all the above systems is essential. In this chapter we will learn about these systems, their role in speech production, need to assess these systems.

4.2 Objectives

To learn about :

1. Respiration and phonation, the process, types and the need to assess these processes
2. Articulation & Phonology: speech organs as articulators,speech sounds and their description & classification. Assessment of articulation.
3. Various prosodic aspects of speech & their assessment
4. Normal development of speech in children from birth
5. Speech intelligibility and factors affecting it. Assessment of speech intelligibility.

4.3 Respiration and Phonation

4.3.1 Respiration

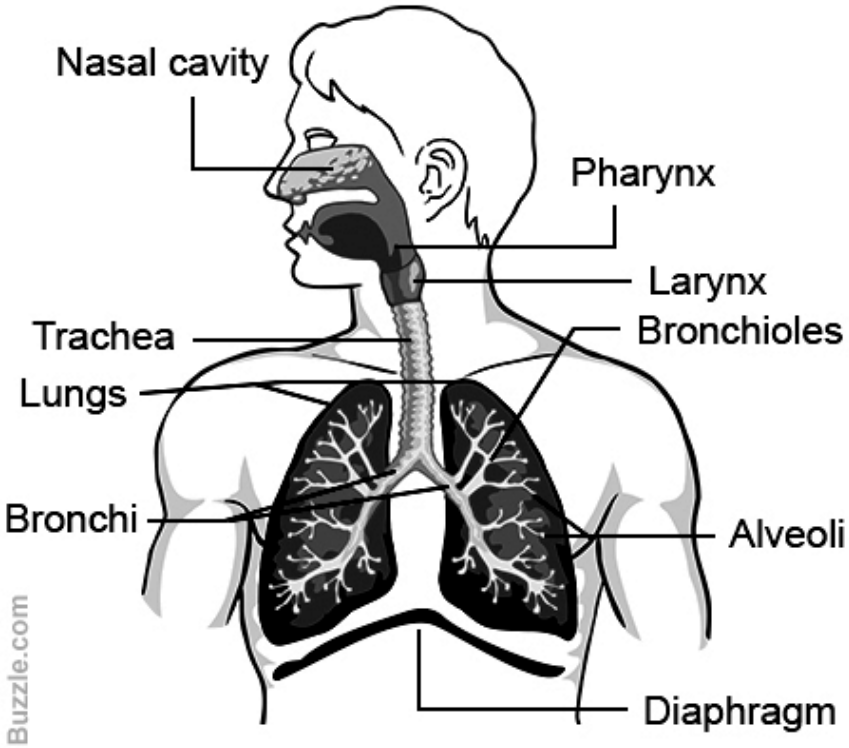
- It is a process which is very essential for human life, it helps in breathing and exchange of air with the environment. Speech production is a secondary function of respiration. Respiration provides the power for the process of speech production. The respiratory process involves the following basic structures/parts:
- Bronchi
- Trachea
- Lungs
- Pharynx
- Larynx
- Oral and nasal cavities

Other structures which provide the structural support are:

- Musculature
- Thorax
- Skeletal framework- spinal column, rib cage and pelvis

- Thorax and abdomen and their muscles
- Muscles of neck, chest and shoulder

Diagram of Respiratory System



4.3.2 Pre-requisites for Respiration

All the above mentioned structures/parts should be anatomically intact and should be physiologically accurate that is have good function in order to carry out the process of respiration. Respiration involves inspiration/inhalation that is taking air in and expiration/exhalation that is breathing air out. All the structures function with each other to help in inspiration and expiration.

The nerve supply and control of higher centres of human body over the process of respiration should be uninterrupted and appropriate for proper functioning of the respiratory system.

The child should not have diseases of the respiratory system, for example upper respiratory tract infection, asthma or conditions of brain damage (cerebral palsy) which may cause disturbances of the respiratory system.

4.3.3 The Process

The general process of respiration is vital for life. It consists of two sub processes namely inhalation/inspiration and exhalation/expiration. The cycle of inhalation followed by exhalation is also called breathing. This is carried out to get fresh air containing oxygen from the environment and removing impure air containing carbon dioxide from the human body.The air is inhaled through the nose/oral cavity,it passes through the pharynx,larynx and then reaches the lungs. It is in the lungs where exchange of oxygen with carbon dioxide takes place. When the lungs have taken in sufficient amount of air from environment, the body prepares for the next cycle of breathing that is exhalation. In exhalation air goes out via the same path. For speech production, the vocal fold vibrate during the exhalation phase. The whole process is controlled by information from the brain conveyed through nerve supply to the respiratory system.

Speech breathing

For speech production the process of general breathing or respiratory mechanism alters. The inspiration time increases or in other words we take in more air so that we can support our speech production especially if the utterance is long and loud. Moreover, we can time our inspiration and expiration–for example during singing or recitation we can decide on the times we want to breathe in and out Moreover, the exhalation time is much longer as compared to quiet breathing.

4.3.4 Types of Respiration/Breathing

There can be variations in the breathing pattern depending upon the structures involved. However the type of breathing used usually do not affect the speech production process. It can be of following types:

1. **Diaphragmatic or abdominal breathing**- It involves expansion of the abdomen. It is carried out in a relaxed state. It leads to deep breathing and is advisable in many respiratory diseases. Best for prolonged singing.
2. **Thoracic breathing-** It is a more shallow breathing. Usually very less amount of air is taken in the chest and exhaled out.
3. **Clavicular Breathing-** It is the shallowest type of breathing. In this the clavicle moves keeping the lower part inactive. Only upper part of lungs get

involved during the breathing. This type is not suitable for speech production and can lead to a strained voice.

4.3.5 Need for Assessment

Respiration is one of the vital supporting mechanism/process for speech production. Any disruption in the structures and function of the respiratory system will lead to speech disorders. Thus the physiology of the respiratory system needs to be assessed in case of speech disorders. Parameters such as air pressure, vital capacity, S/Z ratio, phonation duration are assessed on a routine basis. The needs can be as follows:

1. The assessment and measurement of the parameters related to respiratory system, gives us information about the intactness of the system. The obtained values can be compared with age and sex appropriate norms to check for any abnormality.
2. A general need is to establish normative data according to age, sex and other body statistics such as weight etc. Comparison with these values can help us identify disorders.
3. The measured values can act as baseline before the speech therapy sessions and can be measured in between sessions to check progress of therapy.
4. The assessment results help to differentially diagnose between pathologies or conditions e.g problem of respiratory system vs problem of vocal folds (phonatory system)
5. The measured values can give us idea about child's current capacity, this can help us to set speech therapy goals.
6. Assessment of respiratory function help to decide the therapeutic strategies or methods that can be used for remediation for example behavioural, or instrumental.

4.3.6 Phonation

Phonation occurs when the air flow from lungs causes the vocal folds in the larynx to vibrate. Usually phonation refers to a prolonged or sustained voice production. In order to achieve a sustained voice the air flow from the lungs during exhalation should be carried out in a controlled manner rather slowly and not abruptly.

4.3.7 Process

The process of phonation involves laryngeal muscles, cartilages of the vocal cord, ligaments and nerve supply. The vocal folds are elastic in nature owing to their anatomical make-up. At rest they act as a valve which stops food particles to enter the larynx and prevent aspiration. However the secondary function of vocal folds is speech production, which occurs when they fall apart and close in a periodic fashion due to the process of exhalation. The pathway above vocal folds lead to vocal tract which has two openings oral cavity and nasal cavity. The air flow coming from the lungs passing through vocal folds can come out through oral or nasal cavity. The cycle of vocal fold vibration,that is periodic opening and closing,causes the air pressure beneath the vocal folds to fall or rise. When the air pressure from lungs builds up beneath closed vocal folds they are forced to open or fall apart. Again when the pressure falls below a certain level they again close or come together. Moreover the various muscles and other structures play together and bring changes in tension, length and mass of vocal folds. This leads to faster or slower vibrations and causes changes in the quality of voice produced. For example when the vocal folds are tensed and become thinner, the voice produced increases in pitch. The vibratory patterns vary among humans and gives identity to human voice along with other features.

4.3.8 Prerequisites

1. All the anatomical parts involved in phonation should have normal structure and function. In other words any anatomical anomaly will affect phonation.
2. All the structures involved in phonation should have appropriate working.
3. The respiratory system, which provides power for phonation should be working appropriately.
4. The vocal tract, vocalfolds, larynx should not be affected due to any disease or disorder. E.g motor disorder like cerebral palsy.
5. An individual should have normal hearing sensitivity to monitor the act of phonation and regulate the air flow.
6. An individual should have normal cognitive functions and motor control so that the whole process can be regulated.
7. The individual should not use any faulty ways to produce voice or should not practice any vocal abuse to have a proper phonation.

4.3.9 Types of Phonation

The space between the two vocal folds change in distance and shape depending upon the amount of opening and closing of the vocal folds. Depending upon the shape of this space called glottis,there can be following types of phonation:

- No Phonation/Voiceless sound - There is silent passage of airflow,the vocal folds remain far apart allowing air to pass freely. The sounds produced in this condition are called voiceless.
- Voiced Phonation - The vocal folds vibrate regularly, that is with complete closure on each vibration. The sounds produced in this condition are called voiced.
- Other types - the other types of phonation are breathy, falsetto and whisper, which are produced by different positions of vocal folds between no closure and regular closure.

4.3.10 Need for Assessment

Phonation is the first step in voice/speech production. The presence of normal phonation indicates the initiation of an appropriate speech. Normal phonation is characterised by adequate loudness, age appropriate pitch and soothing quality of voice. Any abnormality of these characteristics will lead to speech disorders especially voice disorders. The detailed assessment of phonatory system is an important part of speech assessment. The parameters assessed are phonation duration, S/Z ratio, objective as well as subjective measurement of pitch, loudness and quality. The needs for assessment are as follows:

1. The assessment of phonation helps to trace the site of dysfunction. For example at the vocal folds, or below at the respiratory level.
2. The assessment results can be used by the medical specialist for medical diagnosis, to check treatment progress. For example assessment before and after some laryngeal surgery or voice rest.
3. The assessment results also help to check efficacy of certain devices used, for example devices used to remove hypernasality.
4. The results of assessment help to set the goals of speech therapy, help in deciding about the therapeutic procedures to be administered.

5. The assessment results act as a baseline measurement for speech therapy and help to monitor progress.
6. The results of assessment can be used to counsel the parents/child about the voice/phonation problem which helps them to get motivated for treatment.
7. Assessment can be carried out to establish normative data in a given population. This data can be used for comparison in case of dysfunctions.

4.4 Basics of Articulation and Phonology

4.4.1 Introduction

ARTICULATION

It is the process where the air stream coming from the lungs through vocal folds is modified by the movements of speech organs in the vocal tract. These speech organs are the lips, the tongue, jaw, soft palate. The speech organs involved in articulation can be classified as active articulators and passive articulators. For producing a speech sound two articulators need to come in contact and modify the air stream. The point of contact is called the place of articulation and the way in which the contact is formed and released is called manner of articulation. The result of the air flow modification is production of speech sounds, or combination of speech sounds, which are recognised by the brain.Again these sounds can be classified as vowels, semivowels, diphthongs &consonants. Any errors in production of the speech sounds causes articulation disorder.

PHONOLOGY

It is the study of speech sounds, how they are organised, used and combined to form language. In other words it is the study of sound system of a language. It includes all the sounds and their features. It also includes the rules which decide how these sounds interact with each other. For example the production of sound /l/ in the words /lal/ and /Balti/ differ from each other. A typically developing child's language is characterised by phonological processes. These are naturally occurring language patterns seen in a child's language. For e.g final consonant deletion /jo/ for /jol/ .However they disappear at a certain age .When this does not disappear at that particular age, it causes phonological disorder.

4.4.2 Active and Passive Articulators

Active Articulators

These are the speech organs which actively move and make contact with other articulator in order to produce a speech sound. The kind of speech sound produced depends on the articulators,the place and manner of articulation. The active articulators are as follows:

- **Lips-** the visible part of mouth. Owing to its muscular make up, it's very flexible and can take a variety of shapes like rounding, retracting, and opening. The lips usually make contact with each other and other structures to produce consonants. For example /b/ is produced when both lips come in contact. And vowels and semivowels are produced with changed shapes. For example lip retracting for /i/.
- **Tongue-** another muscular structure, one end is fixed and the other end moves freely. It can move side to side, move up, touch the part behind upper teeth, lower its body, raise its body. In the production of vowels the tongue's position is altered,resulting in air flow modification. In case of consonants,tongue may make contact with another articulator. For example for the sound /t/, it touches the alveolar ridge or palate.
- **Lower Jaw -** it's a highly movable structures and houses the lower teeth also. The movement of jaw is very crucial for speech sound production,it can lower and raise itself to varying extents which helps in production of different vowels and consonants. Moreover the lower teeth provides as an articulator for some consonants as /f/, /v/.
- **Soft Palate-** it's the muscular portion of palate after the hard palate. It end in the uvula, which acts as a gate between oral and nasal cavities. So when the soft palate and uvula rise and close the nasal path, the air flow has to pass through the oral cavity and the sounds are oral. When the palate moves down and allows air to pass through the nasal cavity, nasal speech sounds are produced. For example /m/,/n/.

Passive Articulators

- **Teeth -** divided into lower and upper teeth. Important for biting, grinding and chewing of foods. It act as a passive articulator for many speech sounds. It does not moves on its own, but an active articulator e.g tongue or lips, makes contact with it to produce a speech sound. For example /t/ in the Bengali

words /tala/ or /tal/ is produced by the contact of tongue and upper teeth. These sounds are called dental or labiodental.

- **Alveolar Ridge-** it is the part just behind the teeth. Usually the ridge behind the upper teeth is of importance for speech productions. The active articulator tongue make contact with this portion to produce sounds like /t/ in the word /tata/,/r/ etc. These sounds are called alveolar sounds
- **Hard Palate-** Just after the alveolar ridge,the rigid and immovable part called har palate starts and continues upto the end of buccal cavity. This portion separates the nasal and oral cavity as it lies between both. It helps to direct the air flow towards the exit of oral cavity. It acts as a passive articulator for many speech sounds.Speech sounds produced with the help of hard palate are called palatal sounds. For example /r/,/l/

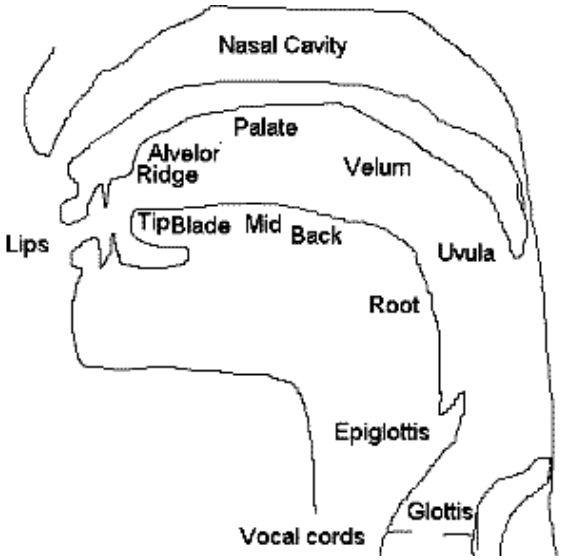


Diagram of Articulators

4.4.3 Classification of vowels and consonants

All the speech sounds produced can be divided broadly into vowels and consonants. Some other descriptions include semivowels and diphthongs. All the speech sounds can be classified into some groups depending on the way they are produced. The classification of speech sounds is very important in every language, as it helps to understand the production of each sound. Moreover it also helps to analyse and remediate speech errors.

Vowels

These sounds are produced when the air flow from the vocal folds can pass freely through the oral cavity. In other words the articulators do not make any constriction or contact with each other to block the air flow. However the active articulators change their shape and position to alter the air flow and result in different vowel production.

Classification of Vowels

Based on lip shape

- Rounded and Protruded - when both the lips take a rounded or protruded shape,the vowels produce are called rounded. For example /o/,/u/.
- Unrounded - when the lips do not assume any rounded shape,can stretch or retract,then unrounded sounds are produced. For example /a/,/i/

Based on Tongue Position

- Front -these vowels are produced when tongue tip moves up or down.For example vowel /i/
- Central - these vowels are produced when tongue's middle part moves up or down.For example vowel /a/
- Back - the back of the tongue rises or lowers compared to the resting position of the tongue. For example /o/, /u/.
- High - tongue moves and stays at higher place than the resting position.
- Mid - the height of the tongue remains unchanged

Based on duration

- Long vowel- longer duration taken to produce a vowel
- Short Vowel- short duration is taken to produce a vowel.

Classification of Consonants

Consonants are produced by movement of active articulators and in some cases complete or partial contact with the passive articulators. The airflow is altered and modified during production of consonants.

Consonants can be classified based on the following aspects:

- Place of articulation
- Manner of articulation
- Voicing or no voicing

PLACE OF ARTICULATION- This category describes the articulators whether active or passive involved in the production of a particular speech sound. It indicates the point at which the air flow is completely or partially obstructed. The consonants can be classified as follows:

Type of the Sounds	**Description**	**Example in English**
Bilabial	Produced by contact of both lips	/b/,/p/
Labiodental	Produced by contact of lower lip and upper teeth	/f/,/v/
Dental	Produced when tongue tip touches upper teeth	/th/,/dh/
Alveolar	Produced when tongue tip touches alveolar ridge (gums behind upper teeth)	/t/,/d/
Palatal	Produced when tongue touches the hard palate	/ch/,/j/
Velar	Produced when back of the tongue touches the soft palate	/k/
Retroflex	Produced when tongue tip twists and make rapid repeated movements and touches the hard palate	/r/
Glottal	Produced when there is simultaneous vibrations of vocal folds and release of puff of air	/h/

MANNER OF ARTICULATION- this category describes consonants based on the way they are produced. The air flow from the vocal folds can pass through a narrow passage between articulators or can be stopped abruptly by an articulator. The stoppage of air flow can be followed by release of air puff or no such release. The sounds can be described as follows:

Type of Sound	Description	Example in English
Plosives or Stops	Produced when air flow is completely and abruptly withdrawn causing sudden release of air	/p/,/t/
Fricatives	Produced when the air flow passes through a narrow constriction causing a friction noise	/s/
Affricates	Produced when air flow is stopped abruptly and then released to cause a frictional noise	/ch/
Nasals	Produced when the air passes through the nasal cavity instead of oral cavity	/m/,/n/
Aspirate	Produced when a greater amount of air is obstructed and suddenly released	/ph/,/kh/
Laterals	Produced when the air flow is blocked in the centre of oral cavity and released through the sides	/l/

Voiced Vs Voiceless-Voiced consonants are produced when vocal folds vibrate and release air stream in to the vocal tract. Voiceless sounds are produced when there

is no vocal fold vibration but the air from the lungs directly reaches the oral cavity. The sounds can be categorised as follows:

Type of Sounds	Voiced	Voiceless
Bilabial	b	P
Alveolar	d	T
Velar	g	K
Labiodental	v	F
Fricative	Sh	s

All the speech sounds can be described by their place of articulation, manner of articulation and voicing characteristics. For example the sound /b/ is a bilabial, plosive and voiced sound.

4.4.4 Assessment of Articulation

Abnormality in any of the articulators lead to errors of speech production. These errors are characterised by phonetic/phonemic errors or articulation errors. The error in production of speech sounds can be specific for example in a particular position of word, or it can be in general erroneously produced all the time. Articulation errors can be caused by abnormality in the structure of articulators or functions of articulators. These abnormalities are present as a associated condition of many disorders like motor speech disorders (cerebral palsy), mental retardation, hearing impairment, structural abnormality (tongue-tie, cleft lip-palate).

Need for Assessment

The assessment of articulation is a part of routine speech assessment. It helps us to understand the underlying cause of disorder,helps to assess the awareness of individual and family thus their counselling about the disorder,to decide the treatment plan like medical vs therapeutical,indicates use of formal tests, helps to form a baseline for therapy, assess the progress of therapy, decide on time of discharge from therapy, and to decide on follow up design.

Assessment Procedure

Brief Case History- The complaint, its onset and nature is recorded in details. The informant can be parents, caregivers and the child himself.A note is taken about

the associated disorders. Brief history about the treatment availed till date is taken for example surgery,therapy etc.

Assessment of Articulators- the articulators are assessed for their appearance and functions. These can be observed directly if the child is cooperative or can be assessed with the information provided by the parents. The following parameters are assessed:

Articulators	APPEARANCE	FUNCTION
lips	Normal/abnormal	Movements like rounding, retraction and protrusion present/absent/restricted
Tongue	Normal/Abnormal	Movements like side to side, pullingup, rolling up
Hard Palate	Normal/Abnormal	NA
Soft Palate & Uvula	Normal/Abnormal	Movement during vocalisation
Teeth	Normal/Abnormal	Chewing
Jaw/Mandible	Normal/Abnormal	Opening & closing of lower jaw.

The primary functions of the articulators are also assessed. These are blowing, swallowing, sucking and chewing. A note is taken about drooling (if present).

Error Analysis-The speech sounds produced which are incorrectly are recoded,the frequency with which they are misarticulated is noted. The position at which they are misarticulated is noted for example final position of a word. The error patterns in word and sentence level is recorded. The consistency of the errors is assessed.

Speech Intelligibility- The overall speech intelligibility is rated on a scale of 0 to 6, where 0 denotes normal speech and 6 denotes very poor speech intelligibility.

Diadochokinetic Rate - the production of syllables /pa/ /ta/ and /ka/ in one second is recorded. This gives information about rate and range of movement of articulators (lips,tongue,mandible & soft palate)

Stimulability - The stimulability of the child is assessed under two conditions with reinforcement and without reinforcement. The stimulus can be auditory, visual, audio-visual, graphic and motokinesthetic.

Formal Tests - Some formal tests can be used to specify the speech sounds erroneously produced, their position in the word level, consistency of their production and the pattern of the error like substitution by another sound, deletion or omission of the sound etc. Example of such tests are Bangla Articulation Test and Picture Articulation Test.

In ***Bangla Articulation Test*** all the vowels and consonants are listed with words comprising these sounds at three positions initial, medial and final. The response is elicited mostly by using pictures or models for young children. For older children the written words can be used directly. For children who cannot read, the tester may produce the words and ask the child to repeat. In the last case factors related to tester like testers speech production skills, knowledge of the language and personal bias should be realised. Also the child's hearing status should be considered while performing the test using auditory stimulus. The child is usually given few trials and then the final response is recorded. The response can be either correct or incorrect. Further the incorrect response can be categorically recorded into four responses, substitution(s), omission (o), distortion (d) and addition (a). The error can be present in all the three positions or any one or two positions. A sample of the format used is as follows:

Sl.No.	Phonemes	Position	Item	Correct	S	O	D	A
1	/a/(the first Bengali vowel)	Initial	onsho					
2		Medial	bol					
3	/aa/	Initial	Aam					
4		Medial	Mach					
5		Final	pa					

4.5 Suprasegmental Aspects of Speech and its Assessment

The speech sounds (segmental features- vowels & consonants) are connected to form phonemes and words. The words are connected to form sentences. The speech of human is characterised by lot of meaning conveyed by words and the way they

are produced in a particular context or environment. The way speech is produced conveys the emotional status of the speaker, his/her intent and also the process of communication is smoothly carried out. Words or segmental part of speech alone cannot convey the full message on its own. Suprasegmental aspects also called prosody of speech give colour and flair to segmental features and make speech production interesting. If suprasegmental features are removed human speech will become robot like. The same sentence can convey varied meanings or intentions with varying use of any of the suprasegmental features. The prerequisite for appropriate suprasegmental features is presence or acquisition of appropriate segmental features,adequate hearing and adequate psychological development. Suprasegmental features also get affected when rate and strength of movement of articulators is affected.

4.5.1 The various suprasegmental features of language are mainly as follows:

- Stress
- Intonation
- Rhythm

Let us learn briefly about each.

Stress - It is that feature which is used to indicate or convey importance of a particular word or phrase in a sentence. It can be used on the whole word or on a part of the word.The part of speech which is stressed is produced with greater energy. Stress patterns also differ based on words/no of syllables. In single syllable words, the primary stress is usually on the whole word. In bisyllabic and multisyllabic words the stress can be on a single or multiple syllables.

For example let us take a sentence THIS IS MY RED BAG. We can convey different information by changing the stress from one word to the other,like

THIS is my red bag indicates the ownership of the bag among many similar bags.

This is **MY** red bag indicates the ownership of the bag to a particular person

Intonation- It is conveyed by variation in pitch pattern of voice production within a phrase or sentence.The pitch can be rising or falling or in any other manner to convey varying meanings. Intonation mark sentence ending. It also convey feelings

like anger, or sarcasm. The use of intonation differentiate a sentence as a statement or a question.

For example, "This is your red bag" with not much pitch variation is a statement. And the same sentence becomes a question when the sentence ends with a rising pitch, 'This is your red bag?'

Rhythm- This is the timing pattern between the successive units of speech. There is a periodicity or timing pattern while the speaker takes breath in between utterances. In one breath he may utter 2-3 or more words depending on the context. In music, this is usually repetitive, same timing is maintained in a full song, but for speech, the rhythm depends on the speaker, content and context. Another aspect called tempo can be understood here, it is the speed or rate at which a speaker speaks. It is dependent on the speaker.

Juncture- It is the pause pattern used between words and leading to association of a particular syllable to a particular word. Moreover the placement of phrases at phrase juncture, the length of pauses is also very crucial. For example "peace talks" vs "pea stalks"

4.5.2 Assessment of Suprasegmental Feature

The assessment of suprasegmental features is carried out as a part of routine speech assessment. The child or speaker under assessment needs to have a developed connected speech. The assessment lead to the understanding of deficits in expression of these features. Thus this helps to plan and carry out speech therapy program.

Perceptual Analysis

There is a lack of standardised tests. Mostly perceptual analysis is carried out to assess each feature. The analysis can be carried out by recording speech samples from the child while reading, talking or storytelling. The analysis can be carried out even during conversation with the child as a part of assessment. Some tests described in the literature describe the use of experienced listeners, for the perceptual analysis. The listeners should have adequate knowledge about the language, context and should be aware of the normal patterns of suprasegmental features. However the perceptual analysis can be carried out by the clinician alone. During reading activities, the features can be highlighted to help the child to produce them correctly. For example stressed words can be underlined. Moreover use of rating scales to rate overall speech intelligibility also gives us information about suprasegmental features. Use of

correct prosodic features is very important to obtain good speech intelligibility. Children using the suprasegmental features correctly are more intelligible.

Instrumental Assessment

Instrumental evaluation always gives direct and objective results. Many parameters of speech can be measured using **spectrographic analysis.** This gives information about durational aspects of speech, pitch variations, intensity, stress, intonation,rate of speech, and voice quality. The prosodic control can be objectively assessed section by section and analysed to get information on fundamental frequency, its parameters and intensity contours. The assessment can be carried out by downloading certain software in an advanced computer fitted with a high fidelity microphone. Examples Praat, Audacity etc. These analyses can also be carried out in standalone systems like Visi-Speech. The assessment of fundamental frequency between two utterances can be done easily to differentiate between question and statement. Similarly the peak fundamental frequency values and intensity values can be compared between stressed and unstressed words.

However accuracy of instrumental measurements can be affected in case of impaired speech. For example presence of hypernasality may reduce the acoustic contrast between utterances, reducing the obtained values. Moreover there can be instrumental errors or lack of tester's knowledge which can affect the results.

4.6 Milestones of Speech Development in Typically Developing Children

Development of speech sounds follows a particular pattern in typically developing children. All the speech sounds including vowels,consonants,semivowels, diphthongs and blends develop at different ages depending upon mastery of central control on motor speech organs,muscles and proficiency of articulatory movements.As a result speech sounds which can be produced with ease develop first followed by more intricate sounds.

The speech development can be illustrated from birth as follows:

Birth to 3 months

The infant mainly has crying and comfort sounds at this stage. These sounds have rudimentary vowel like utterances, which cannot be specified.

3 to 6 Months

The child starts cooing,gurgling and babbling. Speech sounds like /p/,/b/ and /m/ become prominent along with vowels like /o/,/u/./i/ and /a/ in their speech production.

6 to 12 months

Continue to use the above developed consonants and vowels with more efficiency.

1 Year to 2 years

Few more consonants get added n,t,d in the child's speech production. At this stage the child starts to take a step towards developing production of more complex speech sounds. In this time the child experiences certain phonological processes, which might sound faulty to an adult but are very normal patterns found in the speech development of a typically developing child. The phonological processes are:

Voicing- This is where sounds made with no voice are replaced with voiced sounds (e.g. "car" becomes 'gar', "tea" becomes 'dea')

Stopping- This is where sounds made with a long airflow are replaced by sounds made with a stopped airflow (e.g. "sea" becomes 'tea', "shoe" becomes 'to')

Final consonant deletion- The ends of words are often missed out (e.g. "tap" = 'ta')

Velar Fronting- This is where sounds made with the tongue hitting the back of the mouth (e.g. /k/ and /g/) are replaced with sounds made at the front of the mouth (e.g. /t/ and /d/) so "car" becomes 'tar', "key" becomes 'tea'

Palatal Fronting- This is where the tongue is moved forward in the mouth so the 'sh' sound becomes a /s/ sound

Weak Syllable Deletion- This is where non-stressed syllables are deleted from words (e.g. "e**l**ephant" becomes 'ephant')

Assimilation- The pronunciation of the whole word is influenced by the presence of a particular sound in the word (e.g. "do**g**" become '**g**o**g**')

Consonant Cluster Reduction- This is where clusters of consonants in words are reduced by one or more consonants (e.g. '**b**rick' becomes '**b**ick', "**c**lown" becomes '**c**own')

De-affrication - This is where the affricate sounds 'sh', 'ch' and 'j' are replaced with fricative sounds ('sh', /s/, /z/) or the /t/ or /d/ sound.

Gliding - This is where the /l/ and the /r/ sounds are replaced with the /w/ or the 'y' sound.

The voiceless 'th' sound (as in '**th**ank you') is replaced with a /f/ sound

The voiced 'th' sound (as in 'wi**th**') is replaced with a /v/ sound

2-4 years

More speech sounds get included in the production list like /k/,/g/,/f/,/s/. The child also keeps repeating the phonological processes. The child's speech is still not very intelligible to unfamiliar person.

4-6 Years

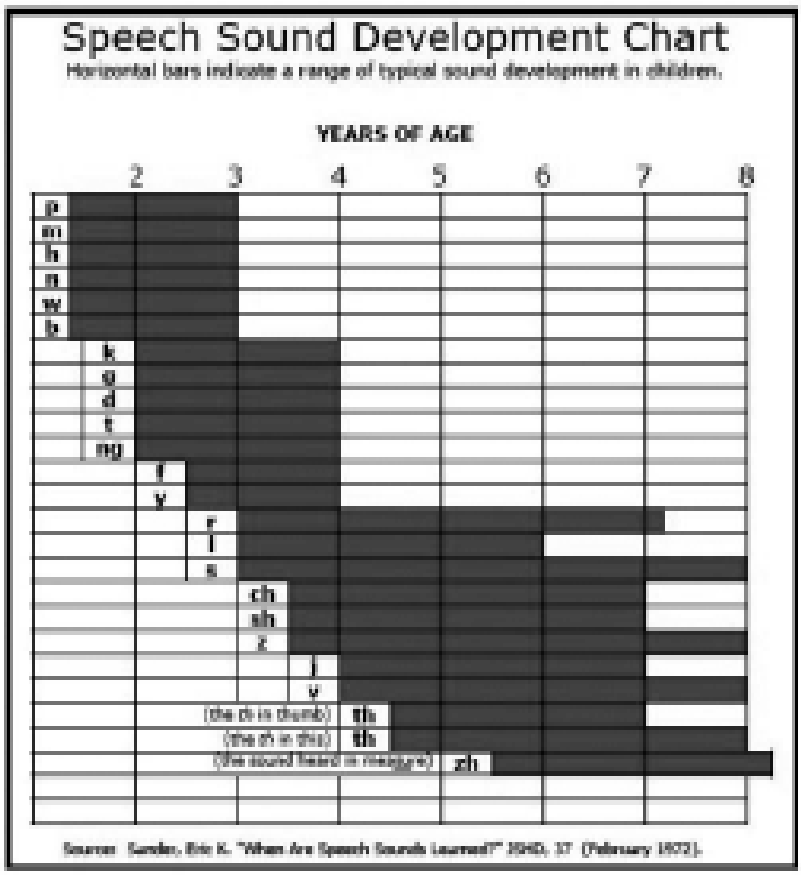
More difficult speech sounds start emerging like , /y/, /h/, 'sh', 'ch', 'j', /z/, /l/, /v/. The child still uses the phonological processes and continues to make the normally occurring errors.By 6 years the child's speech becomes very distinct with few errors like in sounds /r/,and /th/. Even unfamiliar individuals start comprehending the child's speech.

6-8 years

By 8 years the child is able to say almost all speech sounds with much clarity. The normal phonological patterns start to disappear and completely disappear by 8years.

4.6.1 Chart of normal speech sound development sequence.

The horizontal bars represent age.The speech sounds are mastered by the age where the bar terminates. For example the sounds k,g,d,t are masteres by 4 years of age.



4.7 Speech Intelligibility

4.7.1 Concept

To carry out effective and smooth verbal communication, it is mandatory to understand what is being said. That is the speaker should have clear and intelligible speech. Speech intelligibility is a measure of how well a particular speaker's speech is comprehendible. The speaker should be understood by familiar as well as unfamiliar listeners. Age appropriate voice, articulation, normal fluency of speech, normal language development and good quality of speech production sum up to give rise to good speech intelligibility. Usually a child's speech starts to become intelligible even to unfamiliar listener by and after 4 years of age.

Intelligibility to familiar listeners

By 18 months = 25% intelligible

By 24 months = 50-75% intelligible

By 36 months = 75-100% intelligible

Lynch, Brookshire & Fox (1980)

Intelligibility to unfamiliar listeners

Dr Peter FlipsenJr , (2006)

By age 1 = 25% intelligible

By age 2 = 50% intelligible

By age 3 = 75% intelligible

By age 4 = 100% intelligible

4.7.2 Factors affecting speech intelligibility

In order to speak clearly the speaker should have the following characteristics:

1. ***Voice:*** The individual should have age and sex appropriate voice quality. The organs of the respiratory system, vocal tract should be structurally and functionally adequate to result in an acceptable voice quality. The child should not have any structural abnormality, motor speech disorder, intellectual deficiency and hearing impairment in order to be able to produce good quality of voice. The children have similar voice quality until puberty, after which male and female adolescents have different voice quality. The voice should be adequate in loudness, appropriate in pitch and should have a pleasing quality(not harsh, hoarse or nasal)
2. ***Articulation -*** All the articulators should have normal structural make up. The active articulators should have appropriate rate and range of movements. The child should not have any motor speech disorder, hearing impairment, structural anomaly (cleft lip/palate) and intellectual deficiency in order to have clear articulation.
3. ***Fluency -*** The rate at which the speech is produced should be age appropriate. It should be free from any non-fluencies like repetitions, blocks or hesitations. However up to an age of 4 years, the child might display a normal non-fluency pattern which should not be confused with fluency disorder.
4. ***Suprasegmental features-*** The use of stress, intonation, rhythm and pause should be timely and appropriate. A child having speech without these features

will sound robotic, and not pleasing to the ears, and will lead to disinterest, lack of motivation of the listener.

5. ***Knowledge of language-*** The child should have normal language development sequence. It is not only important the way speech is produced, but what content it has.

4.7.3 Assessment of Speech Intelligibility

Assessment of speech intelligibility is a part of routine speech assessment. It provides information about the child's current speech intelligibility which can be used to counsel parents, decide treatment strategies and also curriculum for education. The measurement acts as a baseline before treatment/therapy and also helps to monitor progress of therapy.

Perceptual Procedures

Most of the clinicians use perceptual measures for assessing intelligibility. Rating scales are widely used in all set-ups. A speech sample, either live or recorded is presented to a listener or group of listeners for judging the intelligibility on a scale. For example a scale of 0 to 6 is used, where 0 denotes most intelligible and 6 denotes poor intelligibility. Unfamiliar listeners are best as the listener bias can be removed.

However there can be some limitations of the perceptual measurements. The points on rating scales may not be clearly demarcated. The rating might slightly differ from one judge to another.

Other Procedures:

Write down Methods

The listener/judge can write down the child's utterances as understood. Thereafter the number of words correctly produced can be calculated. The intelligibility can be calculated in percentage by using the simple calculation:

Speech Intelligibility (%) = No of words correctly produced/Total no of utterances

4.8 Let's sum up

Respiration provides the power for the process of speech production. The structures involved in respiration and their respective functions should be intact for adequate speech production. There is a need for assessment of

respiratory process as a part of routine speech evaluation. Phonation is the next step after respiration. It involves the vocal folds and vocal tract. The phonatory system is also evaluated as a part of routine speech assessment procedure. The assessment results are used for management of various speech disorders.

There active and passive articulators which act in coordination to result in smooth speech production. All the speech sounds are classified based on manner, place and voicing characteristics. Articulation assessment provides important information for speech sound correction.

The emotions/feelings of a speaker are conveyed with the help of suprasegmental features used in speech production. Intonation, stress and rhythm are the basic prosodic features. These features can be assessed perceptually as well as instrumentally.

The development of speech sounds in a child follows a particular sequence. Any disruption leads to delayed speech or speech errors. It typically starts at birth and continues till 8 years of age.

Speech intelligibility is obtained by the presence of many contributing factors. It is very important for effective communication. Assessment of speech intelligibility is a part of routine speech assessment. Mostly perceptual measure are employed to assess speech intelligibility.

4.9 Check Your Progress

1. What are the various systems of human body which are involved in the act of speech production?
2. What is speech breathing?
3. Why do we need to assess the respiratory system?
4. What are the sounds which are produced with the help of alveolar ridge and tongue?
5. What are the speech sounds you can expect to hear in the speech of a 4 year old child?
6. Frame a sentence in your language, change the intonation patterns and say the sentence.

7. At what age you can expect to hear intelligible speech from a familiar child and an unfamiliar child?

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মানুষের জ্ঞান ও ভাবকে বইয়ের মধ্যে সঞ্চিত করিবার যে একটা প্রচুর সুবিধা আছে, সে কথা কেহই অস্বীকার করিতে পারে না। কিন্তু সেই সুবিধার দ্বারা মনের স্বাভাবিক শক্তিকে একেবারে আচ্ছন্ন করিয়া ফেলিলে বুদ্ধিকে বাবু করিয়া তোলা হয়।

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Any system of education which ignores Indian conditions, requirements, history and sociology is too unscientific to commend itself to any rational support.

— Subhas Chandra Bose

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