INTRODUCTION

In July, 1997, the Bill Wilkerson Center merged with Vanderbilt University Medical Center, creating a new organization: The Vanderbilt Bill Wilkerson Center for Otolaryngology and Communication Sciences. The new Vanderbilt Bill Wilkerson Center is composed of the former Bill Wilkerson Center, now the Department of Hearing and Speech Sciences, and the Department of Otolaryngology.

The Department of Hearing and Speech Sciences and the Vanderbilt Bill Wilkerson Center are dedicated to improving the lives of the communicatively handicapped through service, education, and research. In addition to recording more than 50,000 patient visits annually in all areas of communication disorders, the Department offers the Master’s degree in speech-language pathology and Doctor of Philosophy degrees with emphasis in either speech-language pathology or audiology. The Doctor of Audiology (Au.D.) degree is offered through Vanderbilt University School of Medicine. The graduate program includes academic, clinical, and research activities.

Currently, Center operations are housed in five different buildings. To fully realize the Center’s potential, a new, state-of-the-art facility is near completion and will bring all services of the Center under one roof. One floor of this new facility will be dedicated to research in hearing and speech sciences and otolaryngology.

The research program encompasses a wide variety of topics in the areas of hearing science, language, speech production and perception, and human performance. Within each of these areas, work focuses on both applied and basic issues.

The following is our 16th research report (our 1st report was published in 1982), which lists our personnel, describes our facilities, and provides abstracts of our most recent scientific work. Requests for further information may be directed to the individual authors at the address given below. E-mail questions and comments may be directed to d.wesley.grantham@vanderbilt.edu. For additional information regarding the Vanderbilt Bill Wilkerson Center for Otolaryngology and Communication Sciences or Vanderbilt Department of Hearing and Speech Sciences, their programs, staff, and mission, please visit our home page on the world wide web:

http://www.vanderbiltbillwilkersoncenter.com

Department of Hearing and Speech Sciences
Vanderbilt Bill Wilkerson Center
1114 19th Avenue South
Nashville, Tennessee 37212
Jay W. Sanders, Ph.D.
Dr. Jay W. Sanders, nationally-known teacher, scholar, clinician in the field of audiology, and Professor Emeritus at Vanderbilt Department of Hearing and Speech Sciences, died on June 21, 2002 at the age of 77. Beloved and respected by professionals, former students, friends and family alike, Dr. Sanders’ contributions to the art of teaching, research, and clinical service in audiology are legendary.

Dr. Jay Sanders was born in Maryland and grew up in North Carolina. He served as a navy fighter pilot during World War II. His distinguished college career began at the University of North Carolina where held membership in Phi Beta Kappa and received his bachelor’s degree. He received his Master’s degree from Columbia University, his Ph.D. at the University of Missouri, and spent two years at Northwestern University doing post-doctoral work in audiology. His academic studies ran the gamut from radio and television, to speech and drama, to audiology. He felt that his range of study proved to be a plus and not a minus in his future pursuits in teaching, lecturing, writing and research.

In 1964 Dr. Sanders came to Vanderbilt as Director of Research at Bill Wilkerson Center and held professorial positions at Vanderbilt Department of Hearing and Speech and Peabody College. Audiologists remember him for his subsequent work in the areas of masking, impedance audiometry, evoked response, and for his numerous scholarly publications in diagnostic audiology and his undisputed reputation as a master teacher. He retired in 1987 as Professor Emeritus.

Among the many honors bestowed upon him by professional organizations to which he belonged were the Honors from two state associations, the New Jersey Speech and Hearing Association and the Tennessee Speech-Language-Association and Fellowship in the American Speech-Language-Hearing Association.

He is survived by his wife Kitty, and three children Mary, Elizabeth, and John. The Jay Sanders Audiology Fund has been established in his memory at the Vanderbilt Bill Wilkerson Center.
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PERSONNEL

Vanderbilt Bill Wilkerson Center for Otolaryngology and Communication Sciences

Robert H. Ossoff, D.M.D., M.D., Director
Fred H. Bess, Ph.D., Associate Director

Department of Hearing and Speech Sciences

Fred H. Bess, Ph.D., Chair
Edward G. Conture, Ph.D., Director of Graduate Studies
D. Wesley Grantham, Ph.D., Director of Research

Research Faculty

Patricia F. Allen, M.S................................................................. Assistant Professor
Daniel H. Ashmead, Ph.D.................................................... Associate Professor
Fred H. Bess, Ph.D................................................................. Professor
Gene W. Bratt, Ph.D................................................................. Associate Professor
Renee Brown, Ph.D................................................................. Assistant Professor
Candice Burger, Ph.D................................................................. Assistant Professor
Mary N. Camarata, M.S......................................................... Assistant Professor
Stephen M. Camarata, Ph.D..................................................... Professor
Edward G. Conture, Ph.D......................................................... Professor
Mary Sue Fino-Szumski, Ph.D................................................... Assistant Professor
David Gnewikow, Ph.D............................................................... Assistant Professor
Lee Ann C. Golper, Ph.D............................................................ Associate Professor
D. Wesley Grantham, Ph.D....................................................... Professor
Troy A. Hackett, Ph.D............................................................... Research Assistant Professor
Ben Hornsby, Ph.D................................................................. Research Assistant Professor
Sue Hale, M.C.D................................................................. Assistant Professor
Gary Jacobson, Ph.D............................................................... Professor
Devin McCaslin, Ph.D.............................................................. Assistant Professor
H. Gustav Mueller, Ph.D......................................................... Professor
Ralph N. Ohde, Ph.D............................................................... Professor
Todd A. Ricketts, Ph.D............................................................. Associate Professor
C. Melanie Schuele, Ph.D.................................................... Assistant Professor
Anne Marie Tharpe, Ph.D...................................................... Associate Professor
Robert S. Wall, Ph.D............................................................ Assistant Professor
Wanda G. Webb, Ph.D.......................................................... Associate Professor
Robert T. Wertz, Ph.D.......................................................... Professor
Adjunct/Clinical Faculty

John Ashford, Ph.D. .................................................................................................. Assistant Clinical Professor
Linda Auther, Ph.D. .............................................................................................. Adjunct Assistant Professor
G. Pamela Burch-Sims, Ph.D. ................................................................................ Adjunct Assistant Professor
Bertha Smith Clark, Ph.D. .................................................................................. Adjunct Assistant Instructor
Rebecca Fischer, Ph.D. ........................................................................................ Adjunct Assistant Professor
Judith S. Gravel, Ph.D. ....................................................................................... Adjunct Associate Professor
Hank Mills, Ph.D. ................................................................................................. Adjunct Associate Professor
Harold D. Mitchell, Ph.D. .................................................................................. Adjunct Professor
Barbara F. Peek, Ph.D. ....................................................................................... Adjunct Assistant Instructor
Amy M. Robbins, M.S. ...................................................................................... Adjunct Assistant Professor
Mia Rosenfeld, Ph.D. .......................................................................................... Adjunct Assistant Instructor
Teris K. Schery, Ph.D. ........................................................................................... Research Professor

Faculty with Secondary Appointments in the Department of Hearing and Speech Sciences

David Haynes, M.D .................................................. (primary appt. Otolaryngology) Associate Professor
Gerald Hickson, M.D. .......................................................................................... (primary appt. Pediatrics) Professor
Howard S. Kirshner, M.D. .................................................................................. (primary appt. Neurology) Adjunct Professor
James Netterville, M.D. ................................................................................... (primary appt. Otolaryngology) Professor
Robert Ossoff, M.D. ........................................................................................ (primary appt. Otolaryngology) Professor

Emeritus Faculty

Russell J. Love, Ph.D. ......................................................................................... Professor Emeritus
Judith A. Rassi, M.A .......................................................................................... Professor Emeritus

Clinical Staff

Audiology

Gary P. Jacobson, Ph.D., CCC-A, Division Head

Bill Wilkerson Audiology Clinic

David Gnewikow, Ph.D., CCC-A, Coord.
Susan M. Amberg, M.A., CCC-A Patti Hergenreder, M.S., CCC-A
Catherine Hayes, M.S., CCC-A Natalie Ozburn, M.S., CCC-A
Andrea Hedley-Williams, M.S., CCC-A Anne Marie Tharpe, Ph.D., CCC-A
### Balance and Hearing Center/The Vanderbilt Clinic

- Devin L. McCaslin, Ph.D., CCC-A
- Lauren Cordle, Au.D, CCC-A
- Mary Edwards, M.S., CCC-A
- David Gnewikow, Ph.D., CCC-A
- Patti Hergenreder, M.S., CCC-A
- Lisa Sykes, M.S., CCC-A

### Satellite Hearing Clinics

- Susan Logan, M.S., CCC-A
- Kristina Rigsby, M.S., CCC-A

### St. Thomas Audiology Clinic

- Barbara Higgins, M.S., CCC-A

### Pediatric Speech-Language Programs

<table>
<thead>
<tr>
<th>Name</th>
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<tr>
<td>Monique Bird</td>
<td>MA, CCC-SLP</td>
</tr>
<tr>
<td>Beth Bowlds</td>
<td>M.A., CCC-SLP</td>
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<tr>
<td>Beth Brucker</td>
<td>MA, CCC-SLP</td>
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<td>Denise Bryant</td>
<td>MA, CCC-SLP</td>
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<tr>
<td>Miki-Jo Castaldo</td>
<td>M.S., CCC-SLP</td>
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<tr>
<td>Michelle Crouthamel</td>
<td>M.S., CCC-SLP</td>
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<tr>
<td>Kimberly Cobb</td>
<td>M.A., CCC-SLP</td>
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<tr>
<td>Kristen Davis</td>
<td>M.S., CCC-SLP</td>
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<tr>
<td>Lauren Duckworth</td>
<td>M.S., CCC-SLP</td>
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<tr>
<td>Megan Duncan</td>
<td>M.S., CFY-SLP</td>
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<tr>
<td>Sabrina Eyal</td>
<td>MS, CFY-SLP</td>
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<td>Brittany Floyd</td>
<td>MS, CCC-SLP</td>
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<td>Jenny Galbreth</td>
<td>M.S., CCC-SLP</td>
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<tr>
<td>Courtney Gallaher</td>
<td>M.S., OTR</td>
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<td>Elizabeth Gardner</td>
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<td>Ginger Geldrich</td>
<td>M.S., CFY-SLP</td>
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<td>Melissa Henry</td>
<td>M.A., CCC-SLP</td>
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<td>Winston Joffrion</td>
<td>M.S., CCC-SLP</td>
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<tr>
<td>Karen Lepp</td>
<td>M.S. OTR</td>
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<td>Jenny Likens</td>
<td>M.S., CCC-SLP</td>
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<td>Lo, Maysee</td>
<td>BA, SLP-A</td>
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<tr>
<td>Megan Morrison</td>
<td>M.S., Teacher of the Deaf/HH</td>
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<td>Lynn McPhaul</td>
<td>M.S., CCC-SLP</td>
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<td>Catherine Nelson</td>
<td>M.S., CCC-SLP</td>
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<tr>
<td>Amy Parker</td>
<td>MS, CCC-SLP</td>
</tr>
<tr>
<td>Jodi Peterman</td>
<td>M.S., CFY-SLP</td>
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<tr>
<td>Mary Love Peters</td>
<td>M.S., CFY-SLP</td>
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<tr>
<td>Jennifer Phillips</td>
<td>M. SP, CCC-SLP</td>
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<tr>
<td>Gwen Provo</td>
<td>M.A., CCC-SLP</td>
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<tr>
<td>Elizabeth Roos</td>
<td>M.A. CCC-SLP</td>
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<tr>
<td>Marcy Sipes</td>
<td>M.S., CCC-SLP</td>
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<tr>
<td>Vicki Scala</td>
<td>B.S., OTR</td>
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<tr>
<td>Geneine Snell</td>
<td>M.Ed., CCC-SLP</td>
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<tr>
<td>Beverly Stacey</td>
<td>M.A., CCC-SLP</td>
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<tr>
<td>Jennifer Vick</td>
<td>M.S., CCC-SLP</td>
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<tr>
<td>Lisa Wallace</td>
<td>M.S., CCC-SLP</td>
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<tr>
<td>Kara Wolfe</td>
<td>M.A., Teacher of the Deaf/HH</td>
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### Hospital Based Adult Speech-Language Pathology

<table>
<thead>
<tr>
<th>Name</th>
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<tbody>
<tr>
<td>Patricia Kennedy</td>
<td>MA, CCC-SLP, Coordinator</td>
</tr>
<tr>
<td>Carmin Bartow</td>
<td>MS, CCC-SLP</td>
</tr>
<tr>
<td>Ellen Dowling</td>
<td>MS, CCC-SLP</td>
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<tr>
<td>Kay Hancock</td>
<td>MS, CCC-SLP</td>
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<tr>
<td>Laura McBride</td>
<td>MA, CC-SLP</td>
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<tr>
<td>Kimber Smith</td>
<td>MS, CCC-SLP</td>
</tr>
<tr>
<td>Laura McBrider</td>
<td>MA, CCC-SLP</td>
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Pi Beta Phi Rehabilitation Institute

Patricia F. Allen, M.S., M.A.T., CCC-SLP, Director
Gary W. Duncan, M.D., Medical Director
Mary Candice Burger, Ph.D., Neuropsych.
Renee Brown, Ph.D., PT
Jill Brown, M.S., PT
Cathey Norton, BS, NCS, PT
Karen Sartin, M.S., CCC-SLP
Christina Stevens, M.S., CCC-SPL
Mark Honeycutt, M.S., CCC-SLP

Graduate Research Assistants

Rima Abou-Khalil, Ph.D. (grad. '03)
Julie D. Anderson, Ph.D. (grad. '02)
Hayley S. Arnold, M.S.
Jessica L. Augusto, B.S.
Suzanne Blumell, B.S.
Karen Brown, M.S.
Michael de Riesthal, Ph.D. (grad. '03)
Celeste Duder, Ph.D. (grad. '03)
John Andrew Dundas, M.A.
Kiara Ebinger, Ph.D. (grad. '02)
Meghan M. Engelbert, M.S.
Eric Erpenbeck, M.S. (grad. '03)
Jason Galster, M.S.
Terrie Gibson, Ph.D. (grad. '02)
Heather Gillum, M.A.
Corrin G. Graham, M.S.

Dominique Herrington, M.A., CCC-SLP
Alicia Hill, M.S., CCC-SLP
Katrina Thomas, B.A., SLP/A
Christy Stanley, B.S., OTR/A
Melanie Block, B.S., OTR/L
Marsena Waller, M.S.O.T., OTR/L
Dawna Coleman, A.B., COTA/L
Tracy Campbell, B.A.

Kia Hartfield, M.S.
Paula P. Henry, Ph.D. (grad. '02)
Candace Bourland Hicks, Ph.D. (grad. '02)
William Irwin, M.S.
Earl Johnson, B.S.
Sarah R. Malech, M.S. (grad. '03)
Ann M. Rothpletz Ph.D. (grad. '02)
Mark Pellowski, Ph.D. (grad. '02)
Terrey Oliver Penn, M.S.
Kathryn A. Quinlan, B.A.
Ellen Rodrigues, B.A.
Lindsay Russell, B.A.
Douglas P. Sladen, M.A.
Angela Yarnell, B.A.
Courtney T. Zackheim, Ph.D. (grad. '03)

Technical Staff

Neal E. Fox. ......................................................................................................... Network Manager

Professional Staff

Kate Carney ................................................................. Coordinator, Public Relations
Janey Gleaves .............................................................. Public Relations Specialist
Shelia Lewis ............................................................. Executive Secretary
Carol Modos .............................................................. Development Coordinator
Kathy Rhody ......................................................... Administrative Assistant, Division of Graduate Studies
Georgia Walker ............................................................. Graphic Designer
Judy Warren ................................................. Medical Education Assistant, Division of Graduate Studies
Penny Whitaker ............................................................. Secretary, Division of Graduate Studies
The Department of Hearing and Speech Sciences, which comprises one part of the Vanderbilt Bill Wilkerson Center for Otolaryngology and Communication Sciences, is housed within its own building (formerly the Bill Wilkerson Center). The Center is a three-story building occupying more than 48,000 square feet of space. Approximately one-half of the space on the lowest floor is devoted to research. Housed within this area is a large anechoic chamber (6m X 6m X 6m), a hearing aid laboratory, three auditory research laboratories, two speech science laboratories, two language science laboratories, and a computer network center.

The **Anechoic Chamber Laboratory (ACL)** is a stand-alone computer-controlled laboratory that allows efficient control of virtually any kind of psychoacoustic experimentation in free sound-field situations. This laboratory is controlled by a Micron Pentium computer system interfaced to Tucker-Davis System II signal acquisition and processing devices. In the chamber itself, there is a "ceiling-fan" apparatus for presenting circularly moving sounds: two loudspeakers are suspended from the ends of a 10-foot overhead boom that can rotate in either direction at speeds up to 40 rpm. This computer-controlled apparatus is employed in investigations of auditory motion perception. In addition to the moving loudspeakers, there is a horizontal array of 55 loudspeakers spanning an arc of 160°. These loudspeakers have been employed in a variety of experiments concerned with localization, the precedence effect, and simulated motion perception.

The **Dan Maddox Hearing Aid Research Laboratory (HARL)** is devoted to the evaluation and design of signal processing schemes for hearing aids and cochlear implants. The laboratory is equipped with a control room and double-wall sound-attenuating test room where normal-hearing and hearing-impaired subjects are tested individually under headphones or via loudspeakers. The laboratory is controlled by a pentium-based PC which houses an array processor from Tucker-Davis Technologies. The array processor is linked via high-speed fiber-optics to an array of external signal processing modules providing digital recording, processing, and playback of signals. The laboratory is also equipped with an audiometer, CD player, and the necessary hardware and software to program a variety of programmable hearing instruments.

**Auditory Research Laboratory No. 1 (ARL 1)** is under the direction of Dr. Ashmead and focuses on experiments in spatial hearing and in human movement control. This laboratory includes a moderate sized room for work on movement control and a smaller sound-insulated test room. The movement control work is conducted using a Northern Digital OPTOTRAK motion analysis system for rapid, accurate measurement of marker lights attached to the research subjects. This system is coordinated by Zenith 386 and 486 computers. The spatial hearing work is conducted using a Zenith 386 computer with a Scientific Solutions LabMaster D-A board, connected with audio equipment.
Auditory Research Laboratory No. 2 (ARL 2) is under the direction of Dr. Grantham and is devoted to psychoacoustic experimentation, especially in areas concerned with binaural hearing. This laboratory is equipped with a control room and a double-walled sound-attenuating test room in which as many as three subjects can be tested simultaneously under headphones. The laboratory is controlled by a PC (pentium) computer system, which is interfaced to a wide array of signal generation and acquisition equipment from Tucker-Davis Technologies, including the Power Dac convolver system. Other equipment includes the necessary measuring and calibrating instruments as well as a full complement of analog signal generation and control devices.

Auditory Research Laboratory No. 3 (ARL 3) is under the direction of Dr. Ashmead and Dr. Tharpe. This laboratory includes a double-walled IAC booth with the capability of testing subjects under headphones or through loudspeakers. Stimulus and response control is provided by a Dell Pentium-based computer interfaced with a psychoacoustic hardware/software system from Tucker-Davis Technologies, Inc. This system has the capability to generate realistic three-dimensional auditory stimuli through earphones, for research on auditory space perception. Additional laboratory equipment includes a Pentium-based PC, otoacoustic emissions equipment, and probe microphone technology for infant hearing aid fitting. The primary focus of ARL 3 is on developmental aspects of auditory processing.

The two Speech Science Laboratories (SSL 1 and SSL 2) are under the direction of Dr. Ohde. Both are two-room laboratories. SSL 1 is devoted primarily to speech perception and speech acoustics research. This laboratory is controlled by an LSI-11/73 and a 486 PC system, which are used in the generation and acoustic analysis of stimuli, and for the control of experimental paradigms. Cypher F880 and Colorado 250 MB magnetic tape systems are used for back-up. Two subjects may be tested simultaneously under headphones. The emphasis of the work in SSL 2 is the phonetic and acoustic analysis of speech sounds. The primary tools for analysis are a Kay Elemetrics digital speech-spectrograph (7900), a 486 PC system supporting the Computerized Speech Lab (CSL), and transcription tape recorders for the phonetic analysis of speech.

The Developmental Disfluency Laboratory is devoted to the study of speech (dis)fluency, in particular, childhood stuttering, and is under the direction of Dr. Conture. Primarily involved with acoustic, audio-visual, and chronometric analysis of speech-language behavior, the laboratory houses three computer workstations, one audio-video record/reproduce/editing station, and associated recording (e.g., cameras) and analysis (e.g., time code generators) devices. One computer workstation supports the Computer Speech Lab (CSL) and inferential statistical analysis software used for various acoustic studies of speech production. The second computer workstation runs the New Experimental Stimulus Unit (NESU) device used for presenting auditory and visual stimuli to subjects and recording subject responses for various studies of phonological, semantic and syntactic priming. The third computer workstation contains and runs demographic, behavioral, temperamental and pedigree analyses on a large database regarding 3 to 5-year-old children who stutter and age, gender-matched children who do not stutter. The
The audiovisual record/reproduce/editing unit is used for frame-by-frame behavioral data analysis of audiovideo recordings, for example, to study the correlation of child and parent rate of utterance. These recordings having been previously obtained in VBWC laboratory space made available to Conture by Drs. Camarata and Ohde.

The Child Language Laboratory (CLL) is devoted to the study of human communication processes. This laboratory, which is under the direction of Dr. Camarata, has two components: an audio-video recording studio for generating high-fidelity tape recordings of communicative interactions, and computer-assisted linguistic analyses of the recorded linguistic behavior. The primary aim in designing the recording studio was to provide a controlled environment for the collection of conversational data while providing a suitably comfortable atmosphere for parents and their children to interact. The three-room suite is composed of a recording room (4m X 6m), control room (3m X 4m) and observation room (3m X 4m). As the recording room is separate from the control room (which houses most of the recording equipment), the parent and child can be left on their own to play and interact without the direct presence of observers. Two high-quality video cameras (with 12.5-75 mm zoom lenses and mounted on pan-tilt motors) are located in opposite corners of the recording room and are operated remotely from the adjacent control room. The two video images are mixed through a special effects generator which allows various video outputs to be recorded (e.g., split-screen images, switching between cameras 1 and 2 for best angle, inserting a close-up of the child into a larger scene of the room). The child wears a small lightweight radio transmitter and mic, which allows a relatively constant mic-to-mouth distance to be maintained, while permitting total freedom of movement about the room. In addition, a pressure-zone mic, which is sensitive enough to record even whispered speech from a distance of 6m, is mounted in the room. These two audio signals are mixed for optimal audibility and routed to both the audio and video recorders. This combination of mics, mixers and recorders has proven to be an exceptional system for the recording of speech, from whispers to shouts, in a semi-naturalistic environment. This studio is being used currently to make longitudinal records of language-impaired children in conversation with their mothers. It has potential use in studying therapist-patient clinical interactions, in student clinical training, in clinical supervision, and in any application requiring high-quality audio and video recording. Once a recording has been made, the tape is transcribed and analyzed using computer-assisted language sample analyses. These analyses are conducted on a DEC MicroVAX II running under the VMS multi-user operating system. This system is currently configured with 7 interactive terminals, 3 printers, and a modem connection to Vanderbilt's VAX-8800 computer.

The Computer Laboratory is devoted to computer teaching for students and in-service training for staff and faculty members. This laboratory is equipped with state-of-the-art computer equipment: a Local Area Network (LAN) connecting all computers (including the latest Pentium computers) in the lab, convenient internet access for email and Web surfing, and a computer projection system for efficient teaching and presentation. In addition, an electronic workshop is set up in the lab. This workshop has the necessary hardware and software for a variety of computer and electronic projects, including a high-resolution scanner for graphics scanning and OCR, a slide maker for making slides from MS PowerPoint, and a plotter for CAD.
Graduate students in the Department of Hearing and Speech Sciences have access to **Department of Otolaryngology** (DO) clinical and laboratory facilities. The Audiology Clinic occupies a 1500 square foot space within The Vanderbilt Clinic and Vanderbilt University Hospital. The Vanderbilt University Hospital is a 650 bed teaching facility. The Audiology Clinic is equipped for comprehensive diagnostic audio-vestibular assessment, including instrumentation for recording sensory evoked responses, otoacoustic emissions, and electroneystagmography. Under the direction of Dr. Terrey Penn, students may conduct clinical research projects within this clinic as well as other Hospital sites, such as the newborn intensive care units and operating rooms. Research facilities within the Department of Otolaryngology comprise a suite of laboratories (2,000 SF) for animal studies in laryngeal and neurophysiology, laser resurfacing and wound healing, cancer cell biology, bioengineering of implants for nerve, muscle, and brain stimulation/recording, muscle biochemistry, brain mapping, and histomorphometric analysis. Students can participate in either applied or basic research projects under the tutelage of Dr. David Zealear or Dr. Robert Labadie.

**The Vanderbilt Balance and Hearing Center** is a 2500 square foot clinical facility located within the Village at Vanderbilt, adjacent to the Vanderbilt University Medical Center campus. The Balance and Hearing Center, a division of the Department of Hearing and Speech Sciences, is equipped with state-of-the-art equipment for comprehensive assessment of vestibular and auditory disorders. The facility includes a sound treated room, a diagnostic audiometer, a tape recorder and compact disk player for speech audiometry, a microprocessor immittance meter, three otoacoustic emissions devices, a rotary vestibular test chair, a computerized electroneystagmography system, a computerized dynamic posturography system, an evoked response system with capability for 64 channels simultaneous brain signal acquisition, a 4-channel clinical evoked potentials system, and, two computerized hearing aid analysis systems. Additionally the facility contains 6 personal computers for use by students and the four staff audiologists, and a neurotologic examination room. The facility also includes student office space. Students also conduct research and acquire clinical practicum experiences at the 1000 square foot audiology facility located within The Vanderbilt Clinic on the Vanderbilt University Medical Center campus. This facility is equipped with three sound treated rooms for adult and pediatric hearing assessment, three diagnostic audiometers, two immittance meters, one evoked response system, and one electroneystagmography system.

**The Voice Center** of Vanderbilt University Medical Center is a 4000 square foot outpatient facility located within the Village at Vanderbilt, adjacent to the Vanderbilt Balance and Hearing Center and within a block of the Vanderbilt University Hospital. The Center includes three state-of-the-art laryngological examination rooms, a voice testing laboratory, a digital audio tape recording facility, stroboscopic laryngoscopy rooms, specially designed areas for patient consultation and education, and several sound-attenuated, humidity-controlled rooms with complete audio and video capabilities. The Center houses a team of physicians, speech pathologists, and voice specialists who are trained in the diagnosis and treatment of disorders of the larynx and problems affecting the voice. Services are provided to professional singers and speakers.
ACKNOWLEDGMENTS

Virtually all of the equipment and most of the facilities described above were nonexistent prior to 1979. We are proud of the manner in which our research program has developed over the past several years. Many agencies and benefactors deserve recognition for their significant contribution to the development of our facilities. We gratefully acknowledge the contributions of the following agencies, corporations, and foundations for their financial assistance:

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The Nashville Scottish Rite Foundation, Inc., the philanthropic arm of Scottish Rite Freemasonry in the Valley at Nashville, sponsors the Scottish Rite Masons Research Institute for Communication Disorders at the Vanderbilt Bill Wilkerson Center for Otolaryngology and Communication Sciences. The primary emphasis of the research institute is on improving the methodology for the treatment of speech, language and hearing disorders in children.

The joint project between the Wilkerson Center and the Nashville Scottish Rite Foundation has been fostered in large part by Illustrious Joseph Martin, 33°, Deputy of the Supreme Council for Scottish Rite Freemasonry in Tennessee. Mr. Martin has also played an active role on the Bill Wilkerson board of directors; during his six-year tenure, he served on the executive committee and as chair of the board from 1993 through 1995. Active in both organizations, Mr. Martin recognized the opportunity for a cooperative effort between the Center and the Foundation.

Since the 1950's, the various Valleys of the Supreme Council, 33° of Scottish Rite Freemasonry have established Scottish Rite Centers nationwide for children with speech and language disorders. These Centers, which began with a pilot project in Colorado, are now found at 73 locations throughout the United States. Staffed with speech-language pathologists and other trained personnel, each Center provides diagnosis and treatment of speech and language disorders and associated learning disabilities. The project at the Wilkerson Center represents the first research effort sponsored by the Scottish Rite.

This research arm of the Scottish Rite Center is dedicated to the advancement of treatment technology for language disorders. Additionally, a service and teaching component is part of the program. Many children have the opportunity to receive therapy as a part of the applied research process. Another important function of the research program is the dissemination of information to the other Centers over the country. Continuing education courses and seminars update professional personnel on the latest research methodology.

The Nashville Scottish Rite Foundation has been a major supporter of the Wilkerson Center since 1982.
Vanderbilt Bill Wilkerson Center has been selected as a five-year clinical research center on language disorders funded by the National Institute on Deafness and Communication Disorders of the NIH (1998-2003). The Principal Investigator for this project is Dr. Stephen Camarata; Co-Investigators are Ann Kaiser, Keith Nelson, Paul Yoder, and Steve Warren.

Language impairments in children often have devastating impacts on social, behavioral, and academic skills. Similarly, language impairments arising from strokes in adult populations often result in decreased social competence, including extensive disruptions in language skills. Moreover, there are relatively few studies of language intervention in the literature, and those appearing are often difficult to interpret due to inherent methodological issues (e.g., very low N, differences in treatments, high subject variability, etc.). Despite this, in recent years, there have been a number of important advances in language intervention, including studies examining the importance of replicating and enhancing key behaviors found in normal parent-child interaction to effectively treat language impairments. Significant elements of this interactive model, rooted in the “transactional theory” of language development (i.e., Moerk, 1992; Yoder & Warren, 1993) and studied under the ruberic of “Milieu teaching” (Warren & Kaiser, 1986), “Conversational Recast,” (Camarata, 1996; Camarata, Nelson, & Camarata, 1994; Nelson, 1989) and “naturalistic” (Camarata, 1993; Koegel, Dunlap, & Koegel, 1987) have yielded promising results, particularly when compared to treatments that do not include these elements (see the review in Camarata, 1996).

Because normal language acquisition is a complex process, it is extremely important to determine which parameters should be enhanced during treatment of language impairment to achieve maximal language gain. From a broad perspective, the parameters under study include child variables, parent variables as they relate to child variables, and how these variables translate into effective interventions. This includes determining: a) which child behaviors are keystones for inducing broader levels of language advance, b) which intervention procedures will maximize acquisition of these keystone language skills, and c) whether these procedures have broad applicability to diverse populations of children and adults with language impairments.

These issues will be examined in five subprojects within an integrated program project on language intervention that includes a multidisciplinary team of psychologists, physicians, special educators, and speech-language pathologists specializing in language impairments in children and adults who have extensive individual and collective expertise in treating diverse populations with language impairments.
Bess, F.H. and Hedley-Williams, A. (In preparation). "Elderly with asymptomatic hearing loss: can they benefit from amplification?"

An important barrier to widespread acceptance of amplification for the elderly has been a failure to demonstrate that a hearing aid provides benefit—that is, given that hearing loss is a major determinant of function, there is limited information to demonstrate that amplification results in an improvement in functional health status or quality of life. This is particularly true for the large numbers of elderly with asymptomatic hearing loss—elderly who exhibit the milder forms of hearing loss and do not voluntarily seek rehabilitative assistance. The intent of this study was to address the question: do elderly individuals with asymptomatic hearing loss benefit from amplification? The study sample comprised 23 asymptomatic adults with no known complaint of auditory deficit who were identified with probable mild hearing loss by a hearing screening administered by a primary care physician during a routine office visit and/or completion of a newspaper advertisement highlighting risk factors for hearing loss. All subjects received the HHIE-S and the Medical Outcome Study (SF36) before and after amplification. The results demonstrated that amplification is appropriate and beneficial for asymptomatic older adults with confirmed mild degrees of hearing impairment who do not voluntarily seek out audiologic intervention. Significant improvement in self reported communication function was evidenced post-hearing aid fitting and maintained over a six-month period.


There have been disparate findings reported previously by investigators who have examined differences in the cortically-generated N1 (i.e. N100) from control and tinnitus samples. These investigators have employed differing stimulation paradigms applied to relatively small subject samples. Accordingly, it is not surprising that there has been no unanimity in the reported findings. The present investigation was conducted to determine, once again, whether differences exist in the cortically-generated N1 potential recorded from both normals and subjects with bothersome tinnitus. In this investigation both passive and selective auditory attention paradigms were employed. Subjects were a total of 63 adults (31 controls and 32 tinnitus patients). The mean score on the Tinnitus Handicap Inventory for the tinnitus group was 39 points. Results failed to reveal group differences in the latency of N1 across listening conditions. However, tinnitus patients demonstrated N1 potentials that were of significantly smaller amplitude than those obtained from normal subjects. These findings are consistent with those reported by previous investigators.


This investigation was conducted to determine whether there was congruence between “physiology-based” definitions of compensated and uncompensated unilateral peripheral vestibular system impairment and “functional” measures of self-perceived dizziness disability/handicap. A retrospective analysis was performed on data obtained from 122 patients evaluated in the Balance Function Laboratory at Henry Ford Hospital over a four-year period. Both electronystagmography and rotational test data were tabulated. Additionally, results of a self-report measure of dizziness disability/handicap were tabulated.
Patients were placed into four groups representing: normal vestibulometric test results, compensated unilateral peripheral vestibular system impairment and then two additional groups representing increasing magnitudes of uncompensated unilateral peripheral vestibular system impairment. The total and subscale scores on the self-report measure served as the dependent variable. Results showed a lack of congruence between the physiological and functional measures. We interpret these findings as evidence that factors other than semi-objective evidence of vestibular system compensation probably impact functional recovery following unilateral peripheral vestibular system impairment.


The purpose of the present investigation was to determine whether there exists in the scientific literature support for a cause and effect relationship between tinnitus and suicide. Medline and HealthStar data bases were queried using the combined search terms “tinnitus” and “suicide” over the time period from 1966 to 2001 for Medline and from 1975 to 2001 for HealthStar. Foreign language reports were included if they had been translated into English, or, at least, if they contained an English language translation of the abstract. A total of 3 published reports pertinent to this topic were recovered. None of these reports showed a causal relationship between tinnitus and suicide. More often patients who had attempted, or, committed suicide had significant pre-existing psychiatric conditions the most common being depression. Accordingly, it is our conclusion that nowhere in the existing literature is there any evidence supporting a cause and effect relationship between tinnitus and suicide.


The objective was to develop, from a pool of clinical electronystagmography (ENG) data, normal lower limits for the corneo-retinal potential (CRP). The CRP evaluated in the present study was derived as a byproduct of eye movement calibration with a computerized ENG system. The data set was collected from a cohort of patients without history of ophthalmic disease. This normative study was designed to develop upper and lower limits for the CRP recorded indirectly from ENG testing. Subjects were 107 consecutive patients (41 males, mean age 57 years). Subject age did not, but gender did, affect significant changes in the CRP. Specifically women showed larger CRP values than men. Case studies are presented that support the contention that the dark-adapted CRP may be helpful in the identification of patients with ophthalmic diseases known to affect the CRP and, thus, augment information normally obtained in the course of the ENG examination.


The Three-Clinic Hearing Aid Selection Profile (HASP) was developed to assess a patient’s beliefs about a number of basic considerations felt to be critical to the Hearing Aid Selection (HAS) process. These characteristics are felt to be key to the acceptance of amplification and include: motivation, expectations, cost of goods and services, appearance (cosmesis), attitudes about technology, physical function/limitations, communication needs, and lifestyle. The results of the first investigation suggest that we have been successful in developing a 40-item metric with adequate internal consistency reliability that assesses the aforementioned characteristics. Secondly, results of the administration of this tool to a large group of individuals indicated that: 1) age impacted scores on the Technology, Physical function,
and Communicative needs subscales; 2) gender impacted scores on the Motivation, Expectation, Technology, Communicative needs, and Appearance subscales; 3) previous hearing aid use affected scores on the Motivation subscale; 4) level of education impacted scores on the Physical function and Lifestyle subscales; and 5) self-perceived hearing handicap had an effect on Motivation and Communicative needs subscale scores. Percentile data collected from this subject sample are presented as a benchmark against which to evaluate responses from individual patients. Case studies are presented to illustrate the potential clinical utility of this device.


Visual Reinforcement Audiometry (VRA) is a test procedure routinely used to evaluate hearing in infants and young children (6 months to 2 years). Most research and current clinical practice utilizes flashing lights and/or animated toys to provide reinforcement to a child during VRA. New technology capable of generating a moving, video image is now available for providing visual reinforcement to infants during VRA testing. It is reasonable to expect that video images, with presumed greater novelty and complexity, would be more interesting and rewarding to children than conventional, animated mechanical toy reinforcers. On the other hand, in today’s society, children are frequently exposed to video images in the home and elsewhere. Therefore, three-dimensional animated toys may present with greater novelty than video images. The purpose of this study was to compare auditory localization behavior, as defined by the number of head turn responses until habituation, during VRA with 2-year-old children using two types of reinforcers: 1) moving images generated by a digital video disc (DVD) player/monitor and 2) a conventional, animated mechanical toy. Twenty children were selected randomly from a total group of 40 and tested using conventional reinforcement. The remaining 20 children were tested using video reinforcement. The average number of head turn responses prior to habituation was approximately 15 for the video-reinforced group and approximately 11 for the conventional toy-reinforced group suggesting that during VRA a video image may be more reinforcing than a conventional animated toy.


The fitting of amplification on young children with multiple impairments in addition to hearing loss is a challenge faced regularly by audiologists. However, very little has been published on this topic in the audiological literature. The purpose of this survey was to document hearing aid fitting practices for this population within the United States. Specifically, audiologists who regularly serve children were asked to complete a series of questions on their educational preparation and their hearing aid selection, fitting, and verification practices for children with multiple impairments. For purposes of this survey, multiple impairments included vision impairment, mental retardation, physical impairment, and autism spectrum disorders. Findings from this survey suggest that children with special needs in addition to hearing loss are typically fit in the same way and with the same type of amplification as those with hearing loss only. In addition, differences were noted in hearing aid selection, fitting, and verification practices across work settings. Future directions and research needs are suggested.


With recent mandates for earlier identification and intervention of infants with hearing impairment, audiologists are finding themselves responsible for fitting hearing aids on younger children than ever
before. Using the same hearing aid selection procedures as are used for adults is problematic for a
number of reasons. Probe microphone measures of real-ear hearing aid performance have been advocated
as the most appropriate method of fitting hearing aids on children. This study investigated the
longitudinal changes and variability in the real-ear-to-coupler difference (RECD; a real-ear measure
commonly used with infants and young children) in the 0 to 12 month population. Twenty-one healthy
newborns participated in this study for a 12-month period. Two methods of measuring the RECD were
examined. These included a constant-insertion depth method and an acoustic method. Discussion
includes recommendations for the clinical use and measurement of the RECD in infants and young
children.
Hearing Science — Basic


Auditory evoked responses (ABR, MLR, ALR) were recorded from unanesthetized juvenile (0 day, 2 w, 2w, 4w, 8w, 12w, 20w) and adult prosimian primates (*Galago crassicaudatus*). Responses were elicited by click stimuli at 5 presentation rates for ABR (10.1/s, 20.1/s, 40.1/s, 66.7/s, 90.1/s) and 4 rates for MLR (5.1/s, 10.1/s, 15.1/s, 19.9/s). ALR was recorded at 2 rates (1.1/s, 2.1/s) and 4 intensity levels (60, 70, 80, 90 dB nHL). Six ABR peaks (I to VI), 4 MLR peaks (Na, Pa, Nb, Pb), and 3 ALR peaks (P1, N1, P2) were analyzed. Expected rate effects were seen for latency and amplitude of the ABR and MLR Pa. Increased rate resulted in increased wave latency and decreased amplitude. Maturational effects were seen for ABR waves III through VI, MLR Pa, and ALR P1, N1, and P2. The ABR showed decreased latencies up to 2 w before becoming stable. Latency of the MLR waves and ALR P1 decreased until 4 w. Later MLR waves were not seen in most animals until 4 w. ALR N1 and P2 latencies continued to show gradual decreases through 20 w. In general, amplitudes increased with age, particularly for MLR wave Pa starting at 8 w. Comparison with results of a companion study (Hackett et al, this volume) indicated that changes in latency and morphology of MLR waves were consistent with myelination of the central nucleus of the inferior colliculus and ventral nucleus of the medial geniculate complex. Prolonged development of the ALR was consistent with slow myelination of the auditory cortex.


Subcortical connections of the inferior colliculus were examined by placing injections of WGA-HRP or cholera toxin B in the central nucleus of the inferior colliculus of New World squirrel and marmoset monkeys, and Old World macaque monkeys. Architectonic subdivisions and transported label in the thalamus and brainstem was reconstructed from sets of coronal sections processed to reveal label, Nissl, acetylcholinesterase, cytochrome oxidase, parvalbumin, and calbindin. In the thalamus, anterograde label was densely concentrated in the ventral and magnocellular divisions of the medial geniculate complex, especially ipsilateral. In the contralateral inferior colliculus, anterograde and retrograde transport was found in the deep layers of the dorsal cortex and central nucleus. In the lateral lemniscus, distinct foci of labeled cells and terminals were located bilaterally in the dorsal, intermediate, and ventral nuclei. Transport to the lateral superior olivary nuclei was comparable bilaterally; whereas, only the medial superior olivary nucleus ipsilateral to the injection was found to contain label. Transport to the MNTB and periolivary nuclei was mostly retrograde ipsilaterally and anterograde contralaterally. Transport to the dorsal and ventral cochlear nuclei was bilateral, but denser to the contralateral side. The results indicate that the connections of the inferior colliculus among New and Old World monkeys are similar, and also compare well with most other mammals.


Auditory spatial resolution was measured in the horizontal plane under several conditions of uncertainty. In experiment 1 the minimum audible angle (MAA) for a 1000-Hz tone burst was determined at three
azimuths (-30°, 0°, and +30°). In the “Certain Condition” all signals within a block of trials were presented from the same azimuthal region; in the “Uncertain Condition” the signal pair on each trial came randomly from one of the three azimuthal regions. MAAs were significantly larger in the Uncertain Condition, indicating that even with a simple stimulus, spatial resolution is better when subjects know where to listen than when they do not know. Experiment 2 measured the MAA in the presence of informational masking. A sequence of five 100-ms, 1000-Hz tone bursts was presented in succession from five different azimuths, and the subject was asked to detect the azimuthal change of one of the five bursts (the target). In the minimum uncertainty condition subjects knew both where (which of the five azimuthal regions) and when (which of the sequence of five tones) the target would occur. In the moderate uncertainty condition, subjects knew where, but not when the target would occur (or, in some runs, when, but not where it would occur). In the high uncertainty condition, subjects knew neither when nor where the target would occur on each trial. The greatest effect of uncertainty occurred for targets that were early in the sequence and were at peripheral azimuths (MAA ranged from 15° to 49° as uncertainty varied from minimum to high). On the other hand, when the target was the last burst of the series and when it was positioned at 0° azimuth, there was little or no effect of uncertainty (Fig. 1). The data support the hypothesis that when a listener is uncertain about when or where a target will occur, he tends to listen “focus attention” straight ahead and on the most recent information. For cases in which the target is not in front, subjects can benefit from prior knowledge to reduce the amount of informational masking. That is, subjects can effectively focus their attention on an azimuthal region to improve the MAA.

![Sequential Position](a) target at -54° (b) target at 0°

**Figure 1.** Average minimum audible angle (MAA) across five subjects for a 100-ms 1000-Hz tone burst (the target) embedded in a five-tone sequence. (a) MAAs for target at -54° azimuth; (b) MAAs for target at 0° azimuth. Within each panel, the left set of bars displays results for the target in the second temporal position and the right set of bars, for target in the fifth (last) temporal position of the sequence. MAAs for four different levels of uncertainty are displayed. Error bars indicate 1 standard deviation. Chandler *et al.* (2003).


The prevailing hierarchical model of cortical sensory processing holds that early processing is specific to individual modalities and that combination of information from different modalities is deferred until
higher-order stages of processing. In this paper, we present physiological evidence of multisensory convergence at an early stage of cortical auditory processing. We used multi-neuron cluster recordings, along with a limited sample of single-unit recordings, to determine whether neurons in the macaque auditory cortex respond to cutaneous stimulation. We found coextensive cutaneous and auditory responses in caudomedial auditory cortex, an area lying adjacent to A1, and at the second stage of the auditory cortical hierarchy. Somatosensory–auditory convergence in auditory cortex may underlie effects observed in human studies. Convergence of inputs from different sensory modalities at very early stages of cortical sensory processing has important implications for both our developing understanding of multisensory processing and established views of unisensory processing.


This study was designed to evaluate the effects of interaural noise correlation and free field noise source correlation on speech intelligibility. Four experiments were completed, evaluating speech intelligibility both in free field and under headphones. The Hearing in Noise Test (HINT) was used in each experiment to measure the level at which 50% of speech stimuli were intelligible. The HINT was administered under correlated and uncorrelated conditions for both white noise and cafeteria babble noise. Initially, binaural intelligibility level difference (BILD) was measured under headphones with white noise masking. The results indicated a significant release from masking of 2.4-dB in the interaurally uncorrelated condition. The free field experiments were designed to determine if, given similar interaural correlations, the same effect of noise correlation could be demonstrated in free field as was shown under headphones. The variables of noise modulation, monaural/binaural listening and calibration method were analyzed. Results from the free field studies indicate no significant effect of noise correlation in free field. Thus, the effect of noise correlation shown under headphones could not be duplicated in free field. For the two types of noises used in these experiments, no significant effect of modulation was found. Subjects’ overall performance was significantly better binaurally than in the monaural conditions; however, binaural listening did not interact significantly with the effect of noise correlation. Finally, significant differences in the pattern of results were found depending on calibration method. The free field method of calibration failed to account for absolute differences in level of the stimuli in the ears of subjects. The results of the experiments were discussed relative to previous research on release from masking and the effects of interaural and noise-source correlation.

Gnewikow, D. and Ricketts, T. (In preparation). "Real world benefit from directional hearing aids." This research was designed to determine the degree of “real world” benefit users of directional hearing aids can expect to achieve. The study is part of a Department of Veterans Affairs Rehabilitation, Research, and Development grant. This study requires that 105 subjects in three hearing loss groups be fit with binaural hearing aids that allow the programmer to set the aids in either omnidirectional or directional mode. Each subject wears the experimental aids for one month and then completes a battery of objective and subjective measures of hearing aid benefit, use, and preference. Subjects and experimenter are blinded to the actual settings of the hearing aids during the trial period. Subjects’ abilities to understand speech in noise are tested using the Hearing In Noise Test (HINT) and the Connected Sentence Test (CST) for unaided, old hearing aids, omnidirectional and directional experimental conditions. Subjects also complete the Profile of Hearing Aid Benefit (PHAB) and the Satisfaction with Amplification in Daily Life (SADL) questionnaires in three conditions: old aids, omnidirectional aids, and directional aids. Subjects maintain use logs throughout the experiment. At the final visit, subjects are complete a preference questionnaire as to which setting was preferred in several environments. Data collection is ongoing and the study is scheduled to be completed by April, 2004. The data from this study should be valuable in linking laboratory results from speech intelligibility in noise tests to real-world
preferences and opinions of hearing aid users. Furthermore, directional candidacy based on the subject’s degree of hearing loss will be assessed in the data analysis.


In an anechoic chamber normal-hearing subjects performed a localization task in the frontal horizontal plane. The stimulus was a 200-ms burst of filtered noise. Within a block of trials, half of the presentations (randomly determined) were "real" – presented from single loudspeakers – and the other half were "phantoms" – produced by the simultaneous activation of two loudspeakers at ±30° using a virtual source imaging technique [Takeuchi *et al.* , *J. Acoust. Soc. Am.* 109, 958-971 (2001)]. Both phantom and real sources spanned the azimuthal range ±80°. When the stimulus was a 4 kHz low-pass filtered noise, rms error was only slightly higher for phantom (D = 7.1°) than for real (D = 5.5°) sources (Fig. 2). For 8 kHz low-pass filtered noise, performance remained about the same for real sources, but increased for phantom sources (D = 11.5°). In a followup experiment, the subject's position was systematically varied outside the "sweet spot." When the subject's position was moved back by 12" (but still equidistant from the two presentation loudspeakers), rms error for the phantoms more than doubled. When his position was moved to the right by 6" (so that he was closer to the rightmost presentation loudspeaker), rms error for the phantoms quadrupled. Results are discussed in terms of robustness of the virtual imaging technique to stimulus and position factors and its potential usefulness as a tool for the investigation of human auditory spatial perception in static and dynamic environments.

![Figure 2. Performance for a typical subject in the localization task. Mean response azimuth (with standard deviation bars) is plotted as a function of stimulus azimuth for real sources (solid circles) and for phantom sources (open circles). Diagonal line represents perfect performance. Dashed lines show the positions of the two presentation loudspeakers employed to create the phantom images. Grantham *et al.* (2003).](image)

Multi-channel cochlear implants have enabled many patients with severe-to-profound hearing loss to achieve near-normal levels of communication in some quiet listening situations (Helms, Müller, and Schön 1997). Bilateral implantation, which has been increasingly performed in recent years, affords the additional potential advantage of an increased awareness of auditory space. In the present study, 18 severely-to-profoundly post-lingually deafened adults, bilaterally implanted with the MED-EL C40+ cochlear device, were tested in a horizontal-plane localization task in both unilateral (only LEFT or only RIGHT device active) and bilateral (BOTH devices active) conditions. In an anechoic chamber, 43 loudspeakers were positioned in a horizontal arc at ear level, 1.8 m in front of the listener, extending from −90° to +90° azimuth. Unbeknownst to the listeners, only 17 of the 43 loudspeakers were active. The stimulus was either a 200-ms broadband noise burst (NOISE), or a 200-ms sampling of a male voice uttering the word "hey!" (SPEECH). On each trial, the stimulus was presented randomly from one of the 17 active loudspeakers, and the listener responded by calling out the loudspeaker number (1 to 43) s/he believed produced the sound. Feedback was not provided. In the unilateral conditions, all listeners responded at chance level, generally localizing all sounds to the side of the active device (Fig. 3a). In the bilateral conditions, most listeners responded at much better than chance level (Fig. 3b, and showed no consistent difference between performance with SPEECH and NOISE stimuli (Fig. 4). The results replicate and extend those of other investigators [van Hoesel et al. (2002), Tyler et al. (2002), Nopp et al. (2003)]. Performance in the bilateral condition must be based on the availability and use of interaural difference cues. Based on previous reports that bilaterally implanted subjects are relatively more sensitive to interaural level differences (ILDs) than to interaural time differences (ITDs) [van Hoesel, Tong, Hollow, and Clark 1993; van Hoesel et al. 2002], it has been surmised that the better-than-chance localization performance shown by cochlear implantees must be based on the processing of ILD cues. We are currently measuring localization performance in bilaterally-implanted persons using bandlimited stimuli to determine the extent to which ITD cues may be potential contributors to localization performance in this population.

Figure 3. Localization responses for listener H, with standard deviations shown. Diagonal line represents perfect performance. The measure $D$ indicates overall rms error. (a) Performance with LEFT device only. (b) Performance with BOTH devices. Grantham et al. (2003).
Figure 4. Constant error for all 18 listeners in the bilateral condition. Upper dashed line indicates chance performance; lower dashed line indicates performance for a naïve normal-hearing listener. Grantham et al. (2003).


Minimum audible angle (MAA) and minimum audible movement angle (MAMA) thresholds were measured for stimuli in horizontal, vertical, and diagonal (60°) planes. A pseudo-virtual technique was employed in which signals were recorded through KEMAR’s ears and played back to subjects through insert earphones. Thresholds were obtained for wideband, high-pass, and low-pass noises. Only 6 of 20 subjects obtained wideband vertical-plane MAAs less than 10°, and only these 6 subjects were retained for the complete study. For all three filter conditions thresholds were lowest in the horizontal plane, slightly (but significantly) higher in the diagonal plane, and highest for the vertical plane. These results were similar in magnitude and pattern to those reported by Perrott and Saberi [J. Acoust. Soc. Am. 87, 1728-1731 (1990)] and Saberi and Perrott [J. Acoust. Soc. Am. 88, 2639-2644 (1990)], except that these investigators generally found that thresholds for diagonal planes were as good as those for the horizontal plane. The present results are consistent with the hypothesis that diagonal-plane performance is based on independent contributions from a horizontal-plane system (sensitive to interaural differences) and a vertical-plane system (sensitive to pinna-based spectral changes) (Fig. 5). Measurements of the stimuli recorded through KEMAR indicated that sources presented from diagonal planes can produce larger interaural level differences (ILDs) in certain frequency regions than would be expected based on the horizontal projection of the trajectory. Such frequency-specific ILD cues may underlie the very good performance reported in previous studies for diagonal spatial resolution. Subjects in the present study could apparently not take advantage of these cues in the diagonal-plane condition, possibly because they did not externalize the images to their appropriate positions in space or possibly because of the absence of a patterned visual field.
The number of auditory cortical fields identified in mammals ranges from 1 (marsupials) to over 12 (primates). Current primate models describe two or three fields with primary-like features comprising a core region, and up to ten non-primary fields in surrounding belt and parabelt regions. Across taxonomic groups, homologies have been established only for the core field, AI, but extending these findings to humans is limited by experimental constraints. The purpose of this study was to determine whether the architectonic criteria used to identify the core region in monkeys could be used to identify a homologous region in chimpanzees and humans. Brain tissue obtained postmortem was processed to reveal structural (cell bodies, myelinated axons) and histochemical (acetylcholinesterase) properties of the superior temporal plane of macaque monkeys, chimpanzees, and humans. Tissue analyses revealed that regions homologous to the core and belt of monkeys could be identified in chimpanzees and humans using the same architectonic criteria. The position of the core with respect to gross anatomical landmarks (e.g., Heschl’s gyri) was most variable in human specimens. The results suggest that current primate models of auditory cortical organization approximate that of humans at the first (core) stage of cortical processing.


In a companion study (Auther & Hackett, this volume) auditory evoked potentials (ABR, MLR, ALR) were recorded from unanesthetized juvenile (0 day, 1 w, 2w, 4w, 8w, 20w) and adult prosimian primates (*Galago crassicaudatus*). In the present study, architectonic features of the developing auditory pathways were analyzed in the brains of two animals from each age group. Series of adjacent sections were processed to reveal Nissl substance (N), myelinated fibers (MF), acetylcholinesterase (AChE), and cytochrome oxidase (CO). Subcortical developmental differences were most apparent in myelin-stained sections of the inferior colliculus (IC) and medial geniculate complex (MGC). In the central nucleus of the IC (ICc), myelination proceeded most rapidly during the first 2 postnatal weeks and more slowly.
thereafter, with minimal change after 4 weeks. In the ventral nucleus of the MGC (MGv), myelination lagged behind the ICc, with the most rapid development during the first 4 postnatal weeks and little change after 8 weeks. Myelination of the non-principal nuclei of the IC and MGC tended to commence later. No clear maturational effects were observed in subcortical auditory nuclei processed for N, AChE, or CO. In auditory cortex, observations focused on the primary (core) region where age-related differences were most obvious in myelin preparations. Myelinated fibers did not appear in the core until about postnatal week 4. Myelination progressed steadily through 20 weeks, but did not reach the adult pattern. Adult-like expression of AChE in distinct laminar bands (layers I, lower III/IV, & Vb) was evident at postnatal day 0, with only subtle changes throughout the developmental period compared with adult animals. The cytoarchitecture of the core was also highly developed at birth. The time-course of myelination in the ICc and MGv was consistent with latency and morphology changes of MLR peaks Na and Pa. The slower myelination of the cortex was consistent with prolonged development of the longer-latency (ALR) peaks in this species.


The goal of the present study was to determine whether the architectonic criteria used to identify the core region in macaque monkeys (Macaca mulatta, M. nemestrina) could be used to identify a homologous region in chimpanzees (Pan troglodytes) and humans (Homo sapien). Current models of auditory cortical organization in primates describe a centrally located core region containing two or three subdivisions including the primary auditory area (AI), a surrounding belt of cortex with perhaps seven divisions, and a lateral parabelt region comprised of at least two fields. In monkeys the core region can be identified on the basis of specific anatomical and physiological features. In this study, the core was identified from serial sets of adjacent sections processed for cytoarchitecture, myeloarchitecture, acetylcholinesterase, and cytochrome oxidase. Qualitative and quantitative criteria were used to identify the borders of the core region in individual sections. Serial reconstructions of each brain were made showing the location of the core with respect to gross anatomical landmarks. The position of the core with respect to major sulci and gyri in the superior temporal region varied most in the chimpanzee and human specimens. Although the architectonic appearance of the core areas did vary in certain respects across taxonomic groups, the numerous similarities made it possible to unambiguously identify a homologous cortical region in macaques, chimpanzees, and humans.


There were two primary aims of the current study. The first aim was to examine auditory localization in the lateral horizontal plane by listeners with impaired hearing with and without amplification. The amplification provided resulted in a different directional sensitivity pattern than that of the unaided ear. To date, little is known about the effects of different microphone directional sensitivity patterns of hearing aids on auditory localization ability. The second aim of this study, therefore, was to examine the effects of different hearing aid microphone directional sensitivity patterns on the accuracy of auditory localization. The current study focused on auditory localization in the horizontal plane, specifically the lateral horizontal plane with high frequency (4000 Hz), narrow-band stimuli. Overall error results indicated poorer localization accuracy for an omnidirectional microphone condition than for unaided or directional
microphone conditions. There was no significant difference in localization accuracy between the directional and unaided listening conditions.


Improving the signal-to-noise ratio (SNR) for individuals with hearing loss listening to speech in noise provides an obvious benefit. While binaural hearing provides the greatest advantage over monaural hearing in noise, many individuals with symmetrical hearing loss choose to wear only one hearing aid. The present study examined the use of changes in head angle by individuals with symmetrical hearing loss for listening in background noise wearing one hearing aid. Fourteen individuals were fit monaurally with a Starkey Gemini in-the-ear (ITE) hearing aid with directional and omnidirectional microphone modes. Speech recognition performance in noise was tested using the audiovisual laserdisk version of the Connected Speech Test (CST; Cox, Alexander, Gilmore & Pusakulich, 1988; Cox, Alexander, Gilmore & Pusakulich, 1989). The test was administered in auditory only conditions as well as with the addition of visual cues for each of three head angles: 0°, 20° and 40°. Results indicated improvement in speech recognition performance with changes in head angle for the auditory only presentation mode at the 20° and 40° head angles when compared to 0°. Improvement in speech recognition performance for the auditory + visual mode was noted for the 20° head angle when compared to 0°. Additionally, a decrement in speech recognition performance for the auditory + visual mode was noted for the 40° head angle when compared to 0°. These results support changes in current clinical recommendations in that individuals with symmetrical hearing loss fit with only one hearing aid may need to be counseled to turn their head slightly in order to improve their recognition of speech in background noise.


Parents, audiologists, and educators have long speculated that children with hearing loss must expend more effort and, therefore, fatigue more easily than their peers with normal hearing when listening in adverse acoustic conditions. Until now, however, very few studies have been conducted to substantiate these speculations. Two experiments were conducted with school-age children with mild-to-moderate hearing loss and with normal hearing. In the first experiment, salivary cortisol levels and a self-rating measure were utilized to measure fatigue. Neither cortisol measurements nor self-rated measures of fatigue revealed significant differences between children with hearing loss and their normal-hearing peers. In the second experiment, however, a dual-task paradigm utilized to study listening effort indicated that children with hearing loss expend more effort in listening than children with normal hearing (see Fig. 6). Results are discussed in terms of clinical application and future research needs.
Figure 6. Average reaction time difference scores by condition for children with hearing loss (HL) and children with normal hearing (NH). Bars represent 1 standard deviation. Hicks & Tharpe (2001).


Previous research suggests that unaided and aided speech recognition performance in noisy, reverberant, environments generally decreases with increasing listener to source distance, at least until the source reaches the “critical distance” from the listener (e.g. Peutz, 1971). This decrement occurs even when the speech source level is held constant at the listener’s ear. Systematic research investigating the impact of source-to-listener distance on directional benefit, however, has not been completed. The current project examined the interactive effect of changes in reverberation time and source-to-listener distance (both within and beyond the critical distance), on the benefit provided to persons with hearing loss by current digital directional hearing aids. Sentence recognition, in a relatively diffuse noise (+4 dB SNR), was assessed at multiple distances from the source speaker (4, 8 and 16 feet) using a hearing aid capable of both omnidirectional and directional modes. A lecture hall (~ 550 sq. ft) was used as the test environment. Testing was completed under conditions of moderate (860 ms) and low (340 ms) reverberation. The low reverberation condition was obtained by adding acoustic blankets to the walls. Results suggest that performance in both directional and omnidirectional hearing aid modes are reduced as the distance from the source-to-listener increases. In addition, the effect of source-to-listener distance appears to vary based on microphone mode, with a more negative effect of increasing distance observed in the directional microphone mode. Contrary to expectations, directional benefit provided by current microphone technology was still apparent (although greatly reduced) even for distances beyond the critical distance in each environment.

Previous research has demonstrated reduced speech recognition when speech is presented at higher-than-normal levels (e.g. above conversational speech levels), particularly in the presence of speech-shaped background noise. Persons with hearing loss frequently listen to speech-in-noise at these levels through hearing aids, which incorporate multiple-channel, wide dynamic range compression. This study examined the interactive effects of signal-to-noise ratio (SNR), speech presentation level, and compression ratio on consonant recognition in noise. Nine subjects with normal hearing identified CV and VC nonsense syllables in a speech-shaped noise at two SNRs (0 and +6 dB), three presentation levels (65, 80 and 95 dB SPL) and four compression ratios (1:1, 2:1, 4:1 and 6:1). Stimuli were processed through a simulated three-channel, fast-acting, wide dynamic range hearing aid. Consonant recognition performance decreased as compression ratio increased and presentation level increased. Interaction effects were noted between SNR and compression ratio, as well as between presentation level and compression ratio. Performance decrements due to increases in compression ratio were larger at the better (+6 dB) SNR and at the lowest (65 dB SPL) presentation level. At higher levels (95 dB SPL), such as those experienced by persons with hearing loss, increasing compression ratio did not significantly affect speech intelligibility.


The speech understanding of persons with “flat” hearing loss (HI) was compared to a normal hearing (NH) control group to examine how hearing loss affects the contribution of speech information in various frequency regions. Speech understanding in noise was assessed at multiple low and high pass filter cutoff frequencies. Noise levels were chosen to ensure that the noise, rather than quiet thresholds, determined audibility. The performance of HI subjects was compared to a NH group listening at the same signal-to-noise ratio and a comparable presentation level. Although absolute speech scores for the HI group were reduced, performance improvements as the speech and noise bandwidth increased were comparable between groups. These data suggest that the presence of hearing loss results in a uniform, rather than frequency-specific, deficit in the contribution of speech information. Measures of auditory thresholds in noise and Speech Intelligibility Index (SII) calculations were also performed. These data suggest that differences in performance between the HI and NH groups are due primarily to audibility differences between groups. Measures of auditory thresholds in noise showed the “effective masking spectrum” of the noise was greater for the HI than the NH subjects. Thus, compared to the NH subjects, audibility was reduced for the persons with hearing loss despite listening at the same acoustic signal-to-noise ratio.


Our working model of primate auditory cortex describes a centrally located core region, encompassed by a narrow belt region comprised of some seven putative subdivisions. The anatomical and physiological properties of the belt fields bordering the core medially are poorly understood and represent the focus of
the present study. Multiple injections of retrograde and bi-directional tracers were made into subdivisions of the medial belt, core, lateral belt, and parabelt regions of auditory cortex in marmoset monkeys (*Callithrix jacchus jacchus*). Injection loci were confirmed by multiunit recordings and postmortem architectonic analyses. Local connections of the medial belt included subdivisions of the core, belt, and parabelt regions. Rostral and caudal medial belt connections varied between rostral and caudal divisions of the core, belt, and parabelt, respectively. For example, projections to the caudal medial belt from rostral auditory fields were less dense and primarily from infragranular layers. Caudal and rostral divisions of the medial belt were further distinguished by thalamic connection patterns. The dorsal and magnocellular divisions of the medial geniculate complex projected to caudal and rostral medial belt fields. Projections to the caudal medial belt also included the suprageniculate, limitans, medial pulvinar, and multisensory nuclei of the posterior thalamus. The cortical and thalamic connection patterns are consistent with current theories concerning functionally distinct domains in rostral and caudal auditory cortex.


Otitis media with effusion (OME) often results in hearing loss for children with the condition. In order to provide appropriate and effective audiologic management, it is important to understand the impact of OME on speech recognition ability when hearing loss is present. This study examined the speech recognition abilities of normal hearing 6- and 7-year old children (n=12) and adults (n=12) using monosyllabic words and nonsense syllables presented at two levels of simulated conductive hearing loss characteristic of OME. Average speech recognition scores decreased as the degree of simulated conductive hearing loss increased. Both age groups scored significantly poorer for nonsense syllables than for monosyllabic words. In general, their children performed more poorly than the adults with the exception of the easiest listening condition for word stimuli. Furthermore, children appeared less able than adults to use their knowledge of familiar words to improve performance. These findings suggest that rehabilitative strategies may be best focused upon combining familiarization techniques and amplification options.

**Penn, T.** (In preparation). “The effect of positive otitis media history on later language skills.”

This study examined the impact of early otitis media experience on later language development. The results from 42 studies that compared language skills of nearly 4500 children with and without significant otitis media histories were pooled using meta-analytic techniques. Expressive and receptive language skills were included in the analyses. Small, yet significant relationships exist between otitis media history and expressive and receptive language development. These relationships existed regardless of study population age, publication status (i.e, published versus unpublished), or study design. Early experience with otitis media leads to poorer expressive and receptive language skills.


The objective of this investigation was to evaluate the impact of low-threshold compression and hearing aid style (ITE versus BTE) on the directional benefit and performance of commercially available directional hearing aids. Forty-seven adult listeners with mild-to-moderate sensorineural hearing loss were fit bilaterally with one BTE and four different ITE hearing aids. Speech recognition performance was measured through the CST and HINT for a simulated noisy restaurant environment. Both the HINT
and CST results indicated that speech recognition performance was significantly greater for subjects fit with directional in comparison to omnidirectional microphone hearing aids. Performance was significantly poorer for the BTE instrument in comparison to the ITE hearing aids when using omnidirectional microphones. No differences were found for directional benefit between compression and linear fitting schemes. These results are exemplified in the data collected using the CST shown in Fig. 7. No systematic relationship was found between the relative directional benefit and hearing aid style; however, the speech recognition performance of the subjects was somewhat predictable based on DI measures of the individual hearing aid models. The fact that compression did not interact significantly with microphone type agrees well with previously reported electroacoustic data.

![Graph showing listeners' performance across all omnidirectional and directional hearing aid conditions using both compression and linear amplification. Standard error of measure exhibited a range from 4.8% to 5.2% across all conditions. Ricketts et al. (2001).](image)

**Figure 7.** Listeners’ performance as measured by the CST, across all omnidirectional and directional hearing aid conditions using both compression and linear amplification. Standard error of measure exhibited a range from 4.8% to 5.2% across all conditions. Ricketts et al. (2001).


Hearing aids currently available on the market with both omnidirectional and directional microphone modes often have reduced amplification in the low frequencies when in directional microphone mode due to better phase matching. The effects of this low frequency gain reduction for individuals with hearing loss in the low frequencies was of primary interest. Changes in sound quality for quiet listening
environments following gain compensation in the low frequencies was of secondary interest. Thirty participants were fit with bilateral in-the-ear (ITE) hearing aids which were programmed in three ways while in directional microphone mode: no gain compensation, adaptive gain compensation, and full gain compensation. All participants were tested with speech in noise tasks. Participants also made sound quality judgments based on monaural recordings made from the hearing aid. Results support a need for gain compensation for individuals with low frequency hearing losses of greater than 40 dB HL.


The effectiveness of adaptive directional processing for improvement of speech recognition in comparison to non-adaptive directional and omnidirectional processing was examined across four listening environments intended to simulate those found in the real world. The test environment was a single, moderately-reverberant room with four loudspeaker configurations: three with fixed discrete noise source positions and one with a single panning noise source. Sentence material from the Hearing in Noise Test (HINT) and Connected Speech Test (CST) were selected as test materials. Speech recognition across all listening conditions was evaluated for twenty listeners fit binaurally with Phonak Claro™ behind-the-ear (BTE) style hearing aids. Results indicated improved speech recognition performance with adaptive and non-adaptive directional processing over that measured with the omnidirectional processing across all four listening conditions. While the magnitude of directional benefit provided to subjects listening in adaptive and fixed directional modes was similar in some listening environments, a significant speech recognition advantage was measured for the adaptive mode in specific conditions. The advantage for adaptive over fixed directional processing was most prominent when a competing noise was presented from the listener’s sides (both fixed and panning noise conditions), and was somewhat predictable from electroacoustically measured directional pattern data.


Past investigations have shown that subjects fit with directional hearing aids reveal significantly better speech intelligibility than when fit with omnidirectional amplification across a variety of laboratory, simulated real world, and real-world listening environments. Studies which have measured directional benefit through formalized self-assessment procedures, however, have been both rare and not overwhelmingly supportive of directional technology. The purpose of this experiment was to systematically examine directional benefit though measures of speech recognition and self-assessment. A number of self assessment questions were developed to determine if a subset of these questions might prove useful when attempting to differentiate between directional and omnidirectional hearing aid modes. In order to provide independent control of the directional parameter, listeners were fit in three different modes: Omnidirectional only (O), directional only (D), and user controlled directional/omnidirectional (DO). In this way, the potential positive and negative impact of directional versus omnidirectional hearing aid experience were assessed independently. The results of this study suggested that the laboratory measures which have revealed significant directional benefit as measured by speech recognition are reflected in self assessment measures of hearing aid benefit which concentrate on listening in noise when the sound source of interest is in front of the listener. These data also support the impact of a variety of environmental and fitting factors unrelated to speech understanding in noise, such as interactions with low frequency gain, wind noise and localization abilities on the magnitude of directional benefit perceived by subjects. Self assessment scores from a newly developed pair of sub-scales provided further support for fitting hearing aids with both directional and omnidirectional modes available to the hearing aid wearer. Specifically, these data indicated that directional amplification was rated as either better, or worse than an
omnidirectional mode, depending on the specific listening situation. These data indicated that full-time use of directional amplification may prove detrimental in listening situations in which the signal of interest is behind the listener, or sound localization is required.


In general, past studies have shown large variations in the magnitude of directional benefit both across individual listeners and across listening environments and hearing aid model. Given the large range of directional benefit reported and the potential for benefit to listeners, a method for prediction of directional benefit for average listeners is of interest. The Articulation Index weighted Directivity Index (AI-DI) has been advocated as an appropriate predictor of average directional benefit. The purpose of this investigation was twofold. First, the equivalency of frequency specific changes in DI and changes in SNR was evaluated. Secondly, the assumption that improved directivity is more important at some frequencies than at others as predicted by application of frequency importance functions was evaluated. To test these hypotheses eight known frequency specific directivity conditions were first applied to the calculation of frequency specific noise levels. These corrected noise levels were then used to calculate SII values for the prediction of speech recognition scores. These predicted speech recognition scores were then compared to measured speech recognition under the same eight listening conditions. All data were examined across three different groups of hearing impaired listeners to determine if the possible relationship between DI values and directional benefit was impacted by degree or configuration of hearing loss. Results revealed that good agreement between predicted and measured directional benefit across the eight test conditions for all three groups of listeners (Fig. 8). Results further revealed little increase in predictive accuracy for several of the proposed AI-DI weightings over a simple average.
Understanding the potential benefits and limitations of directional hearing aids across a wide range of listening environments is important when counseling persons with hearing loss regarding realistic expectations for these devices. The purpose of this study was to examine the impact of speaker-to-listener distance on directional benefit measured in two reverberant environments intended to simulate those commonly experienced by hearing aid wearers. In addition, Speech Transmission Index (STI) measures made in the test environments were compared to measured word recognition to determine if performance was predictable from the Modulation Transfer Function (MTF) across changes in distance, reverberation and microphone mode. The aided word recognition, in noise, for fourteen adult subjects with symmetrical sensorineural hearing impairment was measured across six environmental conditions in both directional and omnidirectional modes. A single room, containing a semi-diffuse, uncorrelated noise source and modified to exhibit both low (RT60 = 0.3 seconds) and moderate (RT60 = 0.9 seconds) levels
of reverberation, served as the test environment. Sentence recognition was measured in each of these two reverberant environments for three different speech loudspeaker-to-listener distances (1.2 M, 2.4 M, and 4.8 M). The MTF was measured for each of seven bands centered at the octave frequencies of 250 to 8000 Hz across all twelve listening conditions (2 microphone X 3 distances X 2 reverberation). These data were then used to derive STI values. Results revealed a decrease in directional benefit was measured with increasing distance in the moderate reverberation condition (Fig. 9). Although reduced, directional benefit was still present in the moderately reverberant environment used in this experiment at distances up to 150% of the estimated critical distance. A similar decrease, however, was not measured in a matched environment with low reverberation. The pattern of average sentence recognition results across varying distances and two different reverberation times agreed with the pattern of STI values measured under the same conditions. While these data reveal that directional benefit in noise is maximized by reducing speaker-to-listener distance, some benefit is still obtained by listeners when listening beyond critical distance under conditions of low (300 ms) to moderate (900 ms) reverberation. These data support the use of aided STI values for the prediction of average word recognition across listening conditions which differ in reverberation, microphone directivity and speaker-to-listener distance.
Decades of research have established exceptional benefit of binaural hearing for understanding speech in noise. Less is known, however, about the value of binaural hearing for understanding speech when signals have been degraded asymmetrically between the two ears. A few previous studies have demonstrated a phenomenon known as binaural interference. Binaural interference occurs when speech perception is poorer when listening binaurally than monaurally to the better of the two signals. The purpose of this study was to examine the effect of asymmetrical signal degradation on binaural speech perception in children and adults with normal hearing. Specifically, we wanted to determine if individuals experience binaural interference or, at a minimum, lose their binaural advantage when presented asymmetrically-degraded signals. In addition, the this study sought to determine whether the effect of asymmetric signal degradation on speech perception was influenced by the listener’s age or which ear (right or left) received the more degraded signal. Two groups of children, age 5-6.5 years (N=14) and 10-11.5 years (N=14), and one group of adults, age 24-29 years (N=14) participated in the project. Sentence recognition ability amidst multi-talker babble was assessed in three listening conditions: 1) monaurally, with mild degradation in one ear, 2) binaurally with mild degradation in both ears, and 3) binaurally with mild degradation in one ear and severe degradation in the other ear. Sentences and babble were digitally degraded to simulate mild and severe cochlear hearing loss using computer algorithms supplied by Dr. Brian Moore of Cambridge University. Results demonstrated that participants in all three age groups.
exhibited considerable binaural advantage when listening to symmetrically-degraded signals. In contrast, participants achieved no binaural benefit, on average, when listening to asymmetrically-degraded signals. Child participants exhibited binaural indifference. That is, children demonstrated no significant increments or decrements in performance when listening binaurally to asymmetrically-degraded signals than when listening monaurally to the better of the two signals (Fig. 10). Adults, however, demonstrated slight evidence of binaural interference. That is, adults exhibited greater difficulty, on average, when listening binaurally to asymmetrically-degraded signals than when listening monaurally to the better signal. The occurrence of binaural interference was not influenced by which ear (right or left) received the more degraded signal.

![Figure 10. Mean signal-to-babble threshold as a function of age group and listening condition. Error bars represent standard error from the group mean. Rothpletz et al.](image)


The purpose of this study was to compare the response times of deaf and normal hearing individuals to the onset of target events in the visual periphery in distracting and non-distracting conditions. Visual reaction times to peripheral targets placed at three eccentricities to the left and right of a center fixation point were measured in prelingually deafened adults and normal hearing adults. Deaf participants responded more slowly than normal hearing participants to targets in the near periphery in the non-distracting condition, and to targets in the near and distant periphery when distracting stimuli were present (Fig. 11). One interpretation of these findings is that deaf individuals may be more deliberate than normal hearing individuals in responding to near peripheral events and to peripheral events that occur in the presence of distracting stimuli.
Figure 11. Median reaction times (±1 standard error) of the deaf and normal-hearing groups as a function of target eccentricity in the non-distracter and distracter conditions. Rothpletz et al.


The primary auditory cortex from human postmortem brains was processed histologically to examine the hemispheric asymmetry of neuron density and cortical volume. Initial brains were from subjects lacking a history of neurological or psychiatric pathology. The borders of the primary auditory cortex were identified by dense parvalbumin immunoreactivity and by cytoarchitectonic features in Nissl stained sections. We excluded the parvalbumin-rich area in the depth of Heschl's sulcus, because its features in Nissl sections were distinct from the rest of the primary auditory cortex. In all brains, the primary auditory cortex was confined to the caudal-medial portions of Heschl's gyrus. In our initial brains, we have not found evidence for consistent hemispheric asymmetries, although a few brains had greater than 10% asymmetries for volume and/or neuron density. The volume of the primary auditory cortex was 780 +/- 150 cubic mm (mean +/- s.d., n = 16 hemispheres, values corrected for post-fixation shrinkage). Cell densities were 42,000 +/- 6,000 cells/cubic mm (n = 16 hemispheres), sampled in layers IIIB/C from the extent of the primary auditory cortex, using the optical dissector method. Cell density measurements revealed an obvious medial greater than lateral density gradient in most hemispheres. Comparisons of these findings with brains from schizophrenics are currently in progress.


The behavioral evaluation of hearing in very young infants has been fraught with procedural and interpretive problems. Despite the introduction of current physiological techniques of estimating hearing sensitivity, such as otoacoustic emissions and auditory brainstem-evoked responses, behavioral hearing assessment of young infants remains of interest to researchers of infant behavior and to clinicians who need to use a battery of tests in their assessment of infant hearing. The objective of this study was to
provide the first longitudinal investigation of infant auditory sensitivity, using a new procedure for behavioral testing of neonates and infants. Behavioral responses to speech noise stimuli were obtained monthly from birth to 12 months of age. During each trial, the signal increased from an inaudible level in 2-dB steps until the infant responded. Therefore, a threshold estimate was obtained on each trial, and the average threshold could be computed across trials within a test session. Threshold estimates were in good agreement with previously reported infant behavioral thresholds based on cross-sectional designs. The age-related changes in threshold were fit with exponential functions for individual infants and for the group data. There was good agreement in the shape of these functions across infants, with asymptotic threshold level approached around 6 months of age (see Fig. 12). Therefore, this longitudinal study confirms that the age trend previously reported from cross-sectional findings is also observed in the development of individual infants.
Fig. 12. Individual subject threshold estimates by age with best fitting exponential function for each subject. The proportions of variance accounted for were, respectively, 0.871, 0.717, 0.977, 0.218, 0.849, 0.895, and 0.622. Tharpe & Ashmead (2001).

The purpose of this work is to improve the computational efficiency in acoustic virtual applications by creating and testing reduced order models of the head related transfer functions used in localizing sound sources. State space models of varying order were generated from zero-elevation Head Related Impulse Responses (HRIR’s) using Kung’s Single Value Decomposition (SVD) technique. The inputs to the models are the desired azimuths of the virtual sound sources (from minus 90 degrees to plus 90 degrees, in ten degree increments) and the outputs are the left and right ear impulse responses. Trials were conducted in the anechoic chamber at the Bill Wilkerson Center at Vanderbilt University in which subjects were exposed to “real” sounds that were emitted by individual speakers across a numbered speaker array, ”phantom” sources generated from the original HRIR’s, and "phantom” sound sources generated with the different reduced order state space models. The error in the perceived direction of the phantom sources generated from the reduced order models were compared to errors in localization using of the original HRIR’s.
The purpose of this investigation was to assess the temperamental characteristics of children who do (CWS) and do not stutter (CWNS) using a norm-referenced parent-report questionnaire. Participants were 31 CWS and 31 CWNS between the ages of 3;0 and 5;4 (years; months) (CWS: mean age = 48.03 months; CWNS: mean age = 48.58 months). The CWS were matched by age (+/- 4 months), gender, and ethnicity to the CWNS. All participants had speech, language, and hearing development within normal limits, with the obvious exception of stuttering for CWS. Children’s temperamental characteristics were determined using the Behavioral Style Questionnaire (BSQ) (McDevitt & Carey, 1978), which was completed by each child’s parents. Results, based on parent responses to the BSQ, indicated that CWS are more apt, when compared to CWNS, to exhibit temperamental profiles consistent with hypervigilance (i.e., less distractibility), nonadaptability to change, and irregular biological functions. Findings (Fig. 13) suggest that some temperamental characteristics differentiate CWS from CWNS and could conceivably contribute to the exacerbation, as well as maintenance of their stuttering.

![Figure 13. Mean (SEM = brackets) scores on the nine dimensions of the Behavioral Style Questionnaire (BSQ) for children between the ages of 3;0 and 5;11 (years; months) who do (CWS) (n = 31) and do not stutter (CWNS) (n = 31). Descriptors (e.g., “activity”) of the nine temperamental dimensions are listed above or below the data bars, depending on height and direction of data bars. Anderson et al. (in press).]

The purpose of this study was to use an age-appropriate version of the sentence-structure priming paradigm (e.g., Bock, 1990; Bock, Loebell, & Morey, 1992) to assess experimentally the syntactic processing abilities of children who do (CWS) and do not stutter (CWNS). Participants were 16 CWS and 16 CWNS between the ages of 3;0 and 5;11 (years; months), matched for gender and age (+/-6 months). All participants had speech, language, and hearing development within normal limits, with the exception of stuttering for CWS. All children participated in a sentence-structure priming task where they were shown and asked to describe, on a computer screen, black-on-white line drawing of children, adults, and animals performing activities that could be appropriately described using simple active affirmative declarative (SAAD) sentences (e.g., “the man is walking the dog”). Speech reaction time (SRT) was measured from the onset of the picture presentation to the onset of the child’s verbal response in the absence and presence of priming sentences, counterbalanced for order. Main findings indicated that CWS exhibited slower SRTs in the absence of priming sentences and benefited more from syntactic primes than CWNS. Findings were taken to suggest that CWS may have difficulty rapidly, efficiently planning and/or retrieving sentence-structure units, difficulties that may contribute to their inability to establish fluent speech-language production.


This study assessed linguistic disparities in 38 young children who do/do not stutter by using standardized speech-language tests. Findings indicate that children who stutter have dissociations in their speech-language abilities that may contribute to their difficulties achieving fluent speech.


The mismatch negativity (MMN) response to speech stimuli was measured in normal and aphasic subject groups. The effects of age and gender on MMN presence, peak latency, duration, and peak-to-peak amplitude were analyzed. No effects of age or gender were found for MMN latency, duration, or peak-to-peak amplitude for either the normal or aphasic subject groups. These results provide information relevant to the application of the MMN response as an index of speech and language abilities.


A variety of language intervention methods are currently available to speech-language pathologists including direct imitation techniques and conversation-based methods. Moreover, considerable debate about which types of methods are most effective in children with specific language impairment (SLI) is ongoing. It is increasingly clear, however, that there are individual differences in the effectiveness of these intervention methods. Rather than attempting to identify a single best procedure for all children,
there may be advantages to pre-intervention identification of key parameters that will predict success under different intervention methods. The purpose of this study was to determine whether pre-intervention imitation skills were associated with intervention effects in children with SLI who were treated using direct imitation and conversational recast methods. The results indicated a significant relationship between pre-intervention imitation levels and speed of target acquisition. Children who were relatively poor imitators at pre-intervention were subsequently relatively inefficient learners during imitation treatment and required high numbers of target presentation prior to use in spontaneous language samples. However, pre-intervention comprehension levels and pre-intervention levels of nonverbal cognitive skills were not significantly associated with intervention effects. The clinical implications of these results as they relate to pre-intervention prediction of treatment effects are discussed.


The purpose of this paper is to discuss why clinicians may want to read research. A variety of aims for keeping up on the research literature are suggested, and methods for determining the validity of research reports’ results are provided. The paper concludes by suggesting that clinicians who read research may elect to not only be consumers of research, but also be contributors to the research literature.


We used a modified narrow transcription procedure to examine a speech sample produced by ten speakers with coexisting aphasia and apraxia of speech. The transcription protocol was limited to eight diacritic marks selected based on previous perceptual descriptions of phonetic distortion among apraxic speakers. One additional general distortion category that was not further specified was also used. The results showed that distortion errors were as common as substitution errors, that vowel and consonant segments were equally vulnerable to misproduction, and that there was no difference between the frequency of consonants produced incorrectly in prevocalic and postvocalic syllable position. Among distortion errors, the most common type was prolongation followed by partial voicing and devoicing. Forty-one percent of perceived distortions were classified as general distortions. An independent transcription that used a comprehensive system of diacritic marks was performed as a follow-up. The results are discussed relative to single word intelligibility testing and the challenges associated with transcribing disordered speech.


Tracking spontaneous eye movement responses may improve the accuracy of comprehension assessment in patients with neurological impairments. Eye movement methods provide an on-line response mode that does not require an overt planned motoric response, tax participants’ understanding of instructions, or interrupt the comprehension process with intervening instructions or prompts. Nineteen adults with no history of neurological involvement were presented with auditory comprehension stimuli from the Revised Token Test (RTT) in each of three conditions: traditional, pointing, and eye movement. A remote pupil center/corneal reflection system was used to monitor eye movements. Dependent variables included the proportion of total viewing time that participants fixated on target images and non-target foils. Traditional RTT scores indicated normal comprehension for all participants, according to published norms. Likewise, pointing condition scores indicated good comprehension. For each of the subtests in the eye movement condition, the proportional amount of time that fixations were allocated to target images significant exceeded chance...
expectations. The language-normal data reported here suggest that the experimental form of the RTT and the application of the eye movement method yield results consistent with more traditional assessments of auditory comprehension. Thus, application of the method with patients with neurogenic disorders is warranted. Ultimately, the use of eye movement methods may help indicate comprehension abilities in patients whose comprehension status might otherwise be invalidly assessed.


This investigation applied the principles of evidence-based medicine—sensitivity and specificity, pre- and post-test probabilities, and positive and negative likelihood ratios—to determine the contribution of selected voice assessment measures for determining the presence of dysphonia beyond that of a voice clinician’s perceptual expertise.


Severity of and change in aphasia may be indexed by a language impairment measure or a functional communication measure, including assessment of pragmatic performance. The relationship of severity of and change in aphasia between different measures has not been clearly established. Performance on measures of language impairment, Porch Index of Communicative Abilities (PICA); functional communication, Rating of Functional Performance (REP); and pragmatic performance, Pragmatic Protocol (PP) was examined to determine whether there are significant relationships among severity of performance deficits and among change in performance on each measure. The research questions were: Are there significant relationships among aphasic patients’ language impairment, functional communication, and pragmatic performance at 4, 15, 26, 37, and 48 weeks postonset? Are there significant relationships among change scores between 4-15, 15-26, 26-37, 37-48, and 4-48 weeks postonset? A total of 20 adults who were aphasic subsequent to a first, single thromboembolic stroke were administered the PICA, the FRP, and the PP at 4 weeks postonset and every 11 weeks thereafter during the first year postonset. *A priori* predictions about the relationships between measures were made, and correlational analyses were used to examine the relationships among measures. Partial correlations and comparisons of correlation coefficients were also employed. Severity of both pragmatic performance and functional communication were significantly related with language impairment. Severity of pragmatic performance and functional communication were significantly related only at 4 weeks postonset. Correlations between measures of severity were not significantly different from each other. Correlations between change scores on repeated test administrations were significant only for the FRP and PICA between 4-15 weeks and 4-48 weeks. Results suggest that while a measure of language impairment may be significantly related with severity of functional communication and pragmatic performance, severity of pragmatic performance is significantly related with severity of functional communication only at 1 month postonset. Moreover, change on any one of the measures is generally not significantly related with change on the other measures. The use of correlational analysis to determine whether different assessments measure different constructs in aphasia is discussed, and alternative methods or analysis are presented.

The purpose of this study was to assess the influence of phonological priming on the speech reaction time (SRT) of children who do (CWS) and do not (CWNS) stutter during a picture-naming task. Participants were eighteen 3- to 5-year-old CWS ($M=50.67$ months; $SD=11.83$ months), matched in age and gender with eighteen CWNS ($M=49.44$ months; $SD=10.22$ months). All thirty-six children participated in a picture-naming task. This task required each child to name, one at a time, computer-presented, white-on-black line drawings of common, age appropriate objects “as quickly as you can” during three different conditions: 1) no prime, 2) related prime and 3) unrelated prime, with naming latency (ms) alternatively referred to as speech reaction time (SRT) as the main dependent variable. Results indicated that all children exhibited faster or shorter speech reaction times during the related than no prime condition. Similarly, SRT was influenced with advancing age for all children, with five year-old exhibiting faster SRT than three year-old children. Furthermore, CWNS, but not CWS, demonstrated a negative correlation between articulatory mastery and speech reaction time (SRT – see Fig. 14). Findings were taken to suggest that phonological priming is a feasible procedure to study the speech-language planning and production of 3- to 5-year old children and that preschool children who stutter, as a group, may have somewhat less well developed articulatory systems than preschool children who do not stutter.

Preschool children who do (CWS) and do not (CWNS) stutter participated in 3 computer-based phonological-priming tasks. CWNS exhibited strong negative correlations between speech reaction time and articulation test scores; CWS exhibited minimal correlations. Results suggested that CWS have a less organized articulatory system.

Figure 14. Scattergrams depicting, during the no, related, and unrelated prime conditions, the relationship between speech reaction time (ms) and Goldman-Fristoe Test of Articulation (GFTA) for (A) children who do not stutter and (B) children who do stutter; $R^2$ = index of determination or what percentage of variation of speech reaction time is accounted for by GFTA score. Melnick et al. (in press).

Pictorial stimuli are a traditional means of discourse elicitation for individuals with aphasia. The discourse genre produced in response to pictures may be affected by the presence of aphasia, the nature of the stimulus, or both. Ethnicity may also influence discourse responses, an issue critical for effective differentiation between communication changes associated with pathology and normal differences associated with ethnicity. There is a need for discourse research with African Americans who have aphasia, highlighted by ethnic group differences in stroke prevalence, and potential ethnic group differences in dialect. This study was designed to address whether the quantity and quality of discourse produced in response to pictorial stimuli differed between African Americans and Caucasians with and without aphasia. We investigated the discourse of 33 African Americans with aphasia, 30 African American no-brain-injured controls, 29 Caucasians with aphasia, and 32 Caucasian non-brain-damaged controls in their responses to two single pictures and one picture sequence. Participants were asked to “tell a story” and responses were produced after the stimulus was removed. Analyses included length of response (in propositions), discourse genre of response (narrative versus descriptive), occurrence of ethnic dialect, and thematic content. In both ethnic groups, individuals with aphasia produced less language on the most complex stimulus. Single pictures elicited more descriptive discourse, and the picture sequence more narratives, for all groups. Features of African American dialect were observed in responses of both African American non-brain-injured controls and African Americans with aphasia on all stimuli, especially in narrative genre responses. Thematic content was similar across groups. Results hold implications for the design of picture-elicited discourse tasks. Lack of ethnic group differences in response length and the thematic content of responses may be a function of task artificiality, or a reflection of ethnic group similarity in overall discourse length and content. Picture sequences seem more effective for eliciting narrative discourse, and single pictures for eliciting descriptive discourse. Descriptive discourse may be simpler to produce for individuals with and without aphasia. Findings suggest a robustness of ethnic dialect features, at least for individuals with mild aphasia, although this may be best seen on responses that are narrative in type. Differentiation between discourse genres provides a useful complement to other approaches to discourse assessment.


The purpose of this paper was to assess the articulatory and phonological abilities of 25 3- to 6-year old children who do stutter (CWS) and 25 age- & sex-matched children who do not stutter (CWNS) by means of standardized tests of articulation (Goldman-Fristoe Test of Articulation) and phonology (Khan-Lewis Phonological Assessment). Findings indicated that the articulation and phonological abilities of CWS significantly differ from CWNS, with articulation and phonology scores of CWS tending to be within the lower ends of normal limits (Fig. 15). Results are taken to suggest that inefficiencies in the accuracy and speed of phonological and/or phonetic encoding may contribute to childhood stuttering.
The purpose of this investigation was to quantitatively and qualitatively characterize speech disfluencies exhibited by 3- and 4-year-old children who do (CWS, N=36) and do not (CWNS, N=36) stutter. Five measures of speech disfluency (e.g., percentage of total, other, and stuttering-like disfluencies, mean number of repetition units, and weighted SLD measure) were used in attempts to differentiate CWS from CWNS. Similar measures of stuttering (e.g., percentage of stuttering-like disfluencies consisting of disrhythmic phonations) were used to characterize speech disfluencies in 3- and 4-year-old CWS in relation to time since stuttering onset (TSO). It was hypothesized that such measures of speech disfluency should significantly differ between CWS and CWNS, as well as 3-versus 4-year-old CWS in relation to TSO. Results indicated that 4 out of the 5 dependent measures significantly differed between CWS and CWNS, and within the CWS group there was a significant relationship between TSO and the percentage of stuttering-like disfluencies when the effects of chronological age were partialled out of the regression analyses (Fig. 16). Furthermore, 4-year-old CWS exhibited a moderate correlation between TSO and the percentage of stuttering-like disfluencies consisting of disrhythmic phonations, whereas 3-year-old CWS exhibited no such relationship between these two variables. Findings were taken to suggest that certain measures of speech disfluency appreciably differentiate CWS from CWNS and that 4-year-old CWS exhibit changes in nonreiterative forms of stuttering as a function of time since stuttering onset.
Figure 16. Weighted stuttering-like disfluencies (SLD) measure as a function of the log of the unweighted SLD percentage for three- and four-year-old 36 children who stutter (triangles) and 36 age- and gender-matched children who do not stutter (circles). Two boundaries separated almost all (97%) of the two talker groups: (a) weighted SLD measure of 4 and (b) unweighted SLD measure of 3. Pellowski & Conture (2002).

Pellowski, M., and Conture, E. (Submitted). "Lexical priming in picture naming of young children who do and do not stutter."

The purpose of this investigation was to assess the influence of lexical/semantic priming on the speech reaction time of young children who do and do not stutter during a picture naming task. Participants were 23 children who stutter, age-matched (+/- 4 months) to 23 children who do not stutter, ranging in age from 3 years, 0 months to 5 years, 11 months. Experimental procedures involved employing a computer-assisted picture naming task, during which each participant was presented with the same set of 28 pictures in each of three different conditions: (a) no-prime condition: no auditory stimulus presented prior to
picture display; (b) **related-prime condition**: a semantically related word (to the target picture) presented auditorily 700 ms prior to picture display; and (c) **unrelated-prime condition**: a semantically unrelated word presented auditorily 700 ms prior to picture display. Results indicated that pre-activation of semantically related words prior to the picture naming response facilitated (i.e., made faster) lexical retrieval for children who do not stutter, but inhibited (i.e., made slower) the lexical retrieval of children who stutter. Moreover, children who do not stutter with higher receptive vocabulary scores exhibited faster speech reaction times and a greater semantic priming effect, whereas no such relationships were found for children who stutter. Findings were taken to suggest that subtle difficulties with lexical encoding may contribute to childhood stuttering, and that linguistic processes warrant further consideration in the study of the onset and development of stuttering in young children.


This investigation examined the relationship between linguistic variables and measures of speech disfluency in 19 3-5-year-old children who stutter. Results indicate that standardized measures of receptive/expressive language performance and vocabulary abilities were significantly correlated with select measures of speech disfluency.

**de Riesthal, M., and Wertz, R.T.** (2002). "Using prognostic variables and multiple regression analysis to provide a prognosis for aphasia." Peer reviewed paper presented to the Clinical Aphasiology Conference, June, Ridgedale, MO. Also presented to the American Speech-Language-Hearing Association, November, Atlanta, GA.

We used pretreatment PICA, CADL, and Coloured Progressive Matrices (CPM) performance, and weeks post-onset (WPO) to predict aphasic patient outcome and amount of improvement on the PICA and CADL following 12 weeks of treatment during a 24-week period. All were significantly correlated with outcome on the PICA and CADL. Pretreatment PICA performance and WPO were significantly, negatively correlated with amount of improvement on the PICA and CADL. Pretreatment CADL performance was significantly, negatively correlated with amount of improvement on the CADL. Multiple regression analyses indicated all were strong predictors of post-treatment CADL performance. All except pretreatment CPM performance were strong predictors of post-treatment PICA performance.


Contextual factors of age, education, and gender were examined to determine their influence on language impairment, communication activity limitation, and quality of life measures and whether they pose threats to the validity of differentiating normal from aphasic performance on the measures. Age and education were significantly related with performance on some measures, and the strengths of the correlations differed between normal and aphasic adults. Thus, age and education may influence the measures’ ability to differentiate between normal and aphasic adults.
Empirical, prognostic evidence of the influence of type on severity of and recovery from aphasia is limited. Forty-one treated adults with aphasia were administered four standardized language impairment and communication activity limitation tests at approximately one month poststroke. Tests were readministered three and six months later to determine whether change in severity and/or type of aphasia had occurred. On all tests, initial severity differed significantly among types. Rate of recovery also differed among types. Some types demonstrated significant amounts of improvement, but others did not. And, while language impairment outcome at seven months poststroke differed significantly among types, the results varied by test. Finally, more than one third of the patients changed type during the six-month period. Percentages and patterns of change varied by time, poststroke, of classification.


A growing consensus among speech-language pathologists that treatment goals should be significant to the consumer and society has spurred clinicians to address stroke survivors’ quality of life (QOL) as a possible target for remediation. Use of formal measures to detect decreased QOL presumes that test performance of aphasic patients is different from that of non-brain injured (NBI) adults. Treatment directed towards decreased QOL presupposes that its symptoms are attributable to a diagnosis of aphasia. Differential performance for chronically aphasic and NBI adults on two QOL measures has been established. However, relationships between residual language and/or communication deficits and QOL have not been confirmed. We examined relationships between residual language and/or communication deficits and QOL to determine whether, within NBI adult and chronically aphasic adult groups, there are significant relationships between language impairment and QOL measures; whether there are significant relationships between communication activity limitation and QOL measures; and, whether the strengths of these relationships differ between groups. A total of 18 NBI controls and 18 adults with chronic aphasia were administered two language impairment tests (WAB, PICA), two communication activity limitation assessments (CADL-2, ASHA FACS), and two QOL measures (WHOQOL-BREF, PWI). Correlation analyses were used to examine relationships between residual language and/or communication deficits and QOL. Although chronically aphasic adults scored significantly lower on all measures than did NBI adults, language-based disability generally was not significantly related with QOL in either group. Within the NBI group, only one language impairment and one QOL measure were significantly related. Within the chronically aphasic group, there were no significant relationships between language impairment and QOL measures, and there were no significant between-groups differences in the strengths of these relationships. Within either group, there were no significant relationships between communication activity limitation and QOL measures. Furthermore, there were no significant between-groups differences in the strengths of these relationships. The results of this investigation may be interpreted to suggest that decreased QOL in chronically aphasic adults is not closely related with language-based disablement. Thus, speech therapy that directly targets QOL in aphasic patients may not be justified. However, the use of correlation analysis limits the ability to rule out viable, alternative hypotheses or to account for misinterpretation due to measurement error. To examine relationships between language-based disablement, other undetermined factors, and QOL, further study, using larger sample sizes and causal modeling techniques is recommended.
Schuele, C. M., and Dykes, J. (Under review). "A longitudinal study of complex syntax production by a child with specific language impairment."

Although there are numerous published studies on the grammatical morpheme development of children with specific language impairment (SLI), there are only a handful of studies on the complex syntax development of children with SLI. The grammatical morpheme studies have documented unequivocally the early linguistic vulnerabilities of children with SLI. Studies of complex syntax in children with SLI are needed to document how these early linguistic vulnerabilities are associated with problems in the acquisition of complex syntax. Only then will we have a complete understanding of the linguistic vulnerabilities that underlie SLI. In this study, the complex syntax development of one child with SLI was documented from three to seven years of age through analysis of spontaneous language samples. Of interest was (a) the order and rate of emergence of a variety of complex syntax structures, (b) the relative frequency with which these structures were produced, and (c) the developmental changes in grammatical form as complex syntax structures were acquired. The most simple complex syntax forms (i.e., catenatives, let’s clauses, and simple infinitives) emerged, but were produced infrequently, at three years of age when the child’s MLU was between 1.91 and 2.25. Prior to MLU of 3.0, other complex forms were rarely produced. At 5;9 and MLU 4.30, the child consistently produced other complex syntax forms, including full proposition clausal complements, WH complement clauses, and relative clauses. However, the emergence of complex syntax revealed developmental change over time; that is, complex structures were not initially produced as grammatically intact utterances. Error patterns included (a) omissions of obligatory relative markers in subject relative clauses (e.g., here’s the girl who is already tired), omissions of infinitival TO, and omissions of WH words in WH clauses (look where that home is). Omissions of these structures are further evidence that children with SLI have particular difficulty with the formal grammatical elements of language. The methodology employed in this case study provides a foundation on which to explore complex syntax in a cross-sectional sample of children with SLI.


This longitudinal case study describes an anomalous error produced by a child with SLI, MM, whose language development was documented from age 3 through age 7. Twelve spontaneous language samples were analyzed. Across nine language samples MM produced the phonetic sequence /ɤɛɾ/ in ungrammatical contexts as if it were the nominative third person plural pronoun, for example, with a past tense form (e.g. /*ɤɛɾ/ ate dinner). The phonetic sequence /ɤɛɾ/ may have been either their, a case error, or they’re, inclusion of a form of BE in an unexpected context. In this paper, we examine describe the distribution of /ɤɛɾ/ and the development of pronominal forms and the verb BE, in order to account for the anomalous error.


Early phonological awareness intervention may promote early reading acquisition for children. In this study, supplemental classroom-based phonological awareness instruction was provided in 15 kindergarten classrooms across the state of West Virginia. In addition, 95 children in first grade (in the Fall) and 95 children in kindergarten (in the Spring) who were identified as the lowest achievers in their classrooms received small group phonological awareness intervention for 12 weeks. Pre and post test results
suggested that the children who received the additional phonological awareness instruction or intervention outperformed comparison children, who received only the adopted reading curricula, on several literacy measures. Group differences were most evident on measures of developmental spelling. In addition, more children in the classrooms with the supplemental instruction surpassed the Spring Benchmark on the *Phonological Awareness Literacy Screening-Kindergarten* as compared to children who participated only in the adopted classroom curricula, 75% as compared to 55%.


There is a danger of interpreting ethnic verb use in aphasic patients as a result of pathology rather than a normal dialectical difference. We examined the verb use of African Americans with and without aphasia on a variety of discourse tasks. While African Americans without aphasia provided discourse superior to that of African Americans without aphasia, culturally different use of verb patterns were present and different in both groups. These results suggest caution in appraising the speech of African Americans with aphasia.


Previous research suggests that performance on language impairment measures and discourse tasks is not significantly related. We examined the relationship between the Western Aphasia Battery AQ and discourse performance in 12 African Americans with moderate aphasia. Also, the presence of ethnic dialect and discourse features in the discourse responses was determined. The results indicate few significant correlations between the WAB AQ and performance on a variety of discourse tasks, and the presence of ethnic dialect and discourse features appears to be influenced by the type of discourse task. Implications for including and selecting discourse measures in aphasia assessment are discussed.


We compared performance on language impairment, functional communication, and discourse measures between 33 African-American aphasic patients and 30 African-American normal subjects. The aphasic group performed significantly lower than the normal group on the Western Aphasia Battery Aphasia and Cortical Quotients, Token Test, and ASHA Functional Assessment of Communication Skills for Adults. Moreover, the aphasic group performed significantly lower than the normal group in their quality of language on a discourse task that required telling a frightening experience. Significant relationships between performance on the measures were confined to those that index, language impairment. Use of a normal ethnic cohort for comparison with African-American aphasic performance may control for potential ethnic bias in the measures. In addition, use of a discourse task permits observation of grammatical and stylistic features in African-American English that may not be captured or are ignored by traditional language impairment and functional communication measures.

The purpose of this study was to access the ability of African Americans with and without aphasia to interpret fables and proverbs using stimuli familiar to their culture. All participants completed a battery of cognitive and linguistic measures to determine the predictive value of these measures for performance on the fable and proverb interpretation tasks. Aphasic participants produced less generalized responses than nonaphasic participants and performed significantly lower on the proverb interpretation tasks. Discourse performance in the aphasic group was significantly correlated with performance on the Western Aphasia Battery.


This investigation examined the potential for cultural bias in selected tests for aphasia and developed culture-free discourse measures for appraising aphasia. Four groups participated in the study: African American normals, Caucasian normals, African American aphasic patients, and Caucasian aphasic patients. The results indicated that both normal groups performed significantly better than both aphasic groups on all aphasia tests and discourse measures. The Caucasian normal group performed significantly better than the African American normal group on the Western Aphasia Battery Construction subtest, the Coloured Progressive Matrices, and the Token Test. The Caucasian aphasic group performed significantly better than the African American aphasic group on the Western Aphasia Battery Information, Fluency, and Construction subtests and the Coloured Progressive Matrices. There were no significant differences between the two normal groups or between the two aphasic groups on any discourse measure.


This investigation compared performance among African Americans and Caucasians with and without aphasia on selected aphasia tests and discourse measures. Groups did not differ significantly on discourse measures. However, significant group differences on some aphasia tests suggest potential for cultural bias.


The purpose of this study was to examine the influence of utterance length and complexity relative to the children's mean length of utterance (MLU) on stuttering-like disfluencies (SLDs) for children who stutter (CWS) and nonstuttering-like disfluencies (nonSLDs) for children who do not stutter (CWNS). Participants were twelve 3;1 to 5;11 (years; months) children: 6 CWS and 6 age-matched (+/-5 months) CWNS, with equal numbers in each talker group (CWS & CWNS) exhibiting MLU from the lower to the upper end of normal limits. Data were based on audio-video recordings of each child in two separate settings (i.e., home and laboratory) during loosely structured, 30-minute parent-child conversational interactions and analyzed in terms of each participant’s utterance length, MLU, frequency and type of speech disfluency. Results indicate that utterances above children’s MLU are more apt to be stuttered or disfluent and that both stuttering-like as well as nonstuttering-like disfluencies are most apt to occur on utterances that are both long and complex. Findings were taken to support the hypothesis that the relative
"match" or "mismatch" between linguistic components of an utterance (e.g., utterance length and complexity) and a child’s language proficiency (i.e., MLU) influences the frequency of the child’s stuttering/speech disfluency.


Phonological priming in picture-naming of five 3-year-old and five 5-year-old children who do not stutter was used to assess holistic versus incremental processing. Findings indicated that children begin to process lexical representations holistically and then, with development, process such representations more incrementally.
Perceptual normalization is a listener’s ability to reduce the amount of information, noise, and variability that is inherent of the spectra that distinguishes the phonetic segments produced by men, women, and children [Klatt, J. Phonetics. 7, 279-312 (1979); Ryalls and Pisoni, Dev. Psych. 33, 441-452 (1997)]. The current investigation was designed to investigate the effects of speaker age and gender on the perceptual normalization abilities (in terms of identification accuracy) of children and adults. Two children (4 years of age), two adult females, and two adult males will serve as the speakers for the recording of the stimulus material. A total of 30 subjects will serve as listeners in the perceptual experiments. Listeners will be divided into three groups. Ten young children (ages 4:0 to 4:6), ten older children (ages 9:0-9:6), and ten adults. Word lists from the Word Intelligibility by Picture Identification (WIPI) test will serve as the stimuli for the experiment. Each subject will participate in two main types of speaker conditions. The single speaker conditions include: 1) Child Only, 2) Adult Female Only, and 3) Adult Male Only. The mixed speaker conditions include: 1). Child speakers, 2) Adult Female Speakers, 3) Adult Male Speakers, 4) Adult Male and Child speakers 5) Adult Female and Child Speakers, 6) Adult Male and Female speakers, and 7) Adult Male, Female, and Child speakers. Percent correct word identification will be calculated for each test condition. Predicted results are that children will perform with less accuracy than adults; however, their scores should show an increase in performance in the following multiple speaker conditions: female speakers, child speakers; female and child speakers.

There is a paucity of research examining preschool children’s production of complex syntax. This study evaluated the production of subordinate conjunctions in a group of typically developing children between the ages of 3;0 and 5;9. Language samples were elicited and analyzed specific to the production of subordinate conjunctions. Developmental change was examined with respect to variety of subordinate conjunctions, the use of subordinate conjunctions to join clauses, and the nature of errors in production. Because and when were the most frequently used conjunctions at all ages and MLU levels, followed by if and so (that). Ten children made at least one error in their production. Errors included using the wrong subordinate conjunction and extraneous use of conjunction, that is, with no meaning. In addition, some children omitted a subordinate conjunction where one was expected. Subordinate conjunctions were first produced with a single clauses (e.g., because I need new shoes), contingent on a conversational partner’s question (e.g., Why are you going to the store?) or statement (e.g., We’ll go to the store). Only when MLU surpassed 5.0 were subordinate conjunctions used consistently to join two clauses within one utterance.

The purpose of this study was to assess coarticulation in 3-, 4-, and 5-year-old children who do (CWS) and do not stutter (CWNS). Fourteen CWS and fourteen age- and gender-matched CWNS in three age groups (3-, 4, and 5-year-olds) participated in a picture-naming task, which elicited single-word utterances. The initial CV
syllables of these utterances, comprised of either bilabial [b m] or alveolar [d n s z] consonants and a variety of vowels [æ e i ə l oʊ u ɛi] were used for acoustic analysis. Using a locus equation metric to assess coarticulation, the second formant (F2) onset frequency, F2 vowel target frequency, and F2 transition rate were computed for each CV syllable and for each subject. Based on these measures, locus equation statistics of slope, y-intercept, and standard error of estimate, as well as the F2 transition rate were analyzed. Findings for locus equation slopes (see Fig. 17), y-intercepts, and F2 transition rates revealed a significant main effect for place of articulation, and that the difference in F2 transition rate between the two places of articulation was significantly larger for CWNS compared to CWS. In summary, coarticulation did not differ appreciably between CWS and CWNS, or among the three age groups under investigation, although transition rate varied significantly between CWNS and CWS. Findings suggest that the organization of rate of speech production for place of articulation may not be as contrastive or refined in CWS as compared to CWNS, a subtle difficulty in the planning for speech-language production which may play a role in the disruption of their speech fluency.
Figure 17. Locus equation slope as a function of speaker age and group (CWS= children who stutter; CWNS= children who do not stutter), and place of articulation. Chang et al. (2002).
The coarticulation patterns of voiced stop consonant-vowel (CV) productions for ten children, ages 17-21 months, were analyzed using the locus equation metric. Voiced stops in the context of high front, mid/low front, high back, mid/low back, and central vowels were analyzed. A spectral analysis was performed for each CV syllable, which provided the second formant measurements of vowel onset and vowel target used to obtain locus equations. The locus equations, which are regression lines, use slope as a measure of coarticulation and standard error of estimate as a measure of variability. Thirty regression equations on the F2 onset and F2 vowel frequencies were obtained for each participant’s productions of voiced stop consonants, [b d g]. A repeated measures ANOVA was used to determine the significance of coarticulation for stop place of articulation. The results revealed a significant main effect for place of articulation \[F(2,32)=20.15; p<0.001\]. Post hoc Tukey tests revealed that [g] was significantly different from both [d] and [b] and that [d] and [b] were not significantly different from each other. Five coarticulation trends were indicated: 1) Young children’s coarticulation patterns of early CV productions, while different from adults, should not be broadly characterized as having more or less coarticulation than adults. 2) Coarticulation patterns of [g]>[b]>[d] found in children under two years of age, are different from the adult pattern of [b]>[g]>[d]. 3) As illustrated in Fig. 18 for [g] productions, velars are produced with consistently high coarticulation, whereas bilabials and alveolars vacillate between low and moderate degrees of coarticulation. 4) Bilabial and alveolar coarticulation patterns overlap in children under two years of age. 5) Complementary distribution of velars may be emerging, but is not firmly established in the early CV productions of 17-21 month old children.

Figure 18. Group mean locus equation of [g] for ten children. Gibson & Ohde.
Coarticulation and coarticulation variability of voiced stop consonants [b], [d], and [g] were analyzed during spontaneous and imitated concurrent babble and words for ten children ages, 17-21 months using the locus equation metric. Voiced stops in the context of high front, mid/low front, high back, mid/low back, and central vowels were analyzed. These CV syllables were divided into two groups: words and babble based on Vihman and McCune (1992) [J. Child Lang. 21, 517-542] criteria. A spectral analysis was performed for each CV syllable, which provided the second formant measurements of vowel onset and vowel target. Fifty-eight statistical regressions were performed on the second formant measurements for each participant’s productions of voiced stop consonants, [b d g], across two groups, (babble and words). Two regressions were omitted due to insufficient data points. The locus equations, which are regression lines, use slope as a measure of coarticulation and standard error of estimate as a measure of variability. A repeated measures ANOVA was used to determine the significance of coarticulation and variability. As illustrated in Fig. 19 for [g] productions, findings indicated that coarticulation and variability were similar for concurrent babble and words across place of articulation, which supported the continuity theory that early words and babble are related. In contrast, similarities of coarticulation variability during concurrent babble and words questions the interpretation that higher coarticulation variability of words compared to babble relates to the child’s purposeful motor movements of words. The evaluation of concurrent babble and words demonstrated the significant role of speech motor constraints in early speech productions. [Work supported by NIH grant DC4034.]
Figure 19. Group mean locus equation of [g] babble (upper panel) and [g] words (lower panel). Gibson & Ohde.

The purpose of this study is to assess the occurrence of stuttering on function and content words in relationship to utterance complexity in 3- to 5-year-old children who stutter. Participants will be 60 3-, 4-, and 5-year-olds, with 20 participants in each age group. With the exception of stuttering, all participants will have speech, language, and hearing development within normal limits. Dependent variables (e.g., percent stuttering on function words in simple vs. complex utterances) will be based on transcription of 15-20 minute samples collected in identical lab settings for all participants during a loosely-structured parent-child interaction. Results are expected to indicate that the relationship between stuttering and word type (i.e., function vs. content words in simple versus complex utterances) will differ between simple and complex words, with older children who stutter less apt to stutter on function words in complex utterances due to greater mastery of complex sentence structure. Findings should help determine whether word type influences stuttering in young children relatively independently of other salient aspects of childhood language development and further our understanding of the role that speech-language encoding plays in the onset and development of childhood stuttering.


We used a modified narrow transcription procedure to examine a speech sample produced by ten speakers with coexisting aphasia and apraxia of speech. The transcription protocol was limited to eight diacritic marks selected based on previous perceptual descriptions of phonetic distortion among apraxic speakers. One additional general distortion category that was not further specified was also used. The results showed that distortion errors were as common as substitution errors, that vowel and consonant segments were equally vulnerable to misproduction, and that there was no difference between the frequency of consonants produced incorrectly in prevocalic and postvocalic syllable position. Among distortion errors, the most common type was prolongation followed by partial voicing and devoicing. Forty-one percent of perceived distortions were classified as general distortions. An independent transcription that used a comprehensive system of diacritic marks was performed as a follow-up. The results are discussed relative to single word intelligibility testing and the challenges associated with transcribing disordered speech.


We examined acoustic and perceptual features of vowel quality in aphasia and apraxia of speech. Twenty aphasic speakers with and without apraxia of speech and ten normal speakers produced the words “hid” and “head” approximately 24 times. Each production was transcribed with broad phonetic transcription, and the first and second formant frequencies were measured at the midpoint of the vowel steady state. According to the phonetic transcription, some aphasic and apraxic speakers displayed a large number of vowel substitutions, whereas others were indistinguishable from normal speakers. Perceived substitutions were generally close to the target and affected almost exclusively vowel height rather than vowel frontness. Acoustically, several speakers in both aphasic groups displayed a formant pattern that deviated from normal. The nature of the deviation pattern varied across individual aphasic and apraxic speakers. For some, formant frequencies were abnormally variable, whereas others displayed a pattern of only occasional deviations, and yet others demonstrated a collapsing of phonetic categories. The results are consistent with previous reports that articulatory positioning for vowels is impaired in many aphasic and apraxic speakers. The existence of
individual articulatory patterns is emphasized, and the limitations of a static approach to formant analysis are noted.


The purpose of the current study was to examine the developmental role that context, and static and dynamic cues have in speech perception. Ten adults and eleven four- to five-year-old children identified a syllable as [ba] or [wa] in three conditions differing in synthetic continua. In the first condition, the first and second formant duration of stimuli varied from those appropriate for [b] to those appropriate for [w]. For the second condition, a burst was added to the make the stimuli more similar to natural speech. For the third condition, the formant transitions of stimuli varied as appropriate for [b] and [w]. In each condition, three syllable durations of 105 ms, 170 ms, and 315 ms were tested. The first condition tested the potential existence of the syllable duration effect in young children, whereas the second and third conditions examined the developmental role of static and dynamic cues, respectively, as related to context effects. The results indicated that context effects were present across all conditions for both adults and children. However, as illustrated in Fig. 20, the adults and children did differ in the third condition in which the acoustic parameters were made closer to normal speech by altering both the transition frequency and the transition duration. Thus, children utilized the dynamic formant transitions differently than adults when transition frequency was varied along with transition duration. These findings support a developmental cue weighting shift model that indicates young children between 3 to 7 years pay particular attention to changes in dynamic cues such as formant transitions.
Figure 20. Percent [b] responses of adults (top) and children (bottom) for condition 3 (transition frequency and transition rate change). Hicks & Ohde.

The purpose of this study was to determine whether children give more perceptual weight than do adults to dynamic spectral cues versus static cues, when identifying vowel sounds. Three experimental stimulus sets were presented, each with 30 ms stimuli. The first consisted of unchanging formant onset frequencies ranging in value from frequencies for [i] to those for [a], corresponding to a bilabial stop consonant. The second two consisted of either an [i] or [a] onset frequency with a 25 ms portion of a formant transition whose trajectory was toward one of a series of target frequencies ranging from those for [i] to those for [a]. Ten children between the ages of 3;8 and 4;1 and a control group of 10 adults identified each stimulus as [bi] or [ba]. The results showed developmental effects: the children relied more heavily than the adults did on the static formant onset frequency cue to identify the vowels, while the adults appeared to give more equal weight to both static and dynamic cues than the children did. For example, Fig. 21 illustrates that children hear fewer of the F2 [a] onset stimuli as [i] compared to adults. Thus, they appear to attend more to the [a] onset than do the adults. These findings contradict the Developmental Perceptual Weighting Shift theory and are discussed in relation to this theory and other current research on the development of vowel perception.

![Figure 21. Mean percent [i] responses of children and adults for the F2 [a]-onset condition. Malech & Ohde (2003).](image-url)

Children's processing strategies appear to favor dynamic cues such as formant transitions as compared to static cues such as F2 onsets and noise bursts. The purpose of this research was to examine children's perception of place of articulation based only on static cues. Ten children at each of five age levels (3, 4, 5, 6, and 7) and a control group of 10 adults identified synthesized stop consonants [d g] in two vowel contexts [i a]. The synthesis parameters included variations in F2 onsets and stop-consonant noise bursts. The F2 onsets were either "appropriate" or "neutral" for place of articulation. The noise bursts were short (10 ms), long (25 ms), or not present (0 ms). Preliminary data show that the F2 onset is not as salient in children's perception as in adults' perception. In addition, children more often than adults categorized neutral F2 onset stimuli as ambiguous indicating stronger category formation in the latter than former groups. The role of noise bursts was more salient in adult perception than child perception. However, as Fig. 22 illustrates, when static formant onsets were neutralized in the [a] context, all subject groups including 3-year-olds appropriately used burst cues in the perception of [g]. The findings will provide information on the role of "static" cues, on the perceptual integration of "static" noise and formant cues, and on the influence of sound category formation in perceptual development.
Figure 22. Correct percent [d] and [g] responses as a function of burst duration and listener age group. Ohde.

The purpose of this study was to determine the role of static, dynamic, and integrated cues for perception in three adult age groups, and to determine whether age has an effect on both consonant and vowel perception. Ten young adults (ages 25-30), eight middle aged adults (ages 52-59), and eight older adults (ages 70-76) listened to synthesized syllables composed of combinations of [b d g] and [i u a]. The synthesis parameters included manipulations of the following stimulus variables: formant transition (moving or straight), noise burst (present or absent), and voicing duration (10, 30, or 46 ms). For the [d] context, vowel perception was high across all conditions and there were no significant differences among age groups. As shown in Fig 23, consonant identification revealed a definite effect of age. Young and middle aged adults were significantly better than older adults at identifying consonants from secondary cues only. Older adults required the integration of static and dynamic cues for accurate identification. Duration was found to be an important, but not essential cue to perception in older listeners.

![Figure 23](image_url)

*Figure 23. Percent correct identification of [d] in stimuli with bursts and moving transitions (A), with bursts and straight transitions (B), with no bursts and moving transitions (C), and with no bursts and straight transitions (D) as a function of duration and listener age. Ohde & Abou-Khalil (2001).*

In perceiving vowels, adults appear to use both "dynamic" formant transition cues and "static" formant target cues. The importance of these cues in perception is based on vowels produced by adults. According to theory, "dynamic" formant transition cues may be salient in adults' perception of vowels. However, the perceptual role of "dynamic" and "static" cues is unclear for vowel-like sounds (vocants) produced by vocal tracts much different from the adult vocal tract. For example, the early vocant productions by infants tend to emphasize "static" cues rather than "dynamic cues". Thus, it is unclear which cues are used by adults in the perception of infant vocants. If adults weight "dynamic" cues more than "static" cues, then poor identification of vocants would be predicted in the early infant productions. The purpose of this study is to examine adults' perceptual weighting of "dynamic" and "static" cues in the perception of infant vocants. In addition, the study will examine if an adult's ability to utilize "dynamic" versus "static" cues changes as a function of child age. The productions of three infants were recorded over a period of time from 9 months of age to 14 months of age. Vowels of the three infants judged by a panel of listeners to be of appropriate quality were edited into the following stimulus conditions: 1) full CV stimulus, 2) vocant target, 3) vocant transition, and 4) vocant target equivalent in duration to vocant transition. Ten adults will phonetically transcribe the vocant stimulus conditions of the three infants. The results will be examined relative to cue weighting of vocants in the emerging vocal tract, and the salience of "dynamic" and "static" properties in the theoretical description of vowel-like perception.


The vocalizations of five prematurely born (preterm) infants and five matched normal control full-term infants were examined longitudinally (range: 5 to 16 months) for an overall index of sound complexity (Mean Babbling Level- MBL), and for specific vocant, closant, and syllable-like structures. The control infants were matched to the preterm infants according to gender and "corrected age," which was defined as the chronological age of the experimental subject minus the number of weeks preterm. The age of the infants at the first session was 5, 6, 6, 6, and 8 months for groups A, B, C, D, and E, respectively. The intrasubject transcription reliability was high, and ranged from 77% to 100% and 81% to 100% for preterm and control infants, respectively. As illustrated in Fig. 24, the results show that the MBL generally increased over time for both preterm and control infants, but the change was not linear for either group. In addition, across subjects A, B, C, and D, little change in MBL occurred during the first 2 to 4 sessions. Thus, for the majority of these infants, the complexity of babbling begins to increase between seven and ten months. The most striking difference in the phonetic inventories of these subjects is the relatively high incidence of quantal vowel, [i u], productions for preterm compared to control infants. Another major finding for these inventories relates to the continuity of vocant production. Those vocants occurring in the initial sampling session continued to be produced in the final session. Moreover, the frequency of these productions increased from the initial to final session. These findings indicate that not only closants, but also vocants are continuous from early to later sound productions.
Figure 24. Mean babbling level across one-month sessions for preterm and full-term normal infant controls. Ohde, Camarata, & Disser.


In order to determine the effects of phonetic training on the identification of naturally produced glide variants, 12 speech pathology students identified normal and articulatory disordered children's /w/ and /r/ productions before and after a course in narrow transcription. In addition, 12 students with no training in phonetics identified the same productions twice with the time interval between sessions comparable to that for the speech pathologists. One type of articulation disorder is a sound distortion, which has been
defined as an allophonic variation within the perceptual boundary of a target phoneme. The speech sample consisted of productions from a normal child and five articulatory disordered children characterized as producing either /w/ for /r/ or distorted [r\textsuperscript{T}]. The findings in Fig. 25 for Child Speaker 2 reflect the trend that standard phonetic training improved distorted [r\textsuperscript{T}] identification in some vowel contexts. The results of a second experiment with subjects who received no training support the view that inherent phonetic ability is a critical factor in the identification of sound variants.

![Graph showing average distorted [r\textsuperscript{T}] identification of Child Speaker 2 before and after phonetic training. Ohde & Eisen.](image)

**Figure 25.** Average distorted [r\textsuperscript{T}] identification of Child Speaker 2 before and after phonetic training. Ohde & Eisen.


Locus equations were investigated as a metric to reflect developmental changes across a broad age range for CV syllable productions. Sixty-four subjects in eight age groups (3-, 4-, 5-, 6-, 7-, 9-, 11-year-olds and adults) produced five repetitions of isolated CV syllables in random order comprised of [b d g] and the vowels [æ i u]. The second formant (F2) onset frequency and F2 vowel target frequency were measured for each CV syllable, and the relationships as locus equations were plotted for each stop consonant place of articulation. Locus equation statistics of slope, y-intercept, standard error of the estimate (SE), and R\textsuperscript{2} were analyzed. Adult slopes were significantly different than most child group slopes (Fig. 26 illustrates the locus equations for the [g] place of articulation). Slopes for place of articulation were significantly different with the exception of [d] and [g]-palatal. Analysis of y-intercepts revealed a significant main effect for place of articulation and a significant place X age interaction. Analysis of standard error of estimate and R\textsuperscript{2} showed significant main effects for age and place of articulation. In summary, the SE results indicated that children 5-years and younger were more variable in production than older children and adults. The findings for slope generally indicated a greater degree of coarticulation in children than adults.
Figure 26. Group mean locus equations for the [g] place of articulation. Slope, Y-intercept, and R-squared values are indicated for each regression scatterplot. Ohde & Geitz.


Researchers investigating prelinguistic speech have suggested that qualitative differences in consonant-vowel (CV) productions may be predictive of later speech production skills [Stoel-Gammon, First]
Qualitative differences in CV productions have been indicated in the babbling of preterm infants when compared to full term infants [Oller et al., *Journal of Child Language* 21, 33-58, (1994)]. The purpose of the current study was to investigate longitudinally the developmental trends in babbling for preterm and full term infants using locus equations to quantify the acoustic parameters. Locus equations use the F2 transition to obtain regression lines that represent relational invariant acoustic patterns for phonemic categories. The slopes and y-intercepts describe the degree of coarticulation and relational differences for place of articulation. Stop consonant-vowel productions of five full term and five preterm infants were analyzed from 8 to 17 months. The results revealed that slopes for place of articulation were significantly different, with the exception of [b] and [d]. Although preterm and full term group differences were not significant, Fig. 27 illustrates that full term infants tend to be more similar to adult coarticulation patterns than the preterm infants. Descriptive comparisons of the two groups indicated that full term infants produced more stop CV productions than preterm infants; preterm infants varied less in their coarticulation of CV syllables than full term infants; and that both groups' slope values indicate that place of articulation was less contrastive than that observed in adult or older children's slopes. In conclusion, the results of this study support the use of the locus equation metric to describe early CV productions.

![Locus Equations](image)

**Figure 27.** Group mean locus equations for the full term infants (upper panels) and preterm infants (lower panels). Place of articulation is [b] (left panels), [d] (middle panels), and [g] (right panels). Slopes, Y-intercepts, and R² values are indicated for each regression scatterplot. Ohde & Gibson.
One type of articulation disorder is a sound distortion which has been defined as an allophonic variation within the perceptual boundary of a target phoneme. An established finding in speech perception is that sounds are more accurately identified across sound categories than within sound categories. In order to determine if distorted \([r^\text{H}]\) could be accurately and reliably perceived, six highly trained speech pathologists identified the productions of prevocalic /r/ and /w/ words of 12 children diagnosed as having an /r/ misarticulation. The results of the identification tests revealed a relatively high average distorted \([r^\text{H}]\) category of 70% or better for four children. Moreover, intrasubject reliability scores for these distorted-\([r^\text{H}]\) children averaged 80% or better. As illustrated in Fig. 28, the findings of spectrographic analyses of formant transition onsets show that F3 onsets of distorted \([r^\text{H}]\) are substantially higher than F3 onsets of /r/ for normal and synthetic versions of children's speech.

*Ohde dedicates this work to Michael McCarver and Donald Sharf who have both died since the inception of this work.

![Figure 28. F2 and F3 onsets for naturally produced and synthetic glide sounds in the [e] vowel context. The open circles represent natural productions of [w] and distorted \([r^\text{H}]\) by misarticulating children. The Xs represent natural [w] and [r] productions by a child with normal articulation. The small filled circles represent synthetic glides modeled after a child vocal tract. Synthetic stimuli above the leftmost dash line were highly identified as [w]; synthetic stimuli below the rightmost dash line were highly identified as [r]; and synthetic stimuli between the solid lines were highly identified as \([r^\text{H}]\) in a previous study (Sharf and Ohde, 1983). Ohde, McCarver, & Sharf.*

This research extends previous developmental studies on the perception of the [m]-[n] distinction in consonant-vowel (CV) syllables [Ohde (1994). *J. Acoust. Soc. Am.* 96, 675-686; Ohde, R.N., and Haley, K. (1992). *J. Acoust. Soc. Am.* 92 No. 4 (Pt. 2), (2463) A]. With only one exception, three talkers for each age level of 3, 5, 7, adult female (FAD) and adult male (MAD) produced CV and vowel-consonant (VC) syllables consisting of either /m/ or /n/ in the context of four vowels /i æ u a/. Two productions of each syllable were modified using waveform editing techniques so that the distribution of place of articulation cues for consonant perception could be determined. Ten adults identified the place of articulation of the nasal from several murmur and vowel transition segments. The findings shown in Fig. 29 indicate that the salience of the place of articulation feature from spectral discontinuity cues (MT stimulus) is substantially weaker in VC syllables than CV syllables for all speaker age groups except adult males (MAD). Moreover, strong developmental trends were not observed for these VC syllable productions. For example, the findings for the vowel transition stimuli illustrated in Fig. 30 reveal that only the adult male speakers were consistently different from the child speakers. In summary, it could be speculated that since regions of spectral discontinuity are particularly salient in CV syllables, these high content and perceptually stabilizing properties may in part be the basis of the early CV acquisition in children, and the universality of this syllable shape across languages.

![Figure 29](image_url)  
*Figure 29. Mean percent correct identification of nasal consonants from the 25-ms transition (25T), 25-ms murmur + 25-ms transition (MT), and 25-ms murmur (25M) stimuli collapsed across adult and child speakers and VC and CV syllables. Ohde, Haley, & Barnes.*
Figure 30. Mean percent correct identification of nasal consonants from the full transition and vowel (TV), 50-ms transition (50T), and 25-ms (25T) transition stimuli collapsed across speaker age (FAD: female adults; MAD: male adults). Ohde, Haley, & Barnes.


The vowel transitions and nasal murmurs of nasal consonant + vowel (CV) syllables were acoustically analyzed in order to identify developmental changes in coarticulatory and segmental properties of speech. Thirty-two subjects in four age groups (3-, 5-, 7-year-olds and adults) produced five repetitions of CV syllables comprised of the nasal consonants [m n] and the vowels [i æ u a]. The onset and target frequencies of the second formant (F2) of the vowel were measured for each CV syllable, and the resulting data points were plotted as locus equation regression lines to assess coarticulated properties. The second resonance peak (N2) of the nasal murmur was analyzed to assess segmental properties. The results revealed that coarticulation and variability in production decreased throughout development. As shown in Fig. 31, the N2 segmental property differentiated between [m] and [n] in children but not in adults. A measure of transition rate did not reveal extensive developmental change, but distinguished between place of articulation from a young age. These findings for nasal+vowel syllables show that both coarticulatory and segmental properties are different between children and adults. For children, there is minimum and maximum production distinction in coarticulatory and segmental properties, respectively, for place of articulation of nasals.

Recent findings [Ohde and Perry, *J. Acoust. Soc. Am.*, 96, 1303-1313 (1994); Ohde and Ochs, *J. Acoust. Soc. Am.*, 100, 2486-2499 (1996)] indicate that a peripheral mechanism may be involved in processing spectral discontinuities from the nasal murmur to vowel onset. The purpose of the current study was to assess the level of perceptual integration of nasal consonants. The speech sample was comprised of CV syllables produced by a 3-year-old child and an adult female and male, and consisted of either [m] or [n] in the context of four vowels [i æ u a]. Thirteen adults identified the place of articulation of the nasal before and after the insertion of periods of silence ranging from 0 to 1000 ms between murmur and vowel transition segments of varying duration. In the experimental conditions, the murmur and the vowel were split and presented to different ears. The major findings, as illustrated in Fig. 32, were as follows: 1. Perceptual integration was significantly greater for the murmur + transition presented monaurally with a 0 ms gap duration than the comparable split channel condition; and 2. Across the split channel conditions, identification of place of articulation of the nasal was near chance level (50%). The results support the conclusion that a major component of the observed perceptual integration effect is based on a peripheral mechanism.
Figure 32. Mean identification of nasal place of articulation for the adult male speaker as a function of stimulus presentation condition (Monaural: both stimuli to one ear; Split 0 ms: stimuli to different ears with 0 ms delay; Split 150 ms: stimuli to different ears with a 150 ms delay; Split 1000 ms: stimuli to different ears with a 1000 ms delay), and short duration stimuli (1M2T: one murmur + two transition periods; 2M1T: two murmur + one transition period; 2M2T: two murmur + two transition periods; 25M+25T: 25 ms murmur + 25 ms transition).


An important component of gender identity is having a voice that is perceived by others as distinctly female or male. The purpose of this study is to provide developmental data on the acoustic and perceptual properties that differ between boys and girls, across an age that spans the transition to adolescence. Ten boys and 10 girls in each of the mean age groups of 4-, 8-, 12-, and 16-years produced five productions of seven vowels, [i I E æ u U a], in the phrase "say h_d again". The first three formant frequencies (F1, F2, F3) were derived from all five productions of each vowel from a combination of spectrographic, linear predictive coding (LPC), and fast fourier transform (FFT) measurements. In addition, fundamental frequency ($f_0$) was determined for each vowel production. In order to determine the importance of these acoustic properties in the perceptual differentiation of gender, 10 adult males and 10 adult females will perceptually rate the gender of the vowels extracted from "h_d" on a six-point scale. Preliminary results reveal that $f_0$ differentiates gender after age 12. On the other hand, formant frequencies show reliable differences as a function of gender by age 4. As illustrated in Fig. 33, average formant frequencies were consistently lower for males than females. These differences were reliable for F1 and F2, and the strength of the effect was greater for the latter than former resonant. The emergence of gender differences revealed an interaction between formant and vowel, with low vowels more reliable for F1 and high vowels more significant for F2.

Poor spoken language skills are often implicated as a factor in the academic underachievement of children from lower socioeconomic families. This paper reviewed the research on the relationship of socioeconomic status and language achievement. Implications for speech-language pathologists were considered.
As a follow up to Schuele and Nicholls (2000) and Schuele and Tolbert (2001), this study explored the production of obligatory relative markers in children with specific language impairment (SLI), ages 5 through 7, as compared to normal language children, ages 3 through 5, matched for mean length of utterance. Production of obligatory subject relative markers was examined in spontaneous language samples and in elicited subject relative clauses. Children with SLI frequently omitted obligatory subject relative markers in spontaneous language as well as in elicited relative clauses. In contrast, only one typical language child omitted relative markers in the elicited task, but several children omitted the markers in spontaneous language. The rate of omissions was far higher in SLI children as compared to language normal children. The omissions in language normal children appeared indicative of performance errors, whereas the omissions in the SLI children indicated underlying linguistic vulnerability.

Although the morphological difficulties of children with specific language impairment (SLI) have been documented extensively, performance on complex syntax production has been explored to a far lesser degree. Leonard’s (1995) functional categories account of SLI suggests that syntactic structures involving the embedding of complementizer phrases may be problematic for SLI children. In a follow up to Schuele (1995) and Schuele and Nicholls (2000), this study explored the inclusion of obligatory relative markers in subject relative clauses by children with SLI (5 to 7 years) as compared to children with typical language (3 to 5 years). Children with SLI omitted the obligatory relativizer that or WH relative pronoun in 63% of the attempted subject relative clauses. In contrast, TL children always included the obligatory relative marker. Thus, children with SLI demonstrated particular difficulty in the production of subject relative clauses, complex syntactic structures that require an overt element in an embedded complementizer phrase.

This pilot study explored the production of a variety of complex syntax structures in 5 children with specific language impairment (SLI) as compared to 5 typical language children, match for mean length of utterance. Spontaneous language samples typically 200 utterances in length were analyzed for production of 13 types of complex syntax, including subordinate clauses and embedded clauses. The distribution of complex syntax types was similar across the two groups of children. However, the grammatical accuracy of the structures was quite different in the two groups. The language normal children used complex syntax forms with relative ease, in that the forms were grammatically intact. In contrast, the SLI children’s attempts at complex syntax more frequently yielded grammatical errors including omissions of infinitival TO, omissions of obligatory subject relative markers, and omissions of WH words in WH complement clauses. The findings suggest that the acquisition of complex syntax may be more problematic for SLI children as compared to language normal children.
Miscellaneous: Neuroscience, Perception, Psychophysics


Sensory perception can be severely degraded after peripheral injuries that disrupt the functional organization of the sensory maps in somatosensory cortex, even after nerve regeneration has occurred. Rehabilitation involving sensory retraining can improve perceptual function, presumably through plasticity mechanisms in the somatosensory processing network. However, virtually nothing is known about the effects of rehabilitation strategies on brain organization, or where the effects are mediated. In this study, Five macaque monkeys received months of enriched sensory experience after median nerve cut and repair early in life. Subsequently, the sensory representation of the hand in primary somatosensory cortex was mapped using multunit microelectrodes. Additionally, the primary somatosensory relay in the thalamus, the ventroposterior nucleus, was studied to determine whether the effects of the enrichment were initiated subcortically or cortically. Age-matched controls included six monkeys with no sensory manipulation after median nerve cut and regeneration, and one monkey that had restricted sensory experience after the injury. The most substantial effect of the sensory environment was on receptive field sizes in cortical area 3b. Significantly greater proportions of cortical receptive fields in the enriched monkeys were small and well localized compared to the controls, which showed higher proportions of abnormally large or disorganized fields. The refinements in receptive field size and extent in somatosensory cortex likely provide better resolution in the sensory map and may explain the improved functional outcomes after rehabilitation in humans.


Affective prosody (AP), commonly associated with right-hemisphere processing, is not well understood. The major obstacle to better understanding of disordered AP is the lack of understanding of normal processing of AP. Perceptual tasks rated by trained judges were employed to determine how well a group of normal adults was able to produce different emotions accurately.


This study investigated the sensitivity and specificity of clinical/bedside measures for detecting the presence or absence of aspiration in adults who had suffered an acute stroke. Each participant received a clinical/bedside evaluation and a videofluoroscopic swallowing study. The presence or absence of aspiration on the clinical/bedside evaluation was compared with the presence or absence of aspiration on the videofluoroscopic swallow study, the gold standard for detecting aspiration. Only two clinical/bedside measures—spontaneous cough after swallowing and an overall estimate of the presence or absence of aspiration—were sufficiently sensitive and specific. Thus, a clinical/bedside evaluation is not an acceptable substitute for a videofluoroscopic evaluation of swallowing.

This study developed a risk profile for aspiration in acute stroke patients. Over a three-year period, 171 participants were recruited at two VA hospitals. Results indicate that likelihood ratios for clinical/bedside signs can be used to estimate an individual’s overall risk of post-stroke aspiration.


The purpose of this study was to examine clinicians’ inter- and intrajudge reliability on videofluoroscopic (VFS) examination procedures and measures commonly used in the assessment of swallowing function. None of the judges were pre-trained to criterion performance. The material for the reliability studies was provided by 20 patients who had suffered a stroke and who received a VFS swallowing evaluation. The results suggest two tentative assumptions regarding reliability for VFS examinations. First, intrajudge reliability on measures of penetration/aspiration, lingual function, oral residue, vallecular residue, pyriform sinus residue, and hypopharyngeal residue appears acceptable. Thus, an experienced clinician may employ consistent standards for rating these VFS measures across patients and time. Second, interjudge reliability for most measures, with the exception of a binary rating of aspiration, appears to vary among clinicians and is unacceptable.


Visual perceptual skills of deaf and normal hearing adults were measured using the Eriksen Flanker Task. Subjects were seated in front of a computer screen while a series of target letters flanked by similar or dissimilar letters were flashed in front of them. Subjects were instructed to press one button when they saw an H, and another button when they saw an N. Targets H and N were flashed with flanking letters that were either H or N, creating response-compatible and response-incompatible arrays. Flankers were presented at different distances from the targets and reaction times were measured. In the present study, reaction times were significantly faster for the hearing group than the deaf group (Fig. 34). However, the hearing group had significantly more errors on this task than the deaf group, suggesting that the deaf subjects may have been more deliberate in their responses. In addition, the deaf group revealed a significantly greater interference effect than the hearing group at a parafoveal (i.e., 1.0°) eccentricity. These findings suggest that deaf individuals may allocate their visual resources over a wider range than those with normal hearing.

Previous studies have reported both positive and negative effects of deafness on visual attention. The purpose of this study was to replicate and expand findings of prior studies by examining visual attention abilities in children with deafness and children with normal hearing. Twenty-eight children, age 8-14 years, were evaluated. There were two groups of children with prelingual deafness and one normal hearing group. The children with deafness were divided further into 2 groups: those with cochlear implants and those with conventional hearing aids. Unlike previous studies, the current study found no substantial differences in performance among these three groups of children on a continuous performance visual attention task or on a letter cancellation task. Children in all three groups performed very well on the visual attention tasks. Furthermore, there was little association between performance on the visual attention tasks and parent or teacher ratings of behavior and attention. Age and non-verbal intelligence were significantly correlated with performance on visual attention tasks. The theoretical implications of these findings are discussed along with directions for future research.

This chapter summarizes research trends on auditory development in infants and children in the areas of absolute sensitivity, frequency resolution, temporal processing, intensity resolution, pitch, speech, and spatial perception. It also addresses methodological constraints in research with infants and young children.


This book chapter reflects on the professional training of audiologists, especially those audiologists working with children. To this end, the chapter offers an overview on professional training from a historical perspective beginning with our past educational efforts, reviewing the present day status of professional training, and then proffering some comments on training needs for the future. The chapter points out training gaps in several specific areas including evaluation, amplification, special populations, counseling, and early intervention. Perhaps most important is the need to provide a greater focus on early audiologic management and intervention within our training programs. Current legislation mandates education to begin attending to children at the infant and toddler age. One impact of this law is the need to train pediatric audiologists on the current issues, theories, and rehabilitation processes of hearing-, speech-, or language-impaired infants and toddlers.


Since the 1980’s, we have come to realize that children with unilateral hearing loss can be at risk for a number of complications including communicative deficits, social and emotional problems, and academic failure. This chapter offers an overview on children with unilateral sensorineural hearing loss. To this end, the chapter focuses on background information pertinent to unilateral hearing loss and includes such topics as binaural versus monaural listening, speech understanding in adverse listening conditions, and learning and educational issues. A review of the current status of this population and recommendations for identification and management is also provided.


The purpose of this paper is to review the past 10-20 years of research and theory regarding stuttering in relationship to present zeitgeist and future directions in stuttering research and theory. Discussion begins with the theoretical perspective of the 1970’s through early 1990’s that an understanding (ab)normal motor processes was central to an explanation of stuttering and then shifts, as does the zeitgeist of the past 10 years, from motor to linguistic accounts of stuttering. Paralleling this apparent sea change in theoretical accounts of stuttering, the paper covers six different lines of inquiry, in specific: brain imaging
studies, length and complexity of utterance, semantic/vocabulary abilities, reaction time, difficulties with sound to sound transitions, and temperament. Other developing lines of inquiry, for example, behavioral differences between children who exhibit recovered versus persistent stuttering, are mentioned. However, the paper focuses on the above mentioned six lines of inquiry that have resulted from several independent investigations and have involved, in some cases, the study of people who stutter across the life span. Opportunities for meaningful collaborations across lines of inquiry are strongly encouraged, for example, combining brain imaging studies with those of syntactic and semantic processes of combining the study of temperamental characteristics with studies of sound-to-sound transitions and genetics. Throughout, regardless of whether the work venue involves a laboratory or clinical setting, the need for theoretical motivation generating testable hypotheses is stressed.


The purpose of the third edition of this 444-page textbook is to present current approaches and thinking regarding the nature, assessment and treatment of stuttering. Based on the assumption that stuttering results from a complex interaction between the person’s environment and the skills and abilities the person brings to that environment, this text covers, both theoretically as well as practically, how these variables must be assessed, studied and treated. Placing special emphasis on the interaction between planning and execution of speech-language, the book provides detailed, broad-based coverage of assessment and treatment, devoting separate chapters to children, teenagers and adults who stutter. The ending chapter of the book summarizes the current state of the art, both theoretically and therapeutically, as well as presents future directions or areas of inquiry seemingly profitable for both clinicians and researchers to explore.


The purpose of this chapter is to describe the theoretical underpinnings for the investigators' study of linguistic processes and childhood stuttering. The authors' basic assumption is that the cause and/or initiation of instances of childhood stuttering is as much related to the process of planning as it is to the execution of speech and language. This assumption leads us to suggest that relatively slow, inefficient (when compared to normal) planning (formulation) of linguistic speech and language processes contribute to instances of childhood stuttering, especially those processes that must interface rapidly, smoothly, and accurately with one another to communicate the speaker's intent. The current writers are exploring these processes (e.g., speed of semantic encoding) by means of chronometric methods designed to provide online, dynamic insights into the syntactic, semantic, and phonological encoding of children who do and do not stutter. Findings, to date, suggest that children who stutter, when compared to children who do not stutter, exhibit differences that may contribute to their inability to rapidly and fluently plan as well as produce speech and language. Research supported by NIH grant (DC000523) to Vanderbilt University.

The purpose of this chapter is to discuss theoretical, research and treatment issues pertaining to the affective, behavioral and cognitive aspects of stuttering across the life span. Following stuttering along its long and winding road from the womb to the tomb, we will see that our knowledge of the disorder waxes and wanes much like stuttering itself. For some time periods during the life span, we encounter surfeits of knowledge, in others a dearth. Because of these “gaps” in either knowledge or understanding, we are not able to cover, at each age period across the life span, all affective, behavioral and cognitive issues of interest, even if we wanted to do so. Why is such a journey necessary? In essence, we thought that it would be of interest to explore how stuttering “behaves” or changes over time as people who stutter encounter the slings and arrows of outrageous fortune unique to them as well as all humans. By so doing, we thought, we might come to better understand what is and is not associated with, what does and does not contribute to and what should and should not be done to change stuttering.


This chapter reviews the theoretical basis of evidence-based practices and relates that background to a review and application of outcomes assessments in speech-language pathology.


This book chapter discussed models of teams within health care services, roles of various members of the team, and how to bring patients and families into leadership roles in teams.


In the sensory systems of the mammalian brain, one of the clearest organizing principles is the existence of topographic maps of the sensory receptors. In the neocortex, orderly representations of the receptor surface are characteristic of the primary sensory areas, and some secondary areas, as well. The location and spatial extent of a given map is correlated with distinctive patterns of interneuronal connections and architectonic features of the tissue. Together, these structural and functional properties contribute to the identification of individual areas, and ultimately to the assembly of areas that comprise a cortical region, such as primary sensory cortex. For many regions of the brain, however, the organizational picture is uncertain because substantive data are scarce. Thus, the identification of cortical fields devoted to sensory processing remains the subject of ongoing investigation, as it has for over a century. With respect to audition, the number of cortical areas identified or proposed varies substantially in number, ranging from 1, in some marsupials, to over 12 in the macaque monkey (1). Of these areas, only the primary auditory field, AI, is considered homologous across taxonomic groups. Additional homologies between other areas are likely, but corroborating data are lacking, at present. In this article the architectonic descriptions of human and nonhuman primate auditory cortex were compared. The results indicate that current models of the monkey auditory cortical system represent a reasonable approximation of the human, suggesting that a model of auditory cortical organization can be used to make accurate predictions about the nature of
auditory processing in human cortex, at least for the early stages of processing. The results also indicate that comparative studies will continue to be useful in bridging some of the gaps between animal and human research imposed by experimental and observational constraints.


The auditory system makes it possible to identify and localize sounds and their sources from a complex and dynamic acoustic environment. To accomplish these tasks the auditory system must encode the relevant cues and appropriately distribute that information amongst a myriad of auditory processing centers in the brain. These events are accomplished in multiple parallel pathways involving an extensive array of interconnected nuclei and fields in the brainstem, thalamus, and cerebral cortex. Both ascending and descending channels contribute to a dynamic exchange in which the response properties of neurons at every level of processing can be modified as needed. Among mammals, the organization of subcortical auditory nuclei and associated pathways is highly conserved. By comparison, the number and organization of auditory fields in cortex varies across taxonomic groups. In nonhuman primates, three major regions containing some twelve subdivisions occupy the superior temporal region where auditory inputs are processed in serial and parallel. Outputs target multiple auditory-related domains in temporal, prefrontal and posterior parietal cortex. From these many interactions information concerning the identity and location of acoustic objects is extracted and used to guide behavior.


This chapter summarizes the current research on phonological awareness, with particular attention to the phonological awareness and literacy deficits of children with speech production difficulties. The chapter describes appropriate assessment and intervention strategies for preschoolers and school-age children with concomitant speech difficulties and phonological awareness deficits.


Recently, a growing body of research and theory suggest that linguistic factors such as phonological, semantic and syntactic encoding play just as much a role in the development of stuttering in children as motoric variables. One prominent theory of stuttering that has received considerable attention is the Covert Repair Hypothesis (e.g., Kolk and Postma, 1997), which suggests that stuttering is a by-product of a slower-than-normal ability to phonologically encode. Although empirical studies have been performed to evaluate the process of phonological encoding, few have systematically assessed or manipulated pertinent variables such as speech reaction time of people who stutter in response to a picture-naming task. To date, those studies of these variables have typically involved adults who stutter, with only one focusing on young children who stutter (CWS). For the latter, preliminary results indicate that both CWS and children who do not stutter (CWNS) benefit from phonological priming. However, CWNS demonstrate a significant negative correlation between scores on a standardized test of articulation and speech reaction time while CWS show little to no relationship between these variables. Such findings suggest continued study of the speech-language planning and production abilities of CWS and seem
supportive of commonly made clinical suggestions to parents of CWS, for example, to minimize
interrupting and allowing more planning time for children’s speech-language production.

(Ed.) Strategies for selecting and verifying hearing aid fittings (2nd edition). New York: Thieme Medical
Publishers, Inc.

This chapter is designed for both the graduate student in Audiology, as well as the practicing clinician.
The chapter provides an initial overview of the impact of maximum output settings on patient use and
satisfaction with hearing aids. This leads to a detailed discussion of the process of selecting targets for
maximum output and various factors that may impact the desired target. Finally, both subjective and
objective methods for verifying a match to these targets, in both children and adults, are presented.


This chapter is intended to provide otolaryngologists and other hearing professionals an introductory
overview of current hearing aid and assistive listening device technology and their application. Hearing
aid and assistive listening device function, type, and electroacoustic evaluation are concisely described.
An introduction to hearing aid candidacy and orientation is also provided.

Strategies, measurement, and limitations," in M. Valente (Ed.), Strategies For Selecting And Verifying

This chapter provides a comprehensive overview of directional applications in current hearing aids.
Directional hearing aids and microphone arrays are advocated as useful methods for improving speech
recognition in noise. The use of directional, in lieu of omnidirectional amplification, is associated with
greater hearing aid satisfaction and perceived benefit in some situations. Directional amplification can
reduce the relative intensity level of sounds arriving from behind and from the sides of the hearing aid
wearer, effectively improving the signal-to-noise ratio (SNR) in specific listening environments. Multiple
factors including venting, alignment of the microphone ports, microphone design and individual patient
differences can all influence the magnitude of directional benefit. Therefore, clinical quantification of
directional hearing aids is advocated. Counseling relative to appropriate expectations is also important
since directional benefit is not expected in environments that are highly reverberant and/or in which
speaker to listener distance is great. In addition, directional amplification may be detrimental both in quiet
and when there are sounds of interest behind the listener.

This chapter provides a broad overview of hearing aid applications for children. Hearing aid technology is first generally introduced. This introduction is followed by discussions of candidacy, selection, fitting, verification, validation and management of hearing aids in the pediatric population. Classroom acoustics and the importance of other assistive listening devices are also considered.


This text is designed to provide an overview of normal and abnormal communication processes for the undergraduate student. Written for the “non-background” student, this text attempts to accurately reflect what a career in speech/language pathology or audiology entails. Numerous case studies accompany each chapter.


There are numerous causes of hearing loss in the newborn infant. Most etiological factors are hereditary in nature and prevention is beyond our control. Approximately 30% of hearing loss in the newborn, however, has been linked to teratogenic factors, many of which are preventable. Teratogens are factors capable of causing physical defects in the developing fetus or embryo and are typically grouped into 4 categories: infectious, chemical, physical, and maternal agents. During intrauterine life, the fetus is protected from many of these teratogens by the placenta that serves as a filter to prevent the toxic substances from entering the fetus’ system. The placenta, however, is not a perfect filter and cannot prevent entry of all teratogens to the fetus. Prenatal susceptibility to teratogens and the severity of the insult are quite variable. Four factors believed to contribute to this variability include dosage of the agent; timing of the exposure, susceptibility of the host, and interactions with exposure to other agents (Gorlin, Cohen, & Levin, 1990). The focus of this chapter is on teratogenic chemicals that contribute to hearing loss in the newborn.


It is often assumed that individuals with dual hearing and vision impairments rely more heavily on their hearing than those with either impairment alone and, thus, would welcome the use of amplification when indicated. However, we have been cautioned to keep in mind that amplification for those with dual impairments has a role beyond that of only enhancing speech perception ability (Wiener & Lawson, 1997). Amplification can also enhance the ability to identify one’s location relative to environmental features and to move safely through one’s environment (i.e., orientation and mobility skills); skills essential to the development of successful independent living skills. It is reasonable to assume that different listening situations may require different hearing aid settings for optimal perception. However, extant research literature is rather sparse with respect to specific hearing aid factors that can enhance both
communication and independent mobility in individuals with dual sensory impairments. The purpose of this research was to investigate specific hearing aid features that would be likely to have an impact on orientation and mobility as well as speech perception. Specifically, we examined the use of directional and omnidirectional microphones, and frequency shaping with and without added low frequency emphasis on the outcome of speech perception and orientation and mobility tasks. Subjects included seven adults and four children with significant hearing and vision deficits. Performance on the speech perception task with the omnidirectional microphone was significantly poorer than with the directional microphone. Very few differences in performance on orientation and mobility tasks were noted across the hearing aid conditions. An exception included significant differences in localization ability when using directional versus omnidirectional microphones depending on the direction the subject was heading relative to the sound source.


This widely-used text is designed for use by medical students and pediatric residents. This chapter on hearing loss in children covers demographics, signs and symptoms, identification and diagnosis, and management of hearing loss in children.


The proper programming, care, and maintenance of cochlear implants take on added importance when the users are young children. Children may not be able to communicate adequately with caregivers when the device is not functioning properly. As such, it is imperative that educators, interpreters, speech-language pathologists and other professionals working with children who have cochlear implants in educational settings become familiar and comfortable with the devices and learn to recognize problems. This knowledge can lead to fewer and shorter periods of time when a child is without hearing during critical educational periods. Speech processing strategies, daily maintenance, and more detailed troubleshooting techniques are reviewed.


A set of proposed “rules to live by” when conducting treatment outcomes research are discussed. These include precise definitions of the outcomes research terminology—outcome, efficacy, and effectiveness; an elaboration of the five-phase model for conducting treatment outcome research, including the purpose of each phase and the appropriate research designs; and the use of level of evidence scales for evaluating treatment outcomes research.

Signs and assumed lesion localization are provided for the classical aphasia syndromes—global, Broca’s, transcortical motor, Wernicke’s, transcortical sensory, conduction, and anomic. Discussion is provided regarding the validity of classifying the aphasias, exceptions to the classical sites of lesion for most aphasic syndromes, and whether different types of aphasia actually constitute syndromes.


Functional electrical stimulation (FES) offers an exciting and dynamic approach toward rehabilitation of the paralyzed larynx. Application of FES to paralyzed laryngeal muscles was conceived and introduced into the field of otolaryngology in 1977. Zealear and Dedo proposed that a unilaterally paralyzed axial (laryngeal, facial, pharyngeal, extraocular, etc.) muscle could be reanimated by electrical stimulation, via control signals relayed from its contralateral partner. While their experimental model was the cricothyroid muscle of the canine, they suggested that FES might also be useful in the "restoration of motion of bilaterally paralyzed vocal cords, paralyzed or uncoordinated pharynx muscles used for swallowing, as well as other paralyzed muscles of the head, neck, and thorax". Over the last two decades, significant strides have been made toward the application of FES for bilateral vocal fold paralysis. In this patient population for which relief of airway compromise is the goal of therapeutic intervention, an implantable laryngeal pacemaker may offer an ideal solution. The concept of laryngeal pacing involves electrical stimulation of a paralyzed posterior cricoarytenoid muscle during the inspiratory phase of respiration to restore glottal opening and ventilation. Inspiratory signals can be detected from various body sites to trigger the device. During noninspiratory phases of respiration, the device becomes disenabled, and the vocal folds passively return to the midline to allow for normal voice production and airway protection. This chapter will outline the key animal studies that have prefaced this emerging technology, the results in the first human trials of laryngeal pacing, and the potential application of FES to other muscle systems of the head and neck.
CURRENTLY ACTIVE SUPPORT

Source & number: MCHB MCJ000217-49 -- Fred H. Bess/Edward Conture/Anne Marie Tharpe, Principal Investigators  
Title: Center for Communication Disorders in Children  
Project period: 7/01/03 - 6/30/08  
Description: To train students in speech-language pathology and audiology from Vanderbilt University School of Medicine and Tennessee State University.

Source & number: DOE/H325A000025--Fred H. Bess, Principal Investigator  
Title: Preparation of Audiologists to Serve Infants and Toddlers with Hearing Loss  
Project period: 7/1/00 - 6/30/05  
Description: This grant supports graduate level personnel with special training in leadership in schools, community clinics, hospitals and parent-home programs. Moreover, trainees will be prepared to take on the roles of administrators, supervisors and/or consultants in educational agencies.

Source & number: DOE/H325D00014--Fred H. Bess, Principal Investigator  
Title: Audiology, Hearing Loss and the High-Risk Infant  
Project period: 7/1/00 – 6/30/04  
Description: This grant supports doctoral-level personnel with special competencies in hearing impairment, at-risk children, including autism spectrum disorders, early amplification, and outcome/efficacy research skills

Source & number: NIH-NIDCD/R01DC00185 -- D. Wesley Grantham, Principal Investigator  
Title: Auditory Motion Perception  
Project period: 2/1/98 - 1/31/04  
Description: This project is investigating the limits of humans’ ability to detect and discriminate the motion of auditory objects in the horizontal plane. Through a series of experiments on motion adaptation and the precedence effect, the project is seeking to describe the mechanisms underlying our ability to perceive auditory motion.

Source & number: NIH-NIDCD/5P50DC03282 -- Stephen Camarata, Principal Investigator  
Title: Program Project on Language Intervention  
Project period: 7/1/98-6/30/04
Because normal language acquisition is a complex process, it is extremely important to determine which parameters should be enhanced during treatment of language impairment to achieve maximal language gain. From a broad perspective, the parameters under study include child variables, parent variables as they relate to child variables, and how these variables translate into effective interventions. These issues will be examined in five subprojects within an integrated program project on language intervention that includes a multidisciplinary team of psychologists, physicians, special educators, and speech-language pathologists specializing in language impairments in children and adults who have extensive individual and collective expertise in treating diverse populations with language impairments.

**Source & number:** NIH-NICHD1R03HD42509 – Stephen Camarata, Principal Investigator
**Title:** Grammatical & Intelligibility Intervention in Down Synd.
**Project period:** 7/1/02-6/30/04
**Description:**
The purpose of the study is two-fold. First, recast intervention techniques that have proven effective in other populations with speech-intelligibility and grammatical deficits will be piloted in children with Down Syndrome. Second, mismatched negativity (MMN) and N1 will be measured using ERP techniques and oral motor functioning as potential predictors of growth during intervention.

**Source & number:** NIH-NIDCD/1R01DC04544 – Subcontract with Purdue Research Foundation -- Stephen Camarata, Principal Investigator (with Laurence Leonard)
**Title:** Grammatical Morphology in Specific Language Impairment
**Project period:** 7/1/00-6/30/05
**Description:**
The specific aim of this program is to explore the possible bases of grammatical morpheme limitations.

**Source & number:** NIH-NEY/1R24EY12894 – Subcontract with Western Michigan University – Daniel H. Ashmead, Principal Investigator
**Title:** Blind Pedestrians’ Access to Complex Intersections
**Project period:** 7/1/00-5/31/05
**Description:**
The central aims of this program are to use the strengths of a multi-disciplinary team to understand the perceptual and cognitive requirements of negotiating complex intersections without vision and with low vision; to design and test engineering and training solutions to problems of information access that are currently known and that are identified in the course of this partnership and to produce materials about the problems and solutions that are useful to transportation engineers, individuals with visual impairments, and rehabilitation personnel.
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<tr>
<th>Source &amp; number:</th>
<th>NIH-NIDCD/2R01DC00523 – Edward G. Conture, Principal Investigator (Ralph N. Ohde and Todd Ricketts, Co-Investigators)</th>
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<tr>
<td>Title:</td>
<td>Linguistic Processes of Children Who Stutter</td>
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<td>Project period:</td>
<td>7/1/96-8/31/07</td>
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<tr>
<td>Description:</td>
<td>The specific aims of the project are to assess differences between: 1) self-repairs in words with systematic vs. nonsystematic speech errors; 2) stutters in words with vs. without systematic speech errors; 3) syllable complexity in words with vs. without non-systematic speech errors; 4) the ratio of self-repairs to nonsystematic speech errors in children who do vs. those who do not stutter, regardless of presence of disordered phonology; and 5) (non)systematic speech errors and speech disfluencies associated with phonologically facilitated vs. non-facilitated picture-naming responses.</td>
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<th>Source &amp; number:</th>
<th>NIH-NIDCD/2R01DC00523S1 – Edward G. Conture, Principal Investigator</th>
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<tr>
<td>Title:</td>
<td>Linguistic Processes of Children Who Stutter: Data and/or Resource Sharing Administrative Supplement</td>
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<tr>
<td>Project period:</td>
<td>9/1/03-8/31/04</td>
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<tr>
<td>Description:</td>
<td>The specific aims of this project are to share selective aspects of the above information with appropriate personnel and institutions outside Vanderbilt University through means of 1) a data enclave; and 2) a data-sharing agreement.</td>
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<tr>
<th>Source &amp; number:</th>
<th>Vanderbilt University Discovery Research – Tedra Walden and Edward G. Conture (Co-Principal Investigators)</th>
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<tr>
<td>Title:</td>
<td>Emotional Arousal, Regulation and Childhood Stuttering</td>
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<td>Project period:</td>
<td>5/1/03-4/30/05</td>
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<tr>
<td>Description:</td>
<td>The specific aims are to focus on emotional arousability and regulation of children who do and do not stutter.</td>
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<tr>
<th>Source &amp; number:</th>
<th>Malcolm Fraser Foundation – Edward G. Conture, Principal Investigator</th>
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<tr>
<td>Title:</td>
<td>Parent-Child Stuttering Group</td>
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<td>Project period:</td>
<td>7/1/98-6/30/04</td>
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<td>Description:</td>
<td>To permit the DHSS to refine and expand upon the quality and quantity of our speech-language pathology services for people who stutter and their families in the Middle Tennessee and surrounding regions.</td>
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<th>Source &amp; number:</th>
<th>DOE/H325A000097 – Teris Schery, Principal Investigator (Anne Marie Tharpe, Co-Investigator)</th>
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<tr>
<td>Title:</td>
<td>Multidisciplinary Personnel Training for work with Deaf Children with Cochlear Implants in Rural Settings</td>
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<td>Project period:</td>
<td>1/1/01-12/31/05</td>
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<tr>
<td>Description:</td>
<td>The specific aims of this collaborative, interagency, and interstate project are as follows: (1) to implement a high-quality,</td>
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multidisciplinary preservice program that uses problem-based learning to enable graduates to serve children with cochlear implants effectively in educational settings; (2) to develop a videoteleconferencing system in remote/rural areas that will facilitate students’ skills as consultants and inservice educators in support of children with cochlear implants; and (3) to recruit and provide opportunities for minority students or those with disabilities to receive preservice training on cochlear implants in children and videoteleconferencing skills.

Source & number: NIH-NIDCD/5R01DC04318 – Troy Hackett, Principal Investigator
Title: Functional Organization of the Auditory Cortex
Project period: 4/1/01-3/31/06
Description: The first specific aim is directed at one of the most tentative aspects of the model which suggests that the medial and lateral portions of the belt region are functionally-distinct. As a second aim, we will compare architectonic features of auditory cortex in non-human primates and humans.

Source & number: Department of Education—Todd A. Ricketts, Principal Investigator
Title: Cochlear Dead Regions: Incidence and Effects
Project period: 9/1/02-8/31/05
Description: The results of the proposed research have the potential to be used to develop appropriate fitting recommendations and counseling techniques for pediatric directional hearing aid fittings.

Source & number: Department of Education—LeeAnn Golper, Principal Investigator
Title: Preparation of Speech and Language Specialists to Serve Children with Autism Spectrum Disorders
Project period: 7/1/02-6/30/07
Description: The project is aimed at preparing speech-language pathologists at the master’s level to provide specialized services to young children with autism spectrum disorders.

Source & number: Med-El Corporation, D. Wesley Grantham, Principal Investigator (Todd A. Ricketts and Daniel H. Ashmead, Co-Investigators)
Title: Spatial Hearing in Bilaterally Implanted Cochlear Implant Users
Project period: 9/1/02-2/28/04
Description: The project is aimed examining the impact of a bilateral cochlear implants on sound localization and speech intelligibility performance.

Source & number: Phonak, AG—Todd Ricketts, Principal Investigator
Title: Minimal Competing Masker, Distance and Hearing Loss Effects on Adaptive Directional Benefit
Project period: 10/1/03-9/30/04
Description: Experiment #1 proposes to investigate adaptive directional benefit in listeners with severe to profound hearing loss fit with the Phonak
Supero. Experiment #2 proposes to further investigate the impact of distance on the directional benefit obtained with listeners fit with the Phonak Claro. Experiment #3 proposes to examine whether directional microphone use will offset the negative impact of informational masking.

**Source & number:** Department of Veterans Affairs – Todd Ricketts, Principal Investigator (with Gene Bratt and David Gnewikow)

**Title:** Real-World Benefit from Directional Hearing Aids

**Project period:** 4/1/01-3/30/04

**Description:** The proposed research involves directional hearing aids and the benefit which they provide for individuals with hearing loss.

**Source & number:** NIH/NIDCD5R01DC001149 – David Zealear, Principal Investigator (Daniel Ashmead, Co-Investigator)

**Title:** Rehabilitation of the Paralyzed Larynx

**Project period:** 12/1/02-11/30/06

**Description:** The overall goal of the applied research is to evaluate the capacity of FES to restore ventilation in canines with chronic bilateral laryngeal paralysis, implanted with electrical stimulation devices.

**Source:** Department of Veterans Affairs -- Linda L. Auther and Robert T.Wertz, Principal Investigators

**Title:** AERs in Aphasia: Severity and Improvement

**Project period:** 1/1/00 - 12/31/03

**Description:** This investigation uses a variety of auditory evoked responses (AERs) to phonologic, semantic, and syntactic stimuli to determine whether the presence or absence of AERs in people who are aphasic subsequent to stroke index the severity of aphasia on behavioral measures and may be useful for predicting improvement in aphasia.

**Source:** Department of Veterans Affairs -- Robert T. Wertz and Nan D. Musson, Principal Investigators

**Title:** Treatment of Premature Spillage and Delayed Swallow Initiation

**Project period:** 5/1/02 - 4/30/05

**Description:** This investigation tests tactile-thermal stimulation as a treatment for two swallowing disorders--premature spillage and delayed swallow initiation--in frail elderly adults.

**Source:** Department of Veterans Affairs -- Robert T. Wertz, Principal Investigator

**Title:** Veterans Administration Predoctoral Fellowship Program in Audiology and Speech Pathology

**Project product:** 8/1/99 - 7/31/04
Description: This grant support doctoral-level students with research interests in hearing, balance, speech, language, voice, or swallowing impairments in adults.
**Source & number:** Department of Education -- Fred H. Bess, Principal Investigator  
**Title:** Psychoeducational Impact of Minimal Sensorineural Hearing Loss in Children  
**Project period:** 7/1/03-6/30/07  
**Description:** The objectives of this study are to identify young school-age children with minimal sensorineural hearing loss (MSHL) and to assess the relationship of MSHL to psychoeducational development.

**Source & number:** Department of Veterans Affairs—David Gnewikow, Principal Investigator (Todd Ricketts, Co-Investigator)  
**Title:** Cochlear Dead Regions: Incidence and Effects  
**Project period:** 10/1/03-9/30/06  
**Description:** The proposed study was designed to investigate the incidence of cochlear dead regions as defined by the TEN test and speech recognition measures, and then to determine if the presence of dead regions significantly affects hearing aid benefit, both measured and perceived.

**Source & number:** Department of Veterans Affairs—Fred H. Bess, Principal Investigator  
**Title:** Development of the AURAL-QOL  
**Project period:** 4/1/04-3/31/07  
**Description:** The objective of this study is to develop a quality of life measure which includes items certain to be influenced by hearing loss.

**Source & number:** American Speech-Language-Hearing Foundation—Benjamin W.Y. Hornsby, Principal Investigator  
**Title:** The Benefits of Amplification in the Presence of a Minimal Number of Competing Maskers  
**Project period:** 9/1/03-8/31/04  
**Description:** The specific aims of this proposal are to: 1) evaluate the impact of informational masking on persons with hearing loss; 2) determine how informational masking, due to single talker maskers, changes as the number of talkers increases; and 3) investigate the effects of amplification on informational masking.

**Source & number:** NIH/NIDCD—Ralph N. Ohde, Principal Investigator (Stephen M. Camarata, Co-Investigator)  
**Title:** Perception in Typically Developing and SLI Children  
**Project period:** 4/1/04-3/31/09  
**Description:** The purpose of the proposed project is to examine speech perception in preschool and early school age children with SLI compared to typically developing children at comparable age levels.
Source & number: NIH/NICHD—Stephen M. Camarata, Principal Investigator
Title: Predictors of Response to Speech Intelligibility Therapy
Project period: 7/1/04-6/30/09
Description: The purpose this project is to examine the relationship between behavioral measures of oral-motor skills, elicited and conversational speech accuracy, and behavioral and EEG/ERP speech processing measures and growth in speech intelligibility within the context of intervention designed to increase speech intelligibility in children with severe phonological disorder.