

# HANDBOOK OF CLINICAL AUDIOLOGY

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second edition

Edited by

Jack Katz, Ph.D.



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# **HANDBOOK OF CLINICAL AUDIOLOGY**

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**Edited by**

**Jack Katz, Ph.D.**

**Professor, Department of Communicative Disorders and Sciences  
State University of New York  
Buffalo, New York**

**Editorial Assistant: WILMA LAUFER GABBAY, M.S.**



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# Preface

SINCE 1972, students, audiologists, and other professionals have used the *Handbook of Clinical Audiology*. Although the original edition was well received, the many new developments in the field make it desirable to have a second edition.

As in the first edition we have attempted, "to provide between one set of covers a summary of the current state of the science-art of clinical audiology." In order to maintain an up-to-date view of the field it has been necessary to revise and delete previous materials and add new information.

Audiology has grown in scope and depth in the past several years. The six-year period between the planning of the first and second editions led to a 16% increase in the number of chapters (from 41 to 49). Twenty-two chapters (45%) are completely new and the 27 chapters remaining from the first edition have been modified in varying degrees. About half of the 43 contributors to the new edition contributed to the previous one.

The second edition of the *Handbook* required even more help from more people than the first edition. I am indebted to Norma Hopkinson, Bill Hodgson, Derek Sanders and Tom White for their guidance. Wilma Cabbay meticulously proofread the entire manuscript in its various stages and gave invaluable suggestions. I am grateful to Ruby Richardson at The Williams & Wilkins Co. who has given me advice and support over the past several years. My wife, Irma, helped a great deal in various phases of the book and especially with compiling the massive index.

The following students, former students and secretaries aided me in getting out what seemed like a million manuscripts, letters and forms: Walter Appling, Carmel Basile, Regina Bryde, Sherry Gottlieb, Margaret Kovel, Steve Perlow, Kim Reinson, Linda Ronis, Peggy Ross and Andrea Segmond. To the above and any others whom I may have inadvertently omitted, my sincere thanks.

The acronym for the *Handbook of Clinical Audiology*, "HOCA," is quite interesting. In Turkish *hoca* (pronounced /hod<sub>3</sub>ə/) means a clergyman, a revered teacher or a schoolmaster. From some of the very nice comments that I have received on the first edition, it seems that the acronym is well suited. I hope that the second edition will be as valuable, or more so, than the first.

J. K.

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## List of Contributors

- CHARLES V. ANDERSON, PH.D.**, Associate Professor, Departments of Otolaryngology and Speech Pathology and Audiology, University of Iowa, Iowa City, IA 52242 (Chapter 5).
- JOAN M. BILLGER, M.A.**, Instructor and Coordinator of Pediatric Audiology, Department of Communication Disorders, Colorado State University, Fort Collins, CO 80523 (Chapter 34).
- ROBERT J. BRISKEY, M.A.**, Advisor on Professional Affairs, Administrative Division, Beltone Electronics Corporation, 4201 West Victoria Street, Chicago, IL 60646 (Chapter 41).
- MICHAEL BRUNT, PH.D.**, Associate Professor, Department of Speech Pathology and Audiology, Illinois State University, Normal, IL 61761 (Chapter 23).
- WILLIAM F. CARVER, PH.D.**, Director, Division of Audiology, Department of Otolaryngology, Washington University School of Medicine, 517 South Euclid Avenue, St. Louis, MO 63110 (Chapters 15 and 39).
- DONALD D. DIRKS, PH.D.**, Professor, Division of Head and Neck Surgery, Audiology Research, University of California at Los Angeles, 1000 Veteran Avenue, 32-34 Rehabilitation Center, Los Angeles, CA 90025 (Chapter 10).
- TIMOTHY N. DOYLE, PH.D.**, Chief of Audiology, Veterans Administration Hospital, Minneapolis, MN 55417 and Assistant Professor, Department of Communication Disorders, University of Minnesota, Minneapolis, MN and Assistant Professor, Department of Otolaryngology, University of Minnesota, Minneapolis, MN (Chapter 4).
- CAROL H. EHRLICH, PH.D.**, Director, Audiology and Speech Pathology Department, The Children's Hospital, 1056 East 19th Avenue, Denver, CO 80218 (Chapter 32).
- ALAN S. FELDMAN, PH.D.**, Professor/Director, SUNY Upstate Medical Center/Communication Disorder Unit, 766 Irving Avenue, Syracuse, NY 13210 (Chapter 30).
- IRWIN A. GINSBERG, M.D.**, Clinical Professor of Otolaryngology, School of Medicine, State University of New York at Buffalo; Chief, Section of Otology, Buffalo General Hospital; Chief of Otology, Buffalo Otological Group, 897 Delaware Avenue, Buffalo, New York 14209 (Chapter 2).

THEODORE J. GLATTKE, PH.D., Associate Professor, Department of Speech and Hearing Sciences, The University of Arizona, Tucson, AZ 85721 (Chapters 28 and 31).

CORNELIUS P. GOETZINGER, PH.D., Professor of Audiology and Director of Audio-ENG Clinic, Department of Otorhinolaryngology, Room 312, Sudler Hall, University of Kansas Medical Center College of Health Sciences and Hospital, Rainbow at 39th Streets, Kansas City, KS 66103 and Consultant Psychologist, Kansas School for Deaf, Olathe, KS (Chapters 13 and 37).

DAVID S. GREEN, PH.D., Director of Audiology, Communication Disorders Department, Southern Connecticut State College, 501 Crescent Street, New Haven, CT 06515 (Chapters 9 and 17).

ALISON M. GRIMES, M.A., Clinical Audiologist, San Francisco Hearing and Speech Center, San Francisco, CA 94115 (formerly: Research Assistant, Audiology Division, Department of Otolaryngology, University of Colorado Medical Center, 4200 East 9th Avenue, Denver, CO) (Chapter 29).

WILLIAM R. HODGSON, PH.D., Professor, Department of Speech and Hearing Sciences, University of Arizona, Tucson, AZ 85721 (Chapters 33 and 44).

JAMES E. HOFFMAN, M.D., Associate Professor, Head of Clinical Sciences, University of Minnesota (Duluth) School of Medicine, Duluth, MN 55812 (Chapter 4).

NORMA T. HOPKINSON, PH.D., Clinical Associate Professor, Department of Otolaryngology, University of Pittsburgh, School of Medicine and Eye and Ear Hospital, E321 Eye and Ear Hospital, 230 Lothrop Street, Pittsburgh, PA 15213 (Chapters 12 and 25).

\* RICHARD L. HUGHES, PH.D., (formerly) Audiologist, Consultant in Audiology, Otologic Medical Group, Los Angeles Foundation of Otology, 2122 West 3rd Street, Los Angeles, CA 90057 (Chapter 18).

RAYMOND H. HULL, PH.D., Chairperson, Department of Communication Disorders, Director of Audiology, School of Special Education and Rehabilitation, University of Northern Colorado, Greeley, CO 80639 (Chapters 35 and 49).

E. W. JOHNSON, PH.D., Director, Clinical Audiology, Otologic Medical Group, Inc., 2122 West 3rd Street, Los Angeles, CA 90057 (Chapter 18).

ROGER N. KASTEN, PH.D., Professor of Audiology, Department of Logopedics, Wichita State University, Wichita, KS 67208 (Chapter 40).

JACK KATZ, PH.D., Professor, Department of Communicative Disorders and Sciences, State University of New York at

\* Deceased.

Buffalo, 4226 Ridge Lea Road, Buffalo, NY 14226 (Chapters 1, 3 and 20).

VINCENT H. KNAUF, PH.D., Audiologist and Speech Pathologist, Ear, Nose and Throat Clinic, 129 West Sixth Street, Reno, NV 89503 (Chapter 45).

ALBERT W. KNOX, PH.D., Chief, Audiology and Speech Pathology Service, Veterans Administration Hospital, 4801 Linwood, Kansas City, MO 64128 and Professor of Audiology and Speech Pathology, Kansas University, Kansas City, MO (Chapter 26).

SAMUEL F. LYBARGER, B.S. (Physics), Acoustical Consultant, 101 Oakwood Road, McMurray, PA 15317 (Chapter 42).

FREDERICK N. MARTIN, PH.D., Professor, Department of Speech Communication, University of Texas, Austin, TX 78712 (Chapters 16 and 24).

WILLIAM MELNICK, PH.D., Associate Professor, Department of Otolaryngology, The Ohio State University, University Hospital Clinic, 456 Clinic Drive, Columbus, OH 43210 (Chapter 6).

JERRY L. NORTHERN, PH.D., Associate Professor, Otolaryngology/Pediatrics and Head, Audiology Division, University of Colorado Medical Center, 4200 East 9th Avenue, Denver, CO 80262 (Chapter 29).

MICHAEL RODEL, M.A.T., Instructor and Coordinator of Audiologic Rehabilitation, Department of Communication Disorders, Colorado State University, Fort Collins, CO 80523 (Chapter 47).

PHILIP E. ROSENBERG, PH.D., Professor of Audiology, Department of Otorhinology, Temple University, School of Medicine, 3400 North Broad Street, Philadelphia, PA 19140 and Professor of Speech and Audiology, Department of Speech, Temple University, Weiss Hall, Philadelphia, PA (Chapters 7 and 14).

MARK ROSS, PH.D., Professor, Department of Speech, University of Connecticut, Storrs, CT 06268 (Chapters 38 and 43).

JAY W. SANDERS, PH.D., Professor of Audiology, Division of Hearing and Speech Sciences, Vanderbilt University, Nashville, TN 37232 (Chapter 11)

DONALD G. SIMS, PH.D., Research Associate, Department of Audiology, National Technical Institute for the Deaf, 1 Lomb Drive, Rochester, NY 14623 (Chapter 46).

PAUL SKINNER, PH.D., Chairman, Department of Speech and Hearing Sciences, University of Arizona, Speech Building, Room 104, Tucson, AZ 85721 (Chapter 27).

WALTER J. SMOSKI, M.S., Instructor, Departments of Speech Pathology and Audiology, Illinois State University, Normal, IL 61761 (Chapter 36).

JAMES H. STEVENS, PH.D., Administrative Manager, Department of Otoneurologic Services, Bishop Clarkson Memorial Hospital, Dewey Avenue at 44th, P.O. Box 3328, Omaha, NB 68103 (Chapter 21).

J. CURTIS TANNAHILL, PH.D., Director, Eckelmann-Taylor Speech and Hearing Clinic, Department of Speech Pathology and Audiology, Illinois State University, Normal, IL 61761 (Chapter 36).

LEON WEISBERG, M.D., Assistant Professor of Neurology, Department of Psychiatry, Tulane University School of Medicine, 1430 Tulane Avenue, New Orleans, LA 70112 (Chapter 3).

THOMAS P. WHITE, M.A., Assistant Professor of Audiology, Department of Communicative Disorders and Sciences, State University of New York at Buffalo; Chief of Audiology, Buffalo Otological Group, 897 Delaware Avenue, Buffalo, New York 14209 (Chapter 2).

LAURA ANN WILBER, PH.D., Professor and Director of Hearing Clinics, Audiology Program, Department of Communication Disorders, Northwestern University, Frances Searle Building, 2299 Sheridan Road, Evanston, IL 60201 (Chapter 8).

JACK A. WILLEFORD, PH.D., Professor and Director, Division of Audiology, Department of Communication Disorders, Colorado State University, Center and Pitkin Streets, Fort Collins, CO 80523 (Chapters 22 and 34).

H. N. WRIGHT, PH.D., Associate Professor, Department of Otolaryngology and Communication Sciences, State University of New York, Upstate Medical Center, 750 East Adams, Syracuse, NY 13210 (Chapter 19).

VERNA V. YATER, PH.D., Program Specialist, Santa Barbara County Schools, 4400 Cathedral Oaks Road, Santa Barbara, CA 93110 (Chapter 48).

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# Nature of Problem

## chapter 1

### CLINICAL AUDIOLOGY

**Jack Katz, Ph.D.**

In the six years between the planning of the first and second editions of the *Handbook of Clinical Audiology*, many changes have taken place in this field and in the world around it. The variations in clinical audiology reflect both internal and external dynamics.

One of the external influences on the field has been a great social change. This includes the status of women, the acceptance of individual differences and an increased awareness of the need for accuracy in interpersonal communication. Vast political change has taken place, including the demand for accountability in government and the desire of citizens to make institutions more responsive to the constituents' needs. The economic change has been no less drastic causing people at every level to take stock and make adjustments.

In recent years the number of audiologists has increased, the sex distribution in the field has been altered, the variety of work settings has been increased and there is a greater average income (Fricke, 1972; Curlee, 1975). At the same time the methods used by audiologists have undergone modification. Some newer procedures have come to the fore gradually or sometimes precipitously in a relatively short space of time. Other methods have lessened in popularity. There is a trend toward more extensive testing, both in scope and in depth.

In the second edition of the *Handbook*, we have attempted to retain the vital and current features of the first edition, weed out the obsolete, update the references, and present the recent information and approaches. New information has been added to the appropriate chapters and in some cases entirely new chapters seemed warranted. While the main purpose of this book is to provide a picture of the current state of the science-art of clinical audiology, background information is also presented as well as thorough bibliographies in various areas of study. We have included published

and unpublished research findings, a wealth of clinical insights and a touch of humor.

As in the first edition the contributors represent an outstanding group of audiologists and related professionals. These individuals are actively involved in the work which they discuss. This helps make the chapters more vital and applicable.

#### AUDIOLOGY A PROFESSION

In recent years clinical audiology has developed and grown as a profession. One measure of growth is the sheer numbers of individuals who are trained and working in the field.

Between 1969 (the year the first edition was being planned) and 1975 (the year the second edition was being planned) the number of American Speech and Hearing Association (ASHA) members with the Certificate of Clinical Competence in Audiology (CCC-A) more than doubled. In 1969 there were about 1500 certified audiologists compared to over 3000 CCC-A members in 1975. Judging from the enrolment figures in graduate training programs the number of students choosing audiology continues to increase.

At the same time new positions have been opening up in both traditional audiology settings and in new areas. Clinical audiology services are being added or expanded across the country in community and university clinics, elementary and secondary schools, hospitals, industry, hearing aid work and in private practices.

It is interesting, according to the records of ASHA, that one-third of all CCC audiologists work for a college or university; another one-third work in community clinics or hospitals, almost 15% in elementary and secondary schools and another 15% in other work settings.

A full one-half of CCC audiologists have direct clinical work as their major activity. The next largest group is involved primarily in college or university teaching (19%), followed by administration (10%) and clinical supervision (7%). Three percent are primarily in research and about 8% of audiologists work in various other types of activities. About 4% were not employed for any of various reasons.

Audiology has become quite specialized over the years. The breadth of this *Handbook* underscores the wide scope of audiologic activities. Some newer areas of audiology were unknown 5 to 10 years ago. Such terms as educational audiology, geriatric audiology, hearing aid audiology, neuro-audiology, and industrial audiology did not appear in the first edition of the *Handbook*. Electrophysiologic work, acoustic impedance, and services to the learning disabled child have shown marked increases in the past few years.

One of the important professional developments has been the growth of private practices in audiology. Well trained audiologists in increasing numbers are providing direct services to the public in either individual or group practice settings. Group practices involve two or more audiologists, or an audiologist might associate himself with other related professionals. By the middle of 1974 over 30% of all CCC-As had full or part-time private practices. Six percent of all audiologists were in full-time private practices.

Private practice is probably the most professional setting in which an audiologist can ply his skill. It offers (1) a high level of rapport between the patient and the clinician, (2) a maximum degree of freedom and job satisfaction, and (3) the potential for greater financial remuneration. The more audiologists who are involved in the private practice option, the stronger the footing and the taller the standing of our entire profession.

An interesting change has taken place in the last few years. Monetary gain was almost an unmentionable topic and the word *money* was rather taboo. This no doubt sprung up because speech pathologists and audiologists thought of themselves in the most altruistic terms without "contamination by material impulses." This followed the model of the social worker and nurse who for many years were overtrained, underpaid, and underregarded (aside from being underutilized).

In the past, more so than presently, institutions and referral sources were willing to receive less than the full impact of the audiologist. From the point of view of service to the public and the economic advantage of getting the full value for every salary dollar, it behooves the parent institution to take full advantage of what the audiologist knows and can do.

Fortunately, audiology has matured to the point where gainful and rightful profit is clearly differentiated from unscrupulous preying on the misfortunes of others. Money is not a dirty word. Rather it is a strong motivation and without it no program can exist. While greed in our society has in some cases reached

unconscionable limits, the audiologist must be adamant to receive appropriate compensation.

Hand in hand with the growth in stature of audiology has come an increasing responsibility and influence. In the past, the reputations of audiologists generally rose and fell with the institution of which they were a part. Institutions do have a profound influence on one's professional activities; however, now a fine clinician can often rise above a weak institution.

The greater independence of action and communication that audiologists have earned make them more in control of their own destiny. The audiologist plans, evaluates, reports, rehabilitates, counsels and consults, thereby quickly demonstrating what he can and cannot do. The weak audiologist, as a distinct professional entity, is able to float along only for a short while on the good reputation of his employer.

### Social Influences

It is difficult to separate social influences from political and economic influences. Certainly, each aspect conditions the others. In recent years there has been a greater trend toward the study of social sciences and people-oriented vocations. This has influenced many bright people who are willing to serve others to enter audiology in increasing numbers. Thus, universities and colleges can be more selective in their choice of students. It would be folly to train all students who wish to enter the field since there must be a balance between supply and demand. Because of the need for reasonable limits we are in an enviable position to admit the most capable and best suited student to the study of audiology. This selection process will continue to have a beneficial effect on the practice of audiology.

Another influence on the field which we might term primarily social is the changing role and attitude of women in our society. No longer are the technical and scientific areas considered exclusively male oriented activities, nor nurturing and giving fields female oriented. Audiology is typically thought of as a technical-scientific field (but has important nurturing-giving aspects as well) and yet reflects a healthy balance between men and women. As of 1974, a full 50% of all CCC-As were women. This represents a distinctive change from a highly male represented field of 10 years ago.

### Political, Legal, and Economic Influences

There have been a considerable number of changes in the political, legal and economic sectors which have had an effect on the practice

of audiology. For example, there are both legal and moral reasons why a patient or family has "the right to know." At one time, professionals (including audiologists) felt free to withhold information, reports or audiograms from the very people who sought out or paid for the services for themselves or family members. The information might then be sent to a professional person (frequently without interest or background). These professionals would be expected to digest the report and explain and counsel the patient appropriately. Needless to say, this was not a practical approach.

With all of its attendant difficulties and complications, it is the current feeling that the patient has the right to know what is wrong and to be given to understand to the best of his knowledge what was found and what needs to be done. Therefore, it is appropriate to permit a patient to have a current audiogram or to have the information explained to him. The audiologist is the person most qualified to do this, except in certain special or complex cases.

The growing influence of government into health and education has an increasing influence on audiology. By their funding regulations the federal and state governments could strengthen or weaken an entire profession. Medicare could strengthen the position of audiology by stating that a licensed audiologist (or one who holds CCC-A or equivalent) must evaluate the patient in order that the service be covered by insurance. It would also encourage an employer and worker who is less well trained to pursue a higher level of attainment.

If an agency indicates that a problem of hearing is determined solely by an unspecified physician, the functions of audiology (and no doubt otology) are undermined. This might encourage some general practitioners, dermatologists or gynecologists to think that they had the needed skills for evaluating hearing. I recall such a case when a general practitioner in the community wanted to use the audiometers and test chamber in a hospital to evaluate a patient with a suspected disorder. He did not even have the most meager of credentials in audiology and was of course denied permission.

In the interest of better patient care it is necessary to establish guidelines for the qualifications required for evaluating and rehabilitating hearing. In this regard many states have enacted legislation to define and license audiologists. In most cases this has served to protect the public by putting the evaluation of hearing in the hands of the audiologist (while not excluding the physician and surgeon who we hope will show reasonable restraint).

Because of the growing outside influence upon health and educational services, audiologists and speech pathologists have become

more vocal in influencing legislation and regulations. Some of the current concerns involve licensure, national health insurance (Klar, 1975), and Professional Standards Review Organizations (PSROs). PSROs permit a peer review of services provided to the public. It seems reasonable that each health team member should be evaluated on the basis of his own performance by individuals in his own profession rather than to have to satisfy those who lack in depth and current knowledge of the field (American Speech and Hearing Association, 1975).

Related to PSROs is the entire question of *accountability*. There are many conflicting interests which influence audiology. Patients, the judicial system, referral sources and professional organizations are demanding high quality services. They also expect that new and valid procedures will be added as needed. At the same time the patient, insurance companies and others insist that the cost be held to a minimum and only costs related to the standard acceptable services can be charged. That is, no funds should be expended for fringe activities like research.

From these somewhat conflicting guidelines, the audiologist must establish a reasonably up-to-date program with costs that are not excessive. In order to account for his charges, the audiologist must decide on what basis a charge will be made (American Speech and Hearing Association, 1971). Is it the time spent by the audiologist that is the crucial commodity in establishing a fee or is it the test or service rendered (training the audiologist, buying the specific equipment, supplies used and time)? If most of the services require comparable equipment, supplies and personnel it is simplest to use time as the unit for charging fees.

### Specialization in Audiology

One measure of development and sophistication in a field is the level of specialization. A number of years ago audiologists were content to limit their hearing evaluation procedures to air- and bone-conduction threshold tests. It is easy to see why the referral source would ask to see the audiogram without audiologic interpretation. With a little training many people were able to interpret "the audiogram" practically as well as the audiologist.

With increased knowledge and technical advances audiology has become highly specialized. It is safe to say that only the rarest of audiologists could read the *Handbook* from cover to cover with relaxed familiarity. Thus, we no longer hear from our physician colleagues that they know as much about audiology as the audiologist. Reading an audiogram

provides only the grossest form of audiological analysis. The audiologist who spends his entire professional life studying cannot feel content that he ever knows enough about his area of specialization.

Clinical audiology can be divided (albeit not too neatly) into two main branches, diagnostic and rehabilitative audiology. The former deals primarily with evaluation, particularly site of lesion testing, and the latter with the management of the hearing impaired person. One can further subdivide the two branches into those audiologists dealing mostly with children and those who work with adults. Other subgroups cluster around the work setting (e.g., private practice or V.A. Hospitals).

There are already a number of offshoots from the two main branches of clinical audiology. Some of these areas have a recognized label (e.g., educational audiology) or in some cases they are unnamed but are evolving divisions of labor (e.g., electrophysiological measurement).

Educational audiology has come into existence along with the impetus to get the hearing impaired or any handicapped children integrated into the general school population. This effort at mainstreaming has required an educationally oriented breed of audiologist to help the child into the regular classroom. This includes screening programs, testing, hearing aid work, visual and auditory training, and counseling. As more schools realize the availability of such professionals they have been quick to make a place for them.

Unlike the audiologists of old, we now have more objective measurements which tap physiological function. This trend started rather meekly with raw data obtained from changes in skin resistance (EDA) and progressed to the present work with computer assisted bioelectrical potentials measured at the vertex of the skull (ERA) including brain stem evoked responses (BSER), or at the round window (ECoG). During the years between the first and second editions of the *Handbook*, acoustic impedance measurement became a rather standard test in most clinics. Its influence on the entire field is reflected in many chapters in the *Handbook*.

In the past several years there has been a growth of clinical interest in the patient with central auditory disturbances. This represents an extension of the site of lesion testing. Neuro-audiology refers to the study of the central auditory nervous system. The central auditory system is within the province of the neurologist and neurosurgeon. One reason for this term is to replace the current misnomer oto-neurology or neuro-otology when they are used to refer to audiologic procedures. The neuro-audiologist (or the audiologist using neuro-audiologic tech-

niques) is able to contribute site of lesion information about the brain stem and brain. This aspect of audiology is growing rapidly as neurologists and other physicians realize the investigative potential of audiology deep into the skull, without potential danger to the patient.

Professionally trained audiologists have entered into the area of dispensing hearing aids. While audiologists have been involved with various aspects of hearing aid selection, modification and dispensing as long as the field of audiology existed, there has been a recent spurt of private and institutional dispensing. This is due to the advances and the increasingly technical nature of the work in ear mold acoustics, and measurement of hearing aid output, as well as the wide variety of options open in the selection of hearing instruments.

Geriatric audiology is also growing as a subspecialty. New positions in audiology clinics and geriatric centers have come about because of the increasing number of older people and their demand to live useful and active lives.

The audiologist has directed his attention to the learning disabled child and his hearing and perceptual difficulties. There is much in the evaluation and management of these children which requires the skills of the audiologist.

## TERMS

Since this book has almost 50 chapters and nearly as many contributors, it was necessary to decide on some uniform terminology. Terms come into usage to accommodate new observations or to make distinctions. Certain terms may become popular if they serve a useful purpose and finally give way to other labels as knowledge continues. Not infrequently words which were used previously return, sometimes with the same meaning but oftentimes representing a new variation. Terms are by no means permanent but deserve careful consideration because they serve an important purpose in professional communication.

Typically one has a theoretical or practical rationale for deciding on a term, however, sometimes it is chosen because of familiarity or emotional reasons. Some decisions on terms used in the *Handbook* are mentioned below. A number of terms differ from the ones used in the earlier edition.

### Signal

The term signal is used to designate the tone, noise or speech which is delivered to the listener. It is a signal whether it is heard or not; whether for the purpose of establishing threshold or for comparing two or more sounds.

If a signal is sufficient to elicit a response

(behavioral or physiologic) we could designate it also as a stimulus since it obviously stimulated the system to respond. However, it would not be appropriate to refer to a "stimulus" if the signal is below threshold. Because the term stimulus is used widely in the electrophysiology literature its use was not completely discontinued. Rather it was deemphasized here to encourage the generic term *signal*.

### Sensitivity

Hirsh (1952) aptly points out that we have misused the term *acuity* when referring to a threshold measure. The visual acuity test requires that we distinguish one letter from the others. This is a visual discrimination, not a visual threshold task. Thus, a test to determine an individual's hearing threshold should be a measure of hearing sensitivity and not a measure of hearing acuity.

Unfortunately, the literature is rampant with the term hearing acuity. Sometimes it is used for sensitivity and sometimes for discrimination. Although it would be well to reestablish this word with its more proper meaning (auditory discrimination), it must be given time to go into disuse before it can be revived and used in a consistent manner. For this reason the word acuity is not used here at all as a reference to auditory function.

### Sensory-neural

The term *sensory-neural* has almost completely supplanted the former terms *neural* and *perceptive* as the indication of a nonconductive hearing loss. Sensory-neural is also spelled *sensori-neural* or *sensorineural* (on rare occasions it is written *neurosensory*) in various publications. There are reasons for using any of these spellings, however, sensory-neural is used here to preserve the important reason for establishing the term. Nonconductive hearing losses are almost exclusively a result of sensory (cochlear) or neural (referring to retrocochlear) dysfunction. In rare instances they may also result from cerebral disorder. The term *sensory-neural* separates sensory from neural, just as the audiologist is trained to separate these two aspects of disorder central to the middle ear. In some clinics where in depth testing is not carried out there is a tendency to equate *sensorineural* with cochlear pathology. Equally depressed air- and bone-conduction thresholds might be due to end organ dysfunction or to a disorder somewhere in the retrocochlear system. By using the spelling *sensory-neural* we maintain before us the knowledge that the cause might be either cochlear or retrocochlear (or a combination of these two factors).

### Hearing Level

In the previous edition the term hearing threshold level (HTL) was used throughout in referring to the number on the audiometer dial. HTL was used for the ISO-1964 standard (Davis and Kranz, 1964) to distinguish it from the ASA-1951 standard. There is presently some momentum to revert back to hearing level (HL) for the ANSI-1969 standard (ASHA Committee on Audiometric Evaluation, 1974). HL seems simpler and more widely applicable than HTL. Since the period of maximum confusion is over we are free to return to HL. However, since there is no agreement at this time we shall use HL and HTL interchangeably.

### CANS

In the first edition of the *Handbook*, one of the contributors (Hodgson) suggested that we use CANS to represent *central auditory nervous system*. This acronym is easy to remember and has saved a great deal of space in this book.

### Pseudohypacusis

We have given way primarily, but not exclusively, to *pseudohypacusis*. The term *nonorganic* which was used previously has not been completely abandoned in this book.

### Audiometric Symbols

Recently a set of audiometric symbols was developed by the Committee on Audiometric Evaluation of the American Speech and Hearing Association (1974) and was approved by the Executive Board of ASHA. We shall follow this system in the *Handbook*. Tables 1.1 and 1.2 show the symbols for unmasked and masked signals.

### Hearing Loss Classification

To maintain consistency throughout this volume it was necessary to adopt one classification system of hearing impairment. Several systems have been proposed for describing or predicting the hearing problems associated with various test results (Davis, 1948; Davis, 1965; Goodman, 1965). Davis (1965) and Goodman (1965) have proposed comparable systems for classifying the pure tone speech averages (for 500, 1000 and 2000 Hz). Although the hearing threshold ranges which they refer to differ by no more than 2 dB, they use different descriptive names for some of the classifications. Since Goodman's descriptions are more generally recognized by audiologists, his system has been adopted for the *Handbook*. This scale of hearing impairment is shown in Chapter 9 and elsewhere.