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Assistive Technology For Hearing and Speech Disorders

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Abstract
Many individuals with hearing loss will need rehabilitation in order to live maximally productive lives. As such, they need a variety of assistive technologies that provide them with improved access to information thereby enhancing their communication capabilities in a wide variety of environments. Most devices either provide sound amplification or alternate ways to access information through vision and /or vibration. These technologies can be grouped into three general categories. Within each main category, there are subcategories based on different purposes or the intended audiences when utilizing the technology. The overall goal of these devices is improved accessibility to information as close as possible to that enjoyed by individuals without speech and language disorders. The paper discusses the assistive technology for those with hearing impairment.
Keywords: Assistive Listening Device, Hearing Technology, Alerting Devices, Communication Support

1. Introduction

Hearing is perhaps man's most important sense. Without it, his power to communicate is greatly diminished. Unfortunately, it is frequently affected by pathology in which a person develops a disabling impairment. William (2000) described the sense of hearing as one of the most important of human senses, needed for communication, protection from danger and enjoyment of surroundings. Sound constantly surrounds us and informs us about many objects in our environment and its localization is one of our most important biological traits. Even in lower animals, sound localization enables an animal to locate food, avoid predators, find a mate and to communicate.

Sounds from various sources are combined into one complex sound field which travels to the outer ear. The auricle (pinna), the visible part of the outer ear, helps in funneling the sound into the ear canal from where it reaches the tympanic membrane. From here, the sound is transmitted through the middle ear to the inner ear where the intricate motions and interactions of the various parts of the cochlea lead to the generation of electric potentials. This activity is continuous and hearing is our only sense which never shuts off and which continually receives input from all directions, giving us a continual connection with and warning of our surroundings. Unlike vision, which can be shut off by simply closing our eyes, hearing can only be partially protected from continual high intensity noise by complex central nervous system mechanisms. Therefore. although hearing impairment is not life-threatening and does not directly restrict physical activity, it can cause severe disability. Hearing loss limits a person's ability to interact with his environment and socially with family and friends and to receive and interpret information in the environment(Becker, Flower, Glass & Newcomer, 1984). Helen Keller, rendered blind and deaf from an early age, is credited with noting that "blindness cuts us off from things, but deafness cuts us off from people" (Dewane, 2010). She declared that if she had the opportunity of choosing between deafness and blindness she would have chosen blindness (Dewane, 2010). Humans are social beings, and in a world full of sound, hearing is essential.

Unfortunately, the significance of the impact of hearing loss on communication and interaction with others often goes unrecognized. Coping with hearing loss is different from other disabilities in that it is an invisible handicap. The reactions or behaviours associated with hearing loss may not be apparent, and even the sight of a hearing aid may not guarantee recognition of a disability. Also, when hearing loss is perceived, individuals with normal hearing often assume that simply saying something louder or turning up the volume will enable someone with hearing loss to hear. Unfortunately, volume is not necessarily the issue; difficulties with sound and differentiating between similarly sounding words may be involved. These lead to negative perceptions and stereotypes that precipitate emotional sequelae in affected individuals. (Dewane, 2010).

'Assistive technology for hearing and speech disorders' refers to any device that helps a person with hearing loss or a voice, speech, or language disorder to communicate, that is, to hear and understand what is being said more clearly and / or to express thoughts more easily. Many such devices are being developed through the help of digital and wireless technologies. This write-up is intended to create an awareness of the availability of assistive technology as rehabilitative measures to improve the quality of life of people with hearing and speech disorders.

2. Assistive Technologies

These technologies can be grouped into three general categories: hearing technology, alerting devices and communication supports.

2.1 Hearing Technology

Hearing Technology can broadly be defined as any device utilized for improving the level of sound available to a listener. There are two general subcategories: assistive listening devices (ALD) and personal amplification. Assistive listening devices can be utilized by individuals or large groups of people and can typically be accessed without the support of specific personnel. Personal amplification is chosen specific to the needs of an individual based on their level of hearing and requires the support of an audiologist to determine candidacy for the different devices and appropriately fit the chosen device.

Assistive Listening Devices

Assistive listening devices are used to improve the signal-to-noise ratio in any given situation. In addition to increased volume, they provide the listener with a direct connection to the sound source and help minimize the effects of background noise, distance and room acoustics. There are both individual assistive listening devices and public or large group devices. All assistive listening devices utilize a transmitter that sends a person's voice or other sound source to a receiver that distributes the sound evenly throughout a room or directly to an individual. Sound is transmitted in four primary ways: Frequency Modulation System (FM); Infrared (light); Induction Loop (electromagnetic); or through a direct connection. Some hearing aids have a special connection option called Direct Audio Input (DAI) that allows the user to connect directly to an FM system or Induction Loop receiver. In many instances, one can even connect directly to other devices such as a computer, TV, MP3, iPod, or radio. Assistive devices include

(A) Hearing Aids – A hearing aid can be defined as a device whose function is to amplify the acoustic signals to a degree that enables a patient with hearing impairment make effective use of his or her residual hearing. The basic components and functions include the microphone, the amplifier, the receiver and the power supply The microphone is a transducer that converts the sound signal into electrical energy and the amplifiers are transformers primarily composed of transistors that are built into and integrated circuit. The primary function of the amplifier is to increase the volume of the electrical signal received from the microphone. The receiver changes the modified electrical signal back to acoustic energy that is directed to the ear and the power supply is derived from its battery.

Types of Hearing Aids

Basically, there are three types – analog, programmable and digital. The difference between digital hearing aids, programmable hearing aids, and analog hearing aids rests partly on how the controls of these hearing aids are set by the hearing aid professionals. For example, conventional analog hearing aid controls such as gain and output (power settings) are set manually using a screwdriver and no software is needed. With programmable and digital instruments, controls such as gain and output are typically manipulated via computer software. Recently, however, new types of hearing aids have been introduced that have multiple characteristics. For example, some instruments are trimmer controlled. This allows for a digital product to be fit without a computer. However, all conventional hearing aids are manually controlled, digital hearing aids can be controlled manually or via computer software, and programmable aids are always manipulated via a computer or remote hand-held device.

Another way to differentiate conventional, programmable and digital instruments is in how they process sound. Conventional analog hearing aids contain what is called analog signal processing. That is, there is no conversion of the incoming signal into numeric values (binary code) or digital format. The sound is processed as its original continuous waveform. Digital hearing aids convert the incoming sound into a numeric language (binary code), and process sound within this format before converting the signal back to analog. The digital processing lends itself to even more flexibility and advanced features such as noise reduction algorithms and automatic/adaptive microphone directionality. Programmable hearing aids can be either digital or analog instruments.

Hearing Aid Styles

Hearing aids are available in four basic styles designed to meet most hearing needs. The last three are referred to as custom hearing aids because an impression of the ear opening is taken and the shell of the hearing aid is manufactured according to this impression.

Behind The Ear (BTE) aid – This fits comfortably behind the ear and it is attached to either a custom ear mould or a universal ear tip that directs sound from the instrument into the ear. Its body rests on the postero-superior part of the auricle. BTE hearing aids are pre-made, not custom made and cost less. They are used by children and individuals with severe to profound hearing loss.

In The Ear (ITE) aid– This is custom-made to fit within the external ear. The ITE hearing aids are the largest of the custom made hearing aids. They can be fitted in a wide range of patients, from mild to severe hearing loss.

In The Canal (ITC) aid– This is also custom made and small enough to fit almost entirely in the ear canal such that it is hardly noticeable. It is more cosmetically appealing and fits hearing losses in the mild to moderate range. Some of its disadvantages include the relatively higher cost and its susceptibility to ear wax damage.

Completely In The Canal (CIC) aid– This is the smallest of the hearing instruments. It is also a custom made aid that fit so deeply inside the ear canal that it is practically invisible. CIC hearing aids are best for adult patients

with larger ear canals and mild to moderate hearing loss. The CIC aid is also highly susceptible to damage by ear wax..

(B) Frequency Modulation (FM) System - FM systems work in the same way as the commercial FM radio. The system sends the auditory message through FM radio waves from a wireless transmitter directly to a small receiver worn by the listener with hearing loss. These systems can be utilized as an independent unit or connected to public address systems. FM systems are equally effective indoors or outdoors. They can be portable or permanently installed. FM signals travel through walls, so the systems are not appropriate for confidential communication. Receivers can be used with neck loops in conjunction with a telecoil (t–coil) equipped hearing aids and cochlear implants or using headsets or ear buds for those without t–coils.

(C) Infrared Systems - FM systems use radio waves and travel through barriers. This makes them unusable in courtrooms and other situations in which confidentiality is essential. For these circumstances, the preferred assistive listening device is an infrared system. Infrared systems use light waves to transmit sounds. Light cannot travel through a wall, so the speaker and listener must be within sight of each other for the system to work. Theaters use infrared systems, since playwrights and producers do not want people to have access to their creative work standing outside a theater (i.e., without paying). Infrared systems have a better track record in terms of static, but a drawback to their use is that bright sunny days can interfere with the transmission of the infrared light.

(D) Audio Loop Systems - An audio or induction loop system transmits sound through a wire loop that surrounds the listening area. The electric current that flows through the loop creates an electromagnetic field that can be received and then amplified by a hearing aid or cochlear implant equipped with a t-coil. As with other assistive listening devices, ear buds or a headset may also be used along with a t-coil receiver. Audio loop systems can be permanently installed in meeting rooms or portable systems can be setup as needed.

(E) Amplified Phones - A phone may have an in built amplifier or may be connected to an external amplifier. Whether the amplification is internal or external, it allows the user to increase the overall volume to their comfort level. This feature is available to some extent in regular cell phones, but there are also specialized phones or external attachments designed specifically for users with hearing loss that provide even greater output levels.

(F) Amplified Stethoscopes - An amplified stethoscope is an instrument that is used by hearing-impaired medical professionals and students. The stethoscope electronically amplifies these sounds so that the person who is using it can hear more easily while performing an examination. Adjustments to reduce background noises may also be made. Many amplified stethoscopes are designed so that the user may adjust the sound frequency from a low (bell) to a high (diaphragm) mode during examinations. . This mode is for listening to lower frequency sounds, like certain sounds made by the heart. Higher frequency sounds, such as the sounds made by the lungs, can be heard using the diaphragm mode. Amplified stethoscopes are electronic and typically run on batteries. They can be used by people who wear hearing aids and hearing-impaired people who do not require them.

2. 2 Alerting Devices

Alerting devices typically provide an amplified and/or visual signal or vibration used to get the attention of the deaf or hard of hearing individuals. They can be used for public emergency alerts like fire alarms and tornados or for everyday situations like the telephone ringing or a baby crying. Devices that can be utilized with alerting technology include the following:

*(a) Smoke Alarm*s - There are a number of types of smoke alarms for those with hearing loss. There include visual smoke alarms, vibrating smoke alarms, a combination of visual and vibrating, and even ones that use scents to alert. The smoke alarm can also be hooked up to burglar alarm systems.

(b) Alarm Clocks – These can be in form flashing lights or vibrating units.

(c) Door Knock Light – This makes use of a light that flashes to alert people with hearing loss that somebody is at the door since they may not hear the knock.

(d) Weather Alert - A weather alert monitor has a special screen which alerts the user visually as to the nature of the alert, be it, tornado, storm, flood, etc. It also has a special kit that fits many brands of weather radios that will alert the user via a strobe light or vibrator when an alarm is sounded.

(e) Wrist Watches – These wrist watches are specially made with visual alarms.

(f) Call Alerts – This is a telephone signal indicator designed for use by individuals with hearing disabilities. The device alerts the user to an incoming telephone call by flashing a lamp.

2.3 Communication Supports

The third category of assistive technology for the speech and hearing defectives are communication support systems.

(a) *The Telecommunication Device for the Deaf (TDD),* previously known as teletype machine (TTY), allows the user to place phone calls using text through a regular phone line. Each TDD has a keyboard with a text screen. A user either needs to connect with another person that has a TDD or use a relay service that can convert the text

into voice for the hearing listener receiving the call. Models range from basic to high-end with additional options such as printers, answering machines, and memory to save text or messages. Advances in technology for phones, pagers, text devices and computer services are however, making the use of the TDD/TTY obsolete.

(b) Captioned/Text Telephones: Just like specialized amplified phones or TDD, captioned telephones allow the user to see text of their telephone conversation as well as access relay services.

(c) Computers with Web Cameras: Many individuals utilize the combination of a web camera and computer Internet service to be able to visually connect with others. This readily available technology has been used increasingly by individuals with hearing loss to expand their communication options. This set-up can be utilized to access an IP relay service using sign language instead of text. This is however only possible when both parties have webcam on their computers.

(d) Video Phones: Sign language can also be communicated through a video phones.

(e) The I-Communicator - This is an application designed to convert the speech into text, speech to video sign language or computer-generated voice, text to computer-generated voice or video sign language providing access to acoustic information in real-time. With an I-Communicator, a hearing person speaks normally, and the software converts his or her spoken words into text. A deaf user can then type a response in which the computer then delivers as text or say aloud using text-to-speech. the I-Communicator was developed to help enhance the literacy levels of people with deafness, promote independent communication thereby boosting self confidence and serve as a communication aid in those environments where sign-language interpreters are not available.

(f) Augmentative and Alternative Communication - Augmentative and alternative communication is used by individuals to compensate for severe speech-language impairments in the expression or comprehension of spoken or written language (ASHA, 2005). People making use of AAC include individuals with a variety of congenital conditions such as cerebral palsy, autism, intellectual disability, and acquired conditions such as amyotrophic lateral sclerosis, traumatic brain injury and aphasia (Angelo, 1997). Augmentative and alternative communication can be categorized into unaided, aided, low –tech and high tech. *Unaided AAC:* Unaided AAC systems are those that do not require an external tool, and include facial expression, vocalizations, gestures, and sign languages and systems (Blackstone, 2004) Informal vocalizations and gestures such as body language and facial expressions are part of natural communication, and such signals may be used by those with profound disabilities (Blischak, 1995).

Aided AAC: An aided AAC aid is any "device, either electronic or non-electronic, that is used to transmit or receive messages" (Angelo, 1997) such aids range from communication books to speech generating devices. Since the skills, areas of difficulty and communication needs of AAC users vary greatly, an equally diverse range of communication aids and devices is required (Chiang & Lin, 2007).

Low-Tech AAC: Low-tech communication aids are defined as those that do not need batteries, electricity or electronics. These are often very simple communication boards or books, from which the user selects letters, words, phrases, pictures, and/or symbols to communicate a message (Clark & Wilkinson, 2007). Depending on physical abilities and limitations, users may indicate the appropriate message with a body part, light pointer, eye-gaze direction, or a head/mouth stick. Alternatively, they may indicate yes or no while a listener scans through possible options (Cook, 2011).

High-tech AAC: High-tech AAC aids permit the storage and retrieval of electronic messages, with most allowing the user to communicate using speech output (Crais, 1991). Such devices are known as speech generating devices (SGD) or voice output communication aids (VOCA) (Creech, 2004). A device's speech output may be digitized and/or synthesized: digitized systems play recorded words or phrases and are generally more intelligible while synthesized speech uses text-to-speech software that can be harder to understand but that permits the user to spell words and speak novel messages (Crais, 1991). High-tech devices vary in the amount of information that they can store, as well as their size, weight and thus their portability (DeCoste, 1997). Access methods depend on the abilities of the user, and may include the use of direct selection of symbols on the screen or keyboard with a body part, pointer, adapted mice or joysticks, or indirect selection using switches and scanning (Cress &Marvin, 2003). Devices with voice output offer its user the advantage of more communicative power, including the ability to initiate conversation with communication partners who are at a distance (Doyle & Phillips 2001). However, they typically require programming may be unreliable. Therefore, low tech systems are often recommended as a backup in case of device failure (Cress & Marvin, 2003).

3. Conclusion

People with hearing loss can be helped. Anyone with some amount of residual hearing can benefit from an assistive listening device. People who are able to converse one-on-one in a quiet room without speech reading would get a lot of benefit from assistive listening devices, because a properly used assistive listening device can duplicate that quality of sound. Even people with less residual hearing will benefit from the use of an assistive listening device as well, because the device will provide more clues for speech reading.

References

American Speech-Language-Hearing Association. (2005). "Roles and responsibilities of speech-language pathologists with respect to augmentative and alternative communication: position statement".

Angelo, D. H. (1997). "AAC in the family and home". In Glennen, S.; DeCoste, D. C. Handbook Of Augmentative And Alternative Communication. San Diego: Singular Publishing Group.

Becker G. Flower, R. M. Glass, L. E. & Newcomer, R. J. (1984). The Management of Hearing Impairment in Older Adults. *OTA* contract No. 333-89700.

Blackstone, S. (2004). "Clinical news: Visual scene displays". *Augmentative Communication News* 16 (2): 1–8.

Blischak, D. M. (1995). "Thomas the writer: Case study of a child with severe speech and physical impairments". *Language, Speech, and Hearing Services in Schools* 25: 11–20.

Chiang, H. M., Lin, Y. H. (2007). "Expressive communication of children with autism". *Journal of autism and developmental disorders* 38 (3): 538–545.

Clarke, M., Wilkinson, R. (December 2007). "Interaction between children with cerebral palsy and their Peers". *augmentative and alternative communication* 23 (4): 336–348.

Cook, A. M. (2011). "It's not about the technology, or is it? Realizing AAC through hard and soft technologies". *Perspectives on augmentative and alternative communication* 20 (2): 64.

Crais, E. (1991). "Moving from "parent involvement" to family centered services". *American Journal of Speech-Language Pathology* 1: 5–8.

Creech, R. (2004). "2004 Edwin and Esther Prentke. AAC distinguished Lecture". *AAC Institute*.

DeCoste, D. C. (1997). "Chapter 10: Introduction to augmentative and alternative communication systems". In Glennen, S.; DeCoste, D. C. Handbook Of Augmentative And Alternative Communication. San Diego, CA: Singular Publishing Group.

Dewane C. 2010. Hearing Loss in Older Adults - Its Effect on Mental Health *Social Work Today*: Vol. 10 No. 4 p. 18.

Doyle, M.; Phillips, B. (2001). "Trends in augmentative and alternative communication use by individuals with amyotrophic lateral sclerosis". *Augmentative and Alternative Communication* 17 (3): 167–178.

Titze, I.R. (1994). Principles of Voice Production, Prentice Hall.

William A. Y. (2000). The World We Hear: An Introduction. Fourth Edition. Academic Press. A Harcourt Science and Technology company: I 65-75.