Chapter 1

The Future of Audiologic Rehabilitation: Overview and Forecast

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The future of audiologic rehabilitation is bright and promising. There is a prevailing climate of optimism which is related to improvements in technology for various sensory aids. The next decade will be prosperous for those with hearing problems because of the merging of education, technology, and legislation. Research and development are consumer driven and scientists are working diligently to address several issues, including reduced feedback; a deep canal fit; hearing soft conversational speech; keeping speech and other environmental signals below the loudness discomfort level; and developing improved speech enhancement capabilities, especially in noise, reverberant, and distance listening environments. There is now, more than ever before, the potential for improved speech perception resulting from digital signal processing. There is also the non-instrumental component of audiologic rehabilitation in the form of informational counseling, group communication training, and computer-driven interactive video using laser videodiscs. Finally, legislative efforts designed to assist the person with hearing-impairment in telephone communication, television reception, and various communication access alternatives have been realized with the passing of the Americans With Disabilities Act. It is exciting to know that the application of these technologies may yield better communication performance for the hearing-impaired adult.

Predicting the future is an awesome task. For example, here are some forecasts which did not quite hit the target:

> "Heavier-than-air flying machines are impossible." – *Lord Kelvin*
> *noted British physicist and President, Royal Society, 1895*

"Everything that can be invented has been invented." – *Charles H. Duell Director, U.S. Patent Office, 1899*

"Ruth made a big mistake when he gave up pitching." – *Tris Speaker, 1921*

"The Japanese auto industry isn't likely to carve out a big slice of the U.S. market." – *Business Week, 1979*

Despite the risks, this author predicts the future of audiologic rehabilitation to be very positive and challenging. Ross (1987) has stated that there seems to be a renewed interest and commitment to the audiologic rehabilitation process. This commitment, coupled with recent technological advances, accompanies a climate of optimism for the audiologist engaged in audiologic rehabilitation.

An overview of audiologic rehabilitation reveals that this aspect of the profession developed in medical settings following World War II. Today, audiologic rehabilitation is present in rehabilitation centers, in VA hospitals, in community and university settings as well as in private practice facilities. Audiologic rehabilitation has always focused on communication performance with the hearing aid, or other sensory devices. According to Montgomery (1993) the future of audiologic rehabilitation is at a point where accurate quantitative assessment procedures, efficient treatment methods, and a supply of well-trained personnel will help determine the directions of service delivery to adults with a hearing impairment.

This chapter will focus on three main areas which are predicted to have the greatest impact on future audiologic rehabilitation services for adults with a hearing impairment. These are issues related to the consumer, to technology, and to computer-based instruction.

Prediction 1: The first prediction concerns the consumer. By the year 2000, the number of persons with a hearing impairment who will seek audiologic rehabilitation services will be significantly greater than now. This prediction will be substantiated by studies of the etiology of hearing impairment as well as research findings that lend a greater understanding of the relationship between the aging process and hearing impairment (Gordon-Salant, 1991). Recognition of the benefits afforded by amplification will increase primarily through education of both individuals with a hearing impairment and professionals who provide audiologic rehabilitation services.

Prediction 2: The second prediction concerns technology. By the year 2000, 75% of all hearing instruments sold will be digital and programmable, affording the user improved quality of the amplified signal and enhanced communication performance in a noisy background. More persons with only a mild hearing impairment will receive amplification. In addition, the Americans With Disabilities Act (ADA) will have a significant impact on communication access in a variety of work, home, and social settings.

Prediction 3: The third prediction concerns computer-based instruction and

audiologic rehabilitation training. By the year 2000, computer-based instruction in the form of interactive video and multimedia presentations will assume a significant role in audiologic rehabilitation by increasing the availability of informational counseling and skillbuilding exercises for adults with a hearing impairment.

PREDICTION 1: CONSUMER EDUCATION

The U.S. population has increased by an average of 25 million persons with each census since 1950. According to the World Almanac (1991), in 1980 the U.S. population was 226 million and reached 250 million in 1990. The population will continue to grow and may reach 280 million by the year 2000. It is estimated that about 8-10% of all U.S. citizens have some degree of impaired hearing. This amounts to approximately 24-28 million persons, of whom about 250,000 are profoundly deaf. Individuals over the age of 65 years currently comprise about 15% of the population in the U.S. This group encounters a much larger incidence of hearing impairment than any other age group. Hearing impairment is America's third most pervasive physical handicap, ranking behind arthritis and hypertension. Hearing impairment is age-related with about 94% of all hearing-impaired persons being over 17 years; 81%, over the age of 41 years; and 54%, over the age of 65 years (Goldstein, 1984). In 1900 the average life expectancy in the U.S. was 47 years of age and in 1982 it was 75 years. The number of persons over the age of 85 years is expected to increase 170% from 1984 to the year 2000. While strides have been made with regard to serving elderly persons, much more must be achieved because currently only about 15-20% of the elderly hearing-impaired population use amplification (American Academy of Audiology, 1993; Downs & Glorig, 1988).

By the year 2000, the current unserved population of 80% with hearing impairment who do not own a hearing aid will be significantly reduced because of educational efforts. More persons will be fitted with hearing instruments, and other sensory aids. Consumers will be better informed about the importance of good quality hearing. By the year 2000, the number of audiologists will be doubled to 18,000 and we will be well on our way to the projected goal of 20,000 audiologists.

Educating the public by helping individuals with a hearing impairment to accept their hearing loss and overcome their resistance to the use of hearing instruments was the number one concern reported by dispensers in a 1992 survey completed by Cranmer-Briskey (1992). When consumers understand the importance of good hearing and know where to obtain services there will be a two-pronged effect. More persons with a hearing impairment will request audiologic rehabilitation services and there will be a need for more audiologists to serve them.

A number of factors have been identified as being important when one consid-

ers the purchase of hearing instruments. These include the degree of hearing loss, cost, the age at onset of hearing difficulty, the stigma of wearing hearing instruments, unrealistic family expectations, insufficient knowledge about what hearing instruments can do to overcome the communication deficit, previous unsuccessful hearing instrument use, and the failure of the physician to identify the communication problem and refer for audiologic rehabilitation assistance (Fino, Bess, Lichtenstein, & Logan, 1992).

Kochkin (1991) reported that the insistence to make the smallest hearing aid possible may well be a contributing factor reinforcing the stigma of hearing loss. The 1990 Hearing Industry Association (HIA) survey clearly showed that stigma associated with a hearing loss is one of the primary reasons why persons do not purchase hearing instruments. A second important factor from the HIA survey was that many individuals did not believe their loss was "severe enough." It is interesting to note that persons who own hearing instruments tend to have a more favorable attitude toward hearing aid wearers than do non-owners. It is possible that this difference is related to one's acceptance of the hearing impairment. Is it likely that the denial of one's hearing loss is related to social stigma ? Hiding hearing loss in small hearing aids may, in fact, be perpetuating this denial factor. Kochkin (1991) asserted that, despite the fact that smaller and less conspicuous hearing aids may be more cosmetically appealing, they do not eliminate the underlying notion that impaired hearing is unacceptable.

Improving client motivation to seek quality hearing care is one way to overcome some of the stigmas associated with hearing impairment. The continued positive portrayal of media people (The Reagan Effect) using hearing aids early in their lives is a good example of positive motivation. Weinstein (1991) suggested that audiologists link the benefits of hearing aids to life satisfaction. For example, learning to use hearing instruments in social-communicative environments will go a long way toward restoring independence. Participating in group communication training in a simulated home environment will help the new hearing instrument user develop appropriate hearing aid adjustment and communication strategies to reduce the communication deficit (Binnie & Hession, 1990; Lesner, 1992). Group audiologic rehabilitation provides several positive educational advantages such as opportunities to practice assertiveness in a non-threatening environment, gaining support and encouragement from others with similar communication problems, and repeating various communication strategies. Incorporating family members into the group audiological rehabilitation process will also help to develop communication autonomy. Developing assertiveness in communication, coupled with a positive and realistic attitude toward hearing aid use, as suggested by Kemp (1990), will facilitate development of communication independence. Joining local consumer support groups like Self Help for Hard of Hearing People (SHHH) can also be of significant assistance to persons struggling to accept their hearing deficit.

The use of hearing aids seems to have beneficial effects on quality of life, one's cognitive status, and psychosocial well-being (Mulrow et al., 1990). A

lack of motivation for hearing aid use continues to be a major obstacle to successful outcome in audiologic rehabilitation. Finally, to be successful audiologic rehabilitation must be seen in the context of the audiologist being the primary case manager. This can best be achieved when the audiologist is a Doctor of Audiology as is the case with vision care when the provider is a Doctor of Optometry (Windmill, 1993). Goldstein (1992) suggested that the hearing instrument may be the single most important element of relief from communication problems produced by hearing impairment. But, he cautioned, it is not the only element. He contended that

> The hearing impairment does not define the patient; it is simply one aspect of the patient's life. The future belongs to the hearing care practitioner who can provide quality service tailored to meet the needs of each unique individual. The path to that future is an education grounded in science, versed in technology and committed to service. (Goldstein, 1992, p. 28)

PREDICTION 2: TECHNOLOGY

By the year 2000, 75% of all hearing instruments will be digital programmable units which will allow audiologists the opportunity to adjust signal processing to the environment. Similarly, the hearing aid user may be able to select hearing aid parameters that have been adjusted for various environmental settings, controlling the signal-to-noise ratio which can improve communication performance. Currently, less than 2% of all hearing instruments are digitally-controlled analog (DCA) programmable units but the future will bring about dramatic increases in the use of these devices. Beck (1991) highlighted the changes that have occurred in hearing health care during the last decade. For example, the personal, wearable hearing instrument has become smaller, more versatile, and acceptable. The hardware has improved significantly with a corresponding increase in the quality of the amplified sound. A summary of the state of the art of hearing aid technology and the procedures used to select and evaluate amplification is presented in *The Vanderbilt Hearing Aid Report* (Studebaker, Bess, & Beck, 1991).

By the year 2000 fewer than 25% of all hearing aids will not be programmable devices. Some persons with a hearing loss may still benefit from both linear circuits and the highly sophisticated K-Amp analog hearing aid (Preves, 1992) because they are comfortable, perform well in noise backgrounds, produce little feedback, and are less expensive. Other persons with mild hearing loss will begin to realize the importance of quality hearing care and will pursue hearing instrument assistance to be used situationally. Some persons may purchase stock canal instruments to handle these early situational needs, probably from audiologists with private practices like optometrists. Initiating persons early to the audiologic rehabilitation process will allow the audiologist to monitor hearing and communication performances. This will have a significant impact on hearing aid use because more and more individuals will speak positively about audiologic rehabilitation benefits. Once they are satisfied with the audiologic rehabilitation

efforts received at a younger age they will continue to seek services as their communicative needs change. Eventually they may be candidates for technological advances in the form of other sensory aids, or assistive listening devices.

Since 1973, numerous laws have been enacted to provide improved communication access to persons with a hearing impairment. Some of these legislative efforts are summarized in Table 1. The most recent legislation is the Americans With Disabilities Act (ADA) which parallels the Civil Rights Act of 1964 and the Rehabilitation Act of 1973. Audiologists will need to become familiar with this legislation which is designed to protect the rights of those with communication disorders.

According to Title I of the ADA, a qualified person with a disability is an individual who can perform the *essential functions of the job* with or without reasonable accommodations (e.g., qualified interpreters, amplified telephones, Text Telephones [TTs], or job restructuring) to the qualified person with a disability unless it would result in an undue hardship. The ADA requires public accommodations to provide TTs upon request whenever the public accommodation offers the participant an opportunity to make outgoing telephone calls on more than an incidental convenience basis. Compton (1991) suggested that the ADA has been an important force in promoting the popularity of assistive technology. The ADA requires the removal of communication barriers that are structural in nature. This can be accommodated by providing flashing alarm systems for wake up calls or smoke/fire detection, by permanent signage, or by providing

Table 1

Summary of Legislation Designed to Provide Communication Access for Persons With a Hearing Impairment

Section 504 of the Rehabilitation Act of 1973 prohibits discrimination against qualified handicapped people in any federally supported program or activity.
Hearing Aid Compatibility Act of 1988 (P.L. 394) requires all telephones manufactured for sale in the United States after August 16, 1989 (cordless phones by 1991) to be hearing aid compatible.
1988 Telecommunications Accessibility Enhancement Act (P.L. 100-542) requires General Services Administration to provide for telecommunications access to Federal agencies, both for employees to be able to use the phone and for deaf and speech-impaired citizens to have access to all Federal Offices.
Television Decoder Circuitry Act ("Chip Bill") (P.L. 101-431) became law on October 15, 1990 and requires that by July 1993 all TV sets sold in the U.S. with screens 13 in or larger must have built-in circuitry that would decode and display closed captions.
The Americans With Disabilities Act (ADA) (P.L. 101-336) was signed into law on July 17, 1990 and extended civil rights protection for people with disabilities in private sector employment, public accommodations, state and local government services, transportation, and telecommunications relay services.

adequate sound buffers. The ADA also provides broad protection for the use of service animals, including hearing (signal) dogs. In essence, hearing dogs have the same legal public accommodation rights available to guide dogs for the visually impaired or blind person. Audiologists will play a pivotal role in the development of partnerships with the private sector, public sector, and consumers. According to Palmer (1992) the audiologist will have several roles in the implementation of the ADA. These include: (a) educating the public about the communicative needs of persons with hearing impairment; (b) educating the public about the various differences in communication possessed by persons with hearing impairment; (c) educating the public about the type and availability of assistive technology and what results might be expected from such efforts; (d) consulting with businesses in the selection of assistive technology for various communication environments; (e) selecting, purchasing, installing, and maintaining these various devices in businesses; (f) selecting and fitting assistive devices for employees, including consideration of devices that are compatible with wearable hearing instruments; and (g) educating consumer groups with hearing impairments about available devices and the ADA.

PREDICTION 3: COMPUTER-BASED INSTRUCTION

By the year 2000, computer-based instruction will assume a significant role in audiologic rehabilitation. During the past 25 years there has been a revolution in learning technologies in the form of interactive video and multimedia. Today, approximately 75% of American homes have a video cassette recorder (VCR). Similarly, audio technology has progressed from turntables and reel-to-reel tape recorders to cassette tape decks and audio compact discs (CDs). There is high definition television (HDTV) and digital audio tape (DAT) and an abundance of emerging technologies as a result of one of the most important developments of all, the personal computer (PC). With relatively simple interfaces, personal computers can control a multitude of media resources, including videodiscs, CD-ROMs, computer graphics, and audio digitized images. All of these media, controlled by the computer, promote effective learning strategies. Thus, one can predict that the application of interactive video and multimedia will have a significant impact on the delivery of audiologic rehabilitation services by the year 2000.

Interactive video is defined as video in which the user has some control over the presentation. In its simplest form, interactive video is present when the user (observer) has control of a hand-held remote device. The user can fast forward, fast rewind, stop, pause (and perhaps even still-frame) sequences of lipreading presentations or sign language instruction. Interactive video responds to choices made by the individual (or small group) user with a keyboard, a mouse, a touch sensitive screen, or other input devices. Interactive video spans several media such as video, audio, text, and graphics interwoven in videodiscs, videotape, compact discs, and other sources. The important characteristic of these various

applications of interactive multimedia is that the various media are controlled by the computer. Computer-based instruction (CBI) or computer based training (CBT) may take on several different names to describe the use of the computer in support of education or training.

There are several ways in which computer-based learning can be used with persons who have a hearing impairment. For example, it can be used in a one-on-one situation where the learner sits at a single computer and receives instruction, such as audiogram interpretation and a presentation of several common auditory pathologies. It can also be used by small groups of individuals with a hearing impairment, usually two to four, in a cooperative and competitive learning environment. CBI can be used effectively in large groups by means of a large monitor, video projector, or liquid crystal display panel.

There are a number of different types of CBI formats (Lehman & Kidd, 1992), including: drill and practice, tutorials, simulations, instructional games and problem-solving software applications exist. The drill and practice application is probably the oldest and most widely used. It is in this mode that the computer is used to help the person master some basic skill, like lipreading or sign language, through repetitive drill. The drill and practice application is used to supplement individualized skillbuilding efforts between the audiologist and hearing impaired person. In tutorial applications, the computer takes on the role of a teacher or tutor. Topics might include the care and maintenance of wearable hearing instruments in a hearing aid orientation program and hearing tactics or stage management techniques designed to improve communication through awareness and assertiveness training. Simulations represent some of the most creative methods of instructional applications that incorporate computers and could be used by audiologists to describe auditory pathologies to audiology students. In addition, computer simulations could create real adverse communication situations, such as listening to a conversation in the presence of background noise. The learner would be provided with the opportunity to experiment with a number of variables in an attempt to enhance the communication experience and reduce the communication deficit. Instructional games add a motivational component to CBI. For example, speech tracking as described by De Filippo (1988) may be used in an interactive video format, providing a challenging and motivational edge to communication training (e.g., Dempsey, Levitt, Josephson, & Porrazzo, 1992). Finally, problem-solving software might be used to foster problem solving skills in both the audiology classroom and clinic. For example, students might use interactive video to make auditory diagnoses, perform cerumen management, validate hearing aid fitting, and score lipreading tests. The hearing-impaired adult might be asked to judge various communicative settings as problematic (e.g., see Trychin & Boone, 1987).

Tye-Murray (1992a) stated that laser videodisc technology will soon find its way into the Audiology Clinic and the results will be most exciting. She speculated that two features make this technology attractive to the audiologic rehabilitation setting. First, auditory-visual integration materials can be accessed

quickly from the laser videodisc and, secondly presentation of materials can be computer-controlled. Research will soon demonstrate the efficacy of this approach to teach a variety of skills to individuals with a hearing impairment, such as the utilization of communication repair strategies (Tye-Murray, 1991, 1992a, 1992b; Tye-Murray, Tyler, Bong, & Nares, 1988).

CLINICAL APPLICATIONS AND RESEARCH IMPLICATIONS

By the year 2000 and in later decades the number of adults seeking audiologic rehabilitation services will increase. Ideally, we will see changes in the aging demographics because of increased consumer education and greater efforts to prevent hearing loss. For example, the public is being informed about the hazardous effects of smoking and alcohol as well as the importance of diet and exercise. Persons are living longer and are healthier than ever before.

A number of research implications emerge from these changing demographics. Will older adults derive substantive benefits from hearing aid use? Will more persons with hearing impairment recognize the importance of audiologic care and seek these services earlier in their lives? Will amplification help decrease the handicaps that accompany a hearing impairment? Will performance expectations of the audiologist and the person with a hearing impairment in the laboratory environment (audiology clinic) match those of real-life listening situations?

One of the biggest impacts of the ADA will be the need for audiologists to evaluate approaches to management of persons with a hearing impairment (Williams, 1992a, 1992b). The ADA will open up new challenges to the audiologist and a new world for persons with hearing impairment. Much of the communication access will be provided through the acquisition of a variety of assistive listening devices (Palmer, 1992). Cranmer-Briskey (1992) predicted that the passage of the ADA will result in increased use of the telecoil in hearing instruments. Grimes and Mueller (1991a, 1991b) suggested that probe-microphone measures could be used to provide an effective and reliable method to validate the selection of telecoils for a variety of assistive devices.

The development of new assistive technology for the future generation of hearing impaired persons is quite promising. Audiologists will find ways to educate the consumer about the communication benefits provided through this new technology. In the classroom environment, students will use computer assisted notetaking (CAN) in which an outline of a lecture, for example, is typed onto a special PC viewer scan placed on top of an overhead projector. Alternatively, a pre-typed script is placed on an overhead projector while an assistant points to the appropriate paragraphs as the speaker speaks. It is likely that students with a hearing impairment who attend classes will tape record the lecture and then take the audio cassette tape to the campus center for instructional services to complete a speech-to-text analysis and obtain a hard copy of the lecture.

More persons with a hearing impairment will utilize real time captioning to

achieve communication access. For example, this technology will be used at political rallies, in which a court stenographer will provide a word-for-word display on a projection screen or wall. This may or may not include the projection of the speaker's image. This technology could be implemented in a classroom, at a public school board meeting, or at the airport. Recently, The Chronicle of Education (1992) reported that a research team at the National Technical Institute for the Deaf (NTID) has developed an inexpensive computer system that offers speech-to-text translation. The system can transcribe a lecture as it is being given and then project the words on a classroom wall. Real-time captioning technology could be implemented in wearable eyeglasses so a hearing-impaired person could instantaneously see in text what is being said while engaging in one-to-one communication. Recently, McDonough (1992) described the ScriptReader – a new technological development designed to help the deaf person appreciate the theater. The ScriptReader uses a headband supporting a 1-in screen which displays the lines of the play allowing the observer to watch the stage action and simultaneously read the script. It will be possible to call in and reserve a ticket on the day of the performance and have this form of communication access available! It is also probable that the time will come when every movie theater and church will have infra-red headsets available for persons with a communication deficit. Other state of the art technologies for hearing-impaired persons were summarized by Harkins (1991). The video telephone (Harkins, 1991) will allow people who use sign language to utilize their natural conversation mode. Similarly, persons who receive speech by combining listening with lipreading would benefit from the video telephone concept. Recently, Slager (1992) was cited by the Johns Hopkins National Search for Computing to Assist Persons with Disabilities for the development of the Liperator. This is a device that provides visual cues to help a hearing-impaired person understand conversation over the telephone.

The incorporation of interactive video in private practices, hospital, audiology centers, and even home environments will produce single-subject design and clinical efficacy studies that may demonstrate improved listening skills, assertiveness, use of repair strategies, sign language, lipreading, hearing aid care, and hearing conservation. Research questions include the following: Is it possible to improve a person's ability to communicate through feedback oriented training using computer-based instruction? Is it possible that such training can take place in the home environment using laser video disks and computer modems? If such training is possible, will there be interactions among various electroacoustic characteristics in hearing instruments, audiometric configurations, and listening environments? Can audiologic rehabilitation efforts improve one's adjustment to amplification in a variety of realistic communication situations? Can a sensory aid produce the best auditory-only and auditory-visual performance for hearing-impaired persons?

What else can the hearing-impaired consumer expect during the next decade? There are no limits! Predicting the future is an awesome task as exemplified

in the story of the Japanese businessman who came to America in the early 1950s to attend a conference on new hearing aid technology. Seeing how transistors were used in these devices, he suggested the same technology be used to make smaller radios. The response was: "Why would anyone want smaller radios?" We will see where we are in 10 years, but the future of audiologic rehabilitation appears very bright and positive.

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