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# Elements Of Anatomy And Physiology Of Speech And Hearing Mechanism

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**ABSTRACT**
The knowledge of the structures (anatomy) and the functions (physiology) of speech and hearing is considered very necessary for the establishment of the relationship among speech, language, hearing and communication. This knowledge will lead to the understanding of the etiology of communication disorders (also known as speech and language disorders) and hearing impairment. This main thrust of this article is to examine the elements of anatomy and physiology of speech and hearing mechanism. It looked at the concept and meaning of speech and hearing mechanism. The anatomy and physiology of speech and hearing mechanism relating to speech and hearing disorders was discussed. The types of speech disorders and the oral mechanism affected leading to disordered speech and its implications for therapeutic interventions for learners with communication disorder were x-rayed. Educational intervention, curriculum and classroom activities for children with communication disorders were well discussed. The authors concluded that human being uses speech and language as a form of communication to express their thoughts, ideas and opinions. Students with communication disorders find it embarrassing, unrewarding, or too frustrating to participate in a class discussion, which in turn impedes their learning. However, with early intervention, this condition can be managed to lead a purposeful life.
**Keywords**: Anatomy, Physiology, Communication, Speech

## INTRODUCTION

Communication is of vital importance in today's society, as such, anything that interferes with communication creates a serious problem for a child. Learners, be it students or pupils need good speech and language skills which are the primary elements of communication to succeed in school and in life. An understanding of the anatomy and physiology of speech and hearing mechanism is vital to having a full knowledge of the etiology of hearing loss and speech disorders in children. This knowledge will also help when determining if there is a discrepancy between a child's level of functioning and what would be expected. The study of the structure of an organism is called anatomy. Therefore, a person who studies anatomy of the ear shows interest in the physical structures of the ear such as pinna also known as the auricle, auditory canal, tympanic membrane or ear drum, ossicles (malleus, incus, stapes), cochlear and so on. It is the anatomical knowledge that leads to the physiological aspects which now gives full meaning to the aspect of the body in question.

Physiology therefore is the study of how organs or the structures of the body work within an individual. In other words, physiology is the function of the organs identified anatomically. One who studies physiology of human body shows interest in how various organs function and how they make the organism function. For instance physiology reveals to us how the different organs, tissues and components of the speech (such as diaphragm, lungs, larynx, pharynx, teeth, lips, tongue, velum, and

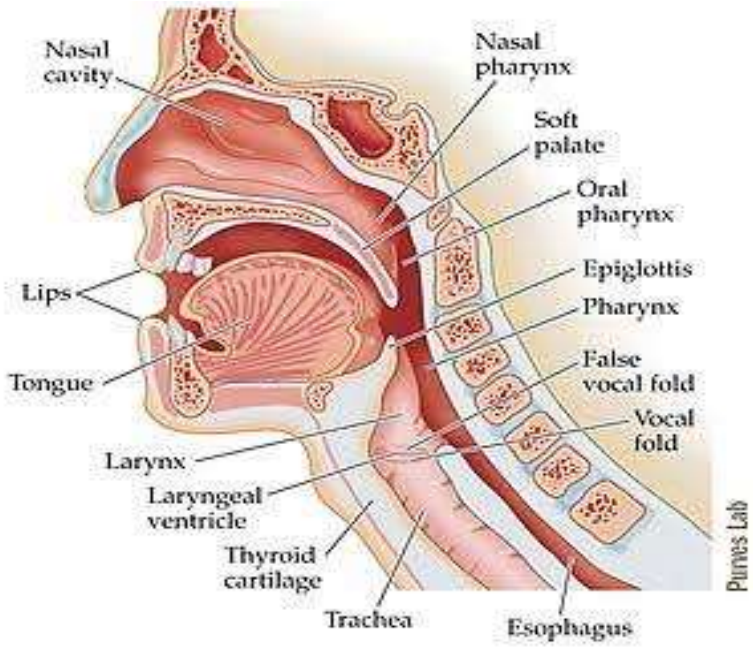
so on) work with the brain to make an individual hear. Anatomy and physiology are studies together to give students a full appreciation and better understanding of human body. The study of anatomy and physiology of speech and hearing mechanism enables students to understand the various organs that make up the hearing or speech mechanism and the causes of damages to the organs that can lead to hearing and communication disorders. Speech and language intervention in form of therapy helps the children with communication disorders, by providing maximum communicative potential, compensatory methods, rehabilitation and mainstreaming. Early diagnosis, treatment and intervening on the communicative problem will reduce the intensity and severity of the problem which enhances effective communication.

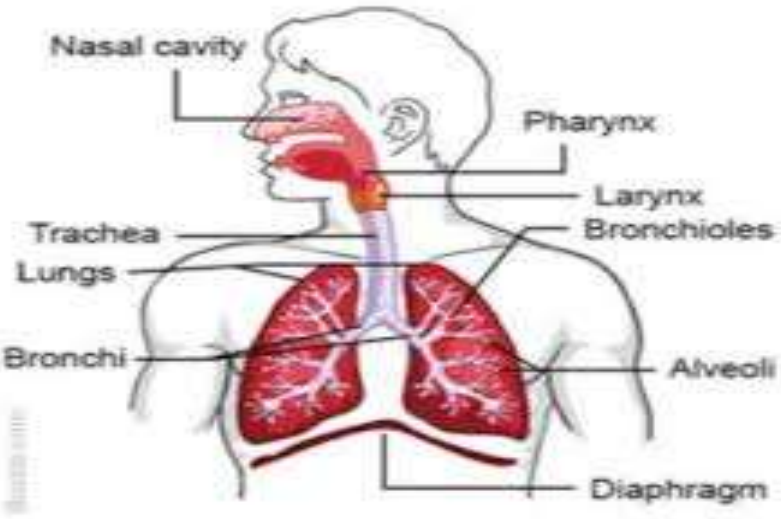
**CONCEPT AND MEANING OF SPEECH AND HEARING MECHANISM**

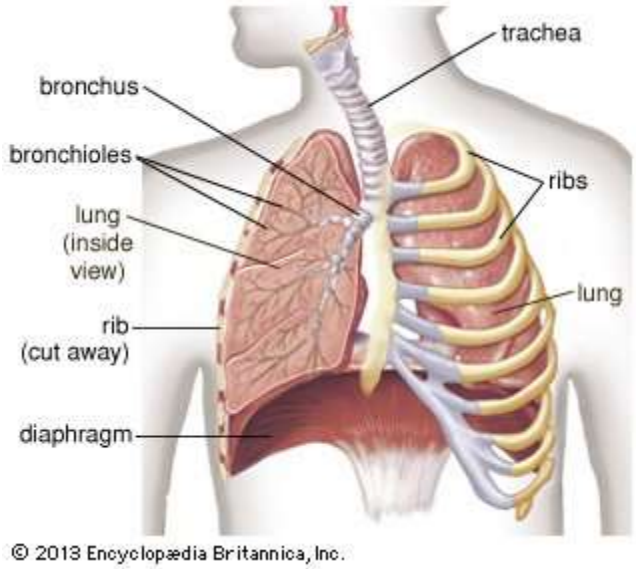
Speech is the sound we use to build up words which implies that speech is the physical production of sounds. These sounds are produced in sequences to create words. Producing speech sounds involves the muscles, nerves and brain working together to plan and execute movements of the tongue, lips, palate, and jaw. Speech can also said to be the expression of ideas and thoughts by means of articulate vocal sounds for expressing ideas and thoughts. In other words, speech is human vocal communication using language. Each language uses phonetic combinations of vowel and consonant sounds that form the sound of its words (that is, all English words sound different from all French words.

**The Anatomy and Physiology of Speech and Speech Mechanism**

The Speech Mechanism/Production






It is important to understand the *mechanisms* of *speech* production for us to have a better knowledge of speech disorder. *Speech* production is the process by which thoughts are translated into *speech*. *Speech mechanisms* are based on physiological systems that develop in man as a result of object-directed activity and association with other people, and that are impossible without certain innate abilities and skills (for example, proper coordination of articulation, syllable-formation, and correct breathing) Kolso, (2014)

Speech requires movement of sound waves through the air. Speech itself is air that is moved from the lungs through a series of anatomic structures that mold sound waves into intelligible speech. This capacity can be accomplished in any volume from a soft whisper to a loud shout by varying the force and volume of air expelled from the lungs. All languages are spoken by the same mechanism, though the words are different and require different usages of the anatomy.

Oral communication involves expelling air from the lungs which set other structures of communication in motion. To expel air from the lungs the diaphragm at the floor of the thorax is relaxed. This allows the diaphragm to return to its resting position which is domed into the thorax, expelling air from the lungs (Hsia, Hyde, Weibel, 2016). Also, the muscles of the chest tighten,

reducing the size of the interior thorax to push more air from the lungs. The air travels up the windpipe (trachea) and passes through the larynx.

The larynx is comprised of a number of cartilages. The largest is the cricoid cartilage which is joined to the top of the trachea. It is structurally different from the rings that form the trachea. The cricoid is a complete cartilaginous ring, while the tracheal rings are horseshoe shaped (open in the back). The back of the cricoid is a large, solid plate. The front slopes down sharply and forms a V angle. At the top of the cricoid lies the thyroid cartilage, which is more elongated front to back in males (Netter, & Frank, 2014). The cartilage forms an angle of about 90° in males. In females, the cartilage is flatter, forming an angle of 120°. Thus the male cartilage protrudes farther forward and often is evident as a knob in front of the throat (known as the Adam's apple).

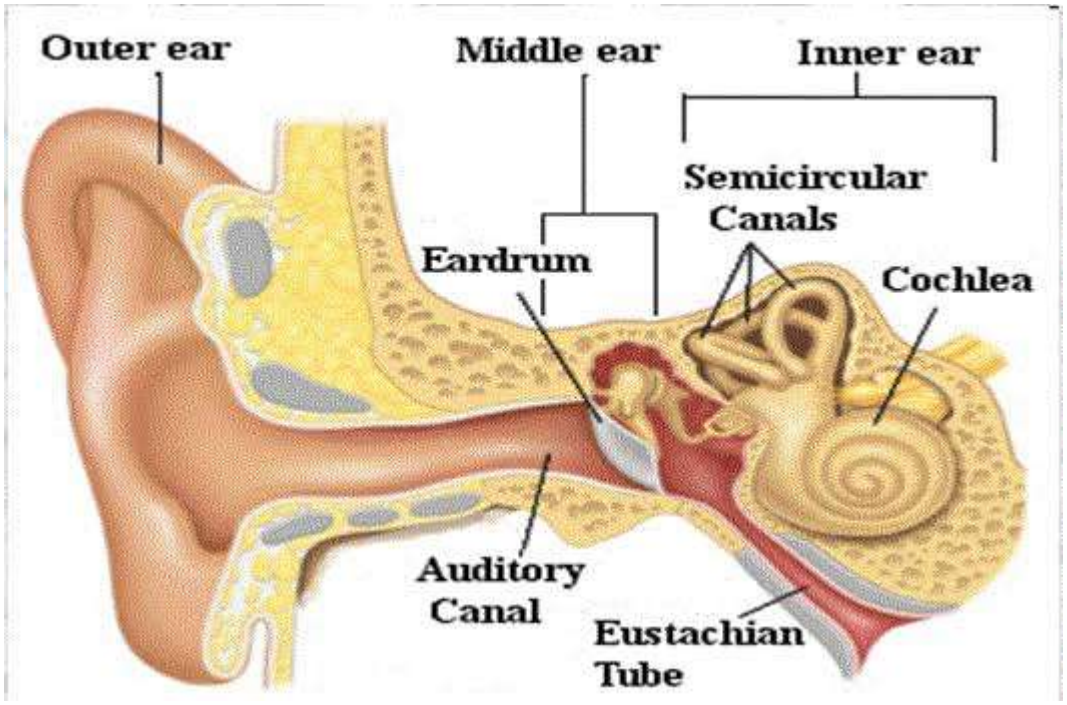
The two cartilages form a hard cartilaginous box that initiates sound by means of the vocal cords that lie at the upper end of the box. The glottis, entrance to the larynx at the upper end, is protected by a flap called the epiglottis. The flap is open during the process of breathing but closes over the glottis when food is swallowed. Both air and food transverse the same area in the throat, the pharynx, and the epiglottis prevents food from entering the trachea and directs air into the lungs. Infection of the epiglottis can occur when a child has a sore throat *(*Robert, 2010). The resulting inflammation can progress rapidly, cause complications in respiration, and may be fatal if not treated promptly because the inflamed epiglottis can close off the laryngeal opening.

If an individual is simply breathing and not talking, the vocal cords lie relaxed and open to allow free passage of air. A series of muscles in and around the larynx pulls the vocal cords taut when speech is required. The degree of stress on the cords dictates the tone of voice. Singing requires especially fine control of the laryngeal mechanism. Word emphasis and emotional stress originate here. Air puffs moving through the larynx place the vocal cords or vocal folds in a state of complex vibration. Starting from a closed configuration the vocal folds open first at the bottom. The opening progresses upward toward the top of the fold. Before the opening reaches the top of the vocal cord the bottom has closed again. Thus the folds are open at the bottom and middle, open at the middle and closed on each end, open at the middle and top, and then only at the top. This sequence is repeated in fine detail during speech. Once the sound leaves the vocal cords it is shaped into words by other structures called articulators *(*Sadley, 2019).These are the movable structures such as the tongue and lips that can be configured to form a given sound.

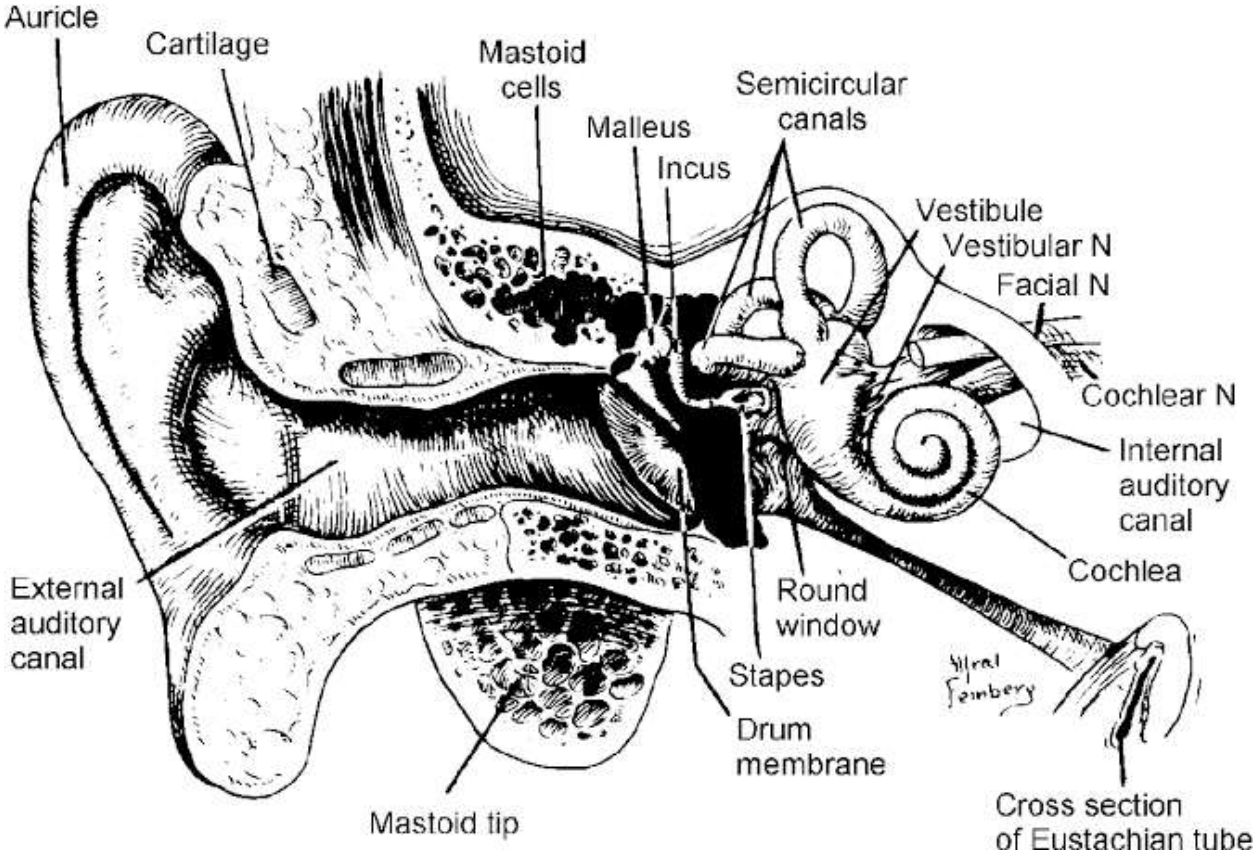
Above the larynx lies the pharynx through which the sound moves on its way to the mouth. The mouth is the final mechanism by which sound is tailored into words. The soft palate at the back of the mouth, the hard or bony palate in the front, the teeth, the tongue, and the lips come into play during speech. The nose also provides an alternate means of issuing sound and is part of the production of speech. Movement of the entire lower jaw can alter the size of the mouth cavern and influence the tone and volume of the speech. Speech is a complex series of events that takes place with little or no conscious control from the speaker other than selection of the words to be spoken and the tone and volume at which to deliver them (Seikel, King, Drumright, (2010). The speech center in the brain coordinates movement of the anatomic structures to make the selected words become reality. Speaking in louder tones is accomplished by greater force on the air expelled from the lungs. Normal speech is accompanied by normal levels of respiration. Whispering involves a reduction in the air volume passing through the vocal cords.

**Hearing Mechanism/Physiology of Hearing**

The process of hearing begins with the occurrence of a sound. Sound is initiated when an event moves and causes a motion or vibration in air. When this air movement stimulates the ear, a sound is heard. In the human ear, a sound wave is transmitted through four separate mediums along the auditory system before a sound is perceived: in the outer ear—air, in the middle ear— mechanical, in the inner ear liquid and to the brain—neural (Rhett, Priscilla , Alexander, Gurgel, 2017)




(Source: *University of Rhode Island. 2019.)*




***(Source: Semantic Scholar.org)***

There are three main components of the human auditory system: the outer ear, the middle ear, and the inner ear.

**Outer ear**

The outer ear includes the pinna, the visible part of the ear, as well as the ear canal which terminates at the eardrum, also called the tympanic membrane. The pinna serves to focus sound waves through the ear canal toward the eardrum. Because of the asymmetrical character of the outer ear of most mammals, sound is filtered differently on its way into the ear depending on what vertical location it is coming from. This gives these animals the ability to localize sound vertically. The eardrum is an airtight membrane, and when sound waves arrive there, they cause it to vibrate following the waveform of the sound *(*Schacter, Gilbert, & Wegner, 2011).

**Middle ear**

The middle ear consists of a small air-filled chamber that is located medial to the eardrum. Within this chamber are the three smallest bones in the body, known collectively as the ossicles which include the 1. *malleus* also known as the hammer, 2. *Incus* also known as *anvil*, and 3. *stapes* also known as *stirrup*. They aid in the transmission of the vibrations from the eardrum into the inner ear - the cochlea. The purpose of the middle ear ossicles is to overcome the impedance mismatch between air waves and cochlear waves, by providing impedance matching**.** The muscle that bends the malleus to the incus is known as *mallioincuda joint* while the muscle that bends the incus to the stapes is known as *incudostapedia joint.*

Also located in the middle ear are the stapedius muscle and tensor tympani muscle, which protect the hearing mechanism through a stiffening reflex. The stapes transmits sound waves to the inner ear through the oval window, a flexible membrane separating the air-filled middle ear from the fluid-filled inner ear. The round window, another flexible membrane, allows for the smooth displacement of the inner ear fluid caused by the entering sound waves *(*Lopez-Poveda, Palmer, Meddis, 2010).

**Inner ear**

*(Source: University of Rhode Island. 2019.)*

The inner is a small but very complex organ which ear consists of the cochlea, which is a spiral-shaped, fluid-filled tube. It is divided lengthwise by the organ of Corti, which is the main organ of mechanical to neural transduction. Inside the organ of Corti is the basilar membrane, a structure that vibrates when waves from the middle ear propagate through the cochlear fluid – endolymph. The basilar membrane is tonotopic, so that each frequency has a characteristic place of resonance along it. Characteristic frequencies are high at the basal entrance to the cochlea, and low at the apex. Basilar membrane motion causes depolarization of the hair cells, specialized auditory receptors located within the organ of Corti (Schacter, Gilbert, & Wegner, 2011). While the hair cells do not produce action potentials themselves, they release neurotransmitter at synapses with the fibers of the auditory nerve, which does produce action potentials. In this way, the patterns of oscillations on the basilar membrane are converted to spatiotemporal patterns of firings which transmit information about the sound to the brainstem (Yost, 2003*).*

**Sound Transmission through the Outer Ear**

Air transmitted sound waves are directed toward the delicate hearing mechanisms with the help of the outer ear, first by the pinna, which gently funnels sound waves into the ear canal, then by the ear canal.

**Sound Transmission through the Middle Ear**

When air movement strikes the tympanic membrane, the tympanic membrane or eardrum moves. At this point, the energy generated through a sound wave is transferred from a medium of air to that which is solid in the middle ear. The ossicular chain of the middle ear connects to the eardrum via the malleus, so that any motion of the eardrum sets the three little bones of the ossicular chain into motion (Osatuyi, 2016)

**Sound Transmission through the Inner Ear**

The ossicular chain transfers energy from a solid medium to the fluid medium of the inner ear via the stapes. The stapes is attached to the oval window. Movement of the oval window creates motion in the cochlear fluid and along the Basilar membrane. Motion along the basilar membrane excites frequency specific areas of the Organ of Corti, which in turn stimulates a series of nerve endings (Osatuyi, 2016).

**Sound Transmission to the Brain**

With the initiation of the nerve impulses, another change in medium occurs: from fluid to neural. Nerve impulses are relayed through the VIII C.N., through various nuclei along the auditory pathway to areas to the brain. It is the brain that interprets the neural impulses and creates a thought, picture, or other recognized symbol (Osatuyi, 2016).

**Anatomy of Speech Relating to Speech Disorders**

Speech refers to the production of meaningful sounds (words and phrases) from the complex coordinated movements of the oral mechanism. Speech requires coordinating breathing (respiration) with movements that produce voice (phonation) and sounds (articulation). Respiration yields a stream of breath, which is set into vibration by laryngeal mechanisms (voice box, vocal cords) to yield audible phonation or voicing. Exquisitely timed and coordinated movements by the articulatory mechanisms, including the jaw, lips, tongue, soft palate, teeth, and upper airway (pharynx), then modify this voiced stream to yield the speech sounds, or phonemes, of the speaker's native language. *Speech disorders* are deficits that may prevent speech from being produced at all, or result in speech that cannot be understood or is abnormal in some other way. This broad category includes three main subtypes: speech sound disorders, voice disorders, and stuttering. Speech sound disorders can be further classified into articulation disorders, dysarthria, and childhood apraxia of speech. The speech variations produced by speakers of different dialects and non-native speakers of English are not defined as speech disorders unless they significantly impede communication or educational achievement (Laitman, & Reidenberg, 2009).

Speech sound disorders, often termed *articulation or phonological disorders,* are deficits in the production of individual speech sounds, or sequences of speech sounds, caused by inadequate planning, control, or coordination of the structures of the oral mechanism.

**TYPES OF SPEECH DISORDER AND THE ORAL MECHANISM AFFECTED LEADING TO DISORDERED SPEECH**

***1.*** **Dysarthria** is a type of speech sound disorder that is caused by medical conditions that impair the muscles or nerves that activate the oral mechanism. Dysarthric speech may be difficult to understand as a result of speech movements that are weak, imprecise, or produced at abnormally slow or rapid rates. Neuromuscular conditions, such as:

i. stroke and/or infections (e.g., polio, meningitis),
ii. cerebral palsy, and
ii. trauma, can cause dysarthria.

**2. Apraxia:** This is another rare type of speech sound disorder, caused by difficulty with planning and programming speech movements. Children with apraxia may be delayed in learning the speech sounds expected for their age, or they may be physically capable of producing speech sounds but fail to produce the same sounds correctly when attempting to use them in words, phrases, or sentences (ASHA, 2007).

***3.*** **Voice disorders:** This is also known as *dysphonias*, *it* occurs when the laryngeal structures, including the vocal cords, do not function correctly. For instance, a voice that sounds hoarse or breathy may be due to growths on the vocal cords, allergies, paralysis, infection, or excessive vocal abuse when speaking. A complete inability to produce any sound, called *aphonia*, may be caused by inflammation, infection, or injury to the vocal cords.

***4.*** **Stuttering:** This also known as *fluency disorder* or *dysfluency*, it is a type of speech disorder that disrupts the ability to speak as smoothly as desired. Dysfluent speech contains an excessive amount of repetitions of sounds, words, and phrases, and involuntary breaks, or "blocks." Severe stuttering can effectively prevent a speaker from speaking at all; it may also lead to other abnormal physical and emotional behaviors as the speaker struggles to end a particular block or avoid blocks in the future (Conture, 2001).

**IMPLICATIONS FOR THERAPEUTIC INTERVENTIONS FOR LEARNERS WITH COMMUNICATION DISORDERS**

Speech and language disorders can accompany or result from any of the conditions that interfere with the development of perceptual, motor, cognitive, or socio-emotional function. Accordingly, conditions as varied as Down syndrome, fragile X syndrome, autism spectrum disorder, traumatic brain injury, and being deaf or hard of hearing are known to increase the potential for childhood speech and/or language disorders, and many children with such conditions will also have speech and language disorders. In addition, studies of children with primary speech and language disorders often reveal that they have abnormalities in other areas of development (Brumbach & Goffman, 2014). Intensive monitoring of speech and language development in such children is important for early detection and intervention to lessen the effects of speech and language disorders.

In many children, however, speech and language disorders occur for unknown reasons. In such children, diagnosing speech and language disorders is a complex process that requires assessing not only speech and language skills but also cognitive, perceptual, motor, and socio-emotional development; biological, medical, and socioeconomic circumstances; and cultural and linguistic environments. Best-practice guidelines recommend evaluating across multiple domains and obtaining information from multiple sources, including a combination of formal, standardized, or norm-referenced tests; criterion-referenced observations by speech-language pathologists and other professionals; and judgments of familiar caregivers about the child's speech and language competence relative to community expectations for children of the same age (ASHA, 2004; Nelson, Nygren, Walker & Panoscha, 2006; Royal College of Speech & Language Therapists, 2005; Shevell, Ashwal and Donley, Flint Gingold, Hirt, Majnemer, Noetzel, and Sheth 2003; Wilkinson, Bass, Diem, Gravley and Harvey, 2013). Early intervention for such children generally is designed to facilitate both language and speech skills.

**1. Language Intervention:** Language intervention activities are used in some therapy sessions. In these exercises, a Speech language pathologist or other trained professional will interact with a child by working with the child through play and other forms of interaction to talk to the child and model language use. The professional will make use of various stimuli, such as books, objects, or simple pictures to stimulate the emerging language. In these activities, the professional will model correct pronunciation, and will encourage the child to practice these skills.

**2. Articulation Therapy:** Articulation therapy is a form of intervention which may be used during play therapy as well, but involves modeling specific aspects of language and the production of sound. The specific sounds will be modeled for the child by the professional often the Speech language pathologist, and the specific processes involved in creating those sounds will be taught as well. For example, the professional might instruct the child in the placement of the tongue or lips in order to produce certain consonant sounds (Barnlund, 2008)

**3. Technological Intervention:** Technology is another avenue of intervention, and can help children whose physical conditions make communication difficult. The use of electronic communication systems allow nonspeaking people and people with severe communication disabilities to engage in the give and take of shared thought.

4. **Oral-motor/feeding and swallowing Intervention/Therapy:** The Speech Language Pathologists may use a variety of oral exercises including facial massage and various tongue, lip, and jaw exercises to strengthen the muscles of the mouth for eating, drinking, and swallowing. The Speech Language

Pathologists may also introduce different food textures and temperatures to increase a child's oral awareness during eating and swallowing.

5. **Environmental Modification** can also be an important part of treatment for communication disorders. For example, children with communication disorders can be given extra time during school-based discussions or oral test situations to more adequately formulate responses (Agin, Geng and Nicholl,2015).

The various interventions discussed above are guided by the strengths and needs determined by the speech and language evaluation. If possible, all interventions will be geared towards the goal of developing typical communicative interaction. The aim of any intervention services for children with communication disorders is either prevention, remediation or compensating for the communication disorders.

To this end, interventions typically follow either a:

a.) Preventive Service Model,
b.) Remedial, or Compensatory Model.

**Preventive Service Model:** The preventive service model is common as an early intervention technique, especially for children whose other disorders place them at a higher risk for developing later communication problems. This model works to lessen the probability or severity of the issues that could later emerge.

**Remedial, or Compensatory Model:** The remedial model is used when an individual already has a speech or language impairment that he/she wishes to have corrected. Compensatory models would be used if a professional determines that it is best for the child to bypass the communication limitation; often, this relies on AAC.

**EDUCATIONAL INTERVENTION, CURRICULUM AND CLASSROOM ACTIVITIES FOR CHILDREN COMMUNICATION DISORDERS**

According to Cash, Wilson, Eileen, and Cruz, (n.d) below are some educational interventions for teaching and learning of children with communication disorders

**1. Address attending and listening skills.** Such skills can be addressed through auditory memory and recall games such as "Whisper Down the Lane." Other ideas are rhymes that feature alliteration, such as "She sells sea shells…" and activities that require the student to identify where a certain sound occurs within a given word (beginning, middle and end.)

**2. Share books with the student, and allow him/her to make guesses or predictions based on context.** Since the student with communication disorders still have their vision is intact, giving the student books to be studied to peruse will prepare the student for the lesson. The teacher further asks the student to make prediction based on what he/she must have read.

**3. Choose reading materials that reflect the student's language experience, familiar vocabulary, sentence structures and sentence patterns** More complex written materials should be adapted or reduced. This compatibility will maximize comprehension and encourage verbalizations. The same can be said for other learning tasks, whether presented orally or in writing.

**4.** Use rhyming songs and poems with the student. Such activities will help the student to tune into the phonetic sounds of different vowels, consonants, and blends.

5. Utilize Language Experience Programs that integrate listening, speaking, reading and writing. Such approaches coordinate all aspects of the language process into a meaningful experience for the student.

6. Utilize multi-sensory modes of teaching which include visual, auditory, kinesthetic and tactile components.

7. Emphasize turn-taking as a social convention that is fundamental to effective communication. The student with language difficulties should have the opportunity to participate in board games and relays to encourage turn-taking. The use of telephones and walkie-talkies are other ways to practice this skill.

8. Incorporate direct instruction in and practice with the following: greeting others, asking questions, making requests, asking for help, and giving messages to others, which are all important social interactions.

9. Try the pause, prompt, praise method. Pause to allow the child time to think and respond, prompt the child if necessary, and praise them for his/her effort.

## CONCLUSION

Communication is vital to the full human experience. Human being use language as a form of communication to express their thoughts, ideas and opinions, which in turn invites interaction that helps him/her mature and grow. Words are used to think through decisions and to tell friends and folks of our feelings and needs. Students with communication disorders experience difficulties at every turn. They might find it embarrassing, unrewarding, or too frustrating to participate in a class discussion, which in turn impedes their learning. However, with early intervention, this condition can be managed to lead a purposeful life.

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