Convention Abstracts

A highlight of the first annual convention, at Kiawah Island, was a special emphasis on poster sessions as a means of conveying research and clinical information to attendees. Presentation of new findings by a poster rather than a brief speech has several advantages. First, there is more time for the interested observer to think through the results, mull them, and reflect on how they might impact his or her own daily work. Second, there is a better opportunity to present the specific details of research methodology, so that the adequacy of the design, analysis, and interpretation of results can be appropriately assessed.

The following section presents a summary of each of the poster presentations at the convention. It illustrates the remarkable scope of topics and interests among academy members.

Acquired Hearing Impairment Among Older Females With Psychopathology

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Age is the most critical risk factor for hearing impairment in the elderly. Fifteen to twenty percent of older adults may need psychiatric services. Research data on hearing impairment among older adults with psychopathology have not been based on DSM-III classification criteria. Hearing loss in the elderly has been associated with paranoid disorder and late-onset schizophrenia, but not mood disorder.

Twenty psychotic and twenty normal females aged 55 years and older, received a behavioral audiologic assessment (pure-tone air- and bone-conduction audiometry, speech audiometry, immittance testing) following otoscopic inspection and cerumen removal. A detailed questionnaire on otologic, medical, and social histories was presented to all subjects. The Hearing Handicap Inventory for the Elderly-Screening Version (HHIE-S) was administered to hearing-impaired subjects.

Discriminant analysis (multivariate analysis) and ANOVA (univariate analysis) were applied to all hearing variables for the psychotic and normal groups (between group), mood disorder and nonmood disorder groups (within group), and paranoid and nonparanoid groups (within group). MANOVA was applied to all groups to determine an age-effect for hearing impairment. Chi-square analysis was applied to all questionnaire categories for all groups.

The data differentiated between the psychotic and normal groups (α = 0.50), for right ear PTA (p = 0.0319), left ear speech discrimination (p = 0.0368), and right ear speech discrimination (p = 0.0016). Mood disorder subjects differed from nonmood disorder subjects for left ear PTA (p = 0.0410). Paranoid subjects differed from nonparanoid subjects for right ear PTA (p = 0.0319), left ear speech discrimination (p = 0.0368), and right ear speech discrimination (p = 0.0368). An age effect for hearing loss was found in the paranoid group only. Chi-square analysis demonstrated a relationship between psychosis and otologic and social histories, and between mood disorder and social history. The HHIE-S data were inconclusive.

These findings do not support previously published data. The impact of presbycusis needs to be considered as a potential risk factor for psychopathology among older females. Otoscopic inspection and hearing screening should optimally be included in the differential diagnostic work-up of all older adults with psychopathology.

Aging and Pharmacologic Effects Upon the ABR of Guinea Pigs: A Study of Sodium Thiosulfate

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Sodium thiosulfate has come under recent investigation since it has been reported to reduce the nephrotoxic and otoxic effects of Cisplatin and enhance its anticancer action. While investigating Cisplatin-sodium thiosulfate interaction Otto et al observed a significant increase in Wave III amplitudes for animals that were treated with sodium thiosulfate alone for 8 days compared with control animals treated with normal saline.
An acute as well as a chronic change in ABR amplitude was demonstrated in a follow-up study using guinea pigs in the 360-600 g range. The purpose of the present study was to investigate acute and chronic effects of sodium thiosulfate upon the ABR of more mature guinea pigs (800-1100 g).

ABRs of five white adult female guinea pigs were monitored before, during, and after an 8-day treatment with sodium thiosulfate (1200 mg/kg/day i.p.). Four guinea pigs receiving similar volumes of normal saline and four guinea pigs of comparable weight receiving no treatment were monitored at the same intervals as controls. Animals were excluded from this study if they could not pass an otologic screening and an ABR screening with 31 dB peak SPL click stimuli.

Prior to ABR testing, each guinea pig was sedated with a 0.39 ml/kg mixture of ketamine and xylazine (5 mg/ml Ketalar to 3 mg/ml Rompun). ABRs were recorded at presentation levels of 91, 81, 41, and 31 dB peak SPL. The test regimen was designed to gather data for assessing both chronic and acute effects. To assess chronic effect animals were monitored on day 0 (baseline), and treatment days 1, 6, and 8, and on day 10 (2 days post treatment). To assess acute effects ABRs were monitored on each of the above days at 10-minute intervals during the first hour after treatment.

Statistical analysis was done by analysis of variance in combination with the Tukey 'a' studentized range statistic. Although some animals showed an acute amplitude increase following administration of thiosulfate, changes were not of the same magnitude or consistency noted in two previous studies with younger animals. There was no significant difference between experimental and control animals either chronically or acutely. We conclude that the thiosulfate effect seen in the 360-600 g guinea pigs may be partially age-related. Implications for auditory research with guinea pigs will be discussed.

**Application of Neural Networks to Audiology**

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The objective of this presentation is to introduce the concept of neural networks to audiologists and to illustrate several important applications of neural computing to the communication sciences. A neural network is a computing, neural-like circuit that consists of many simple processing elements operating in parallel. They are inspired by research on biologic neural systems and may provide powerful insight into cortical function, cognition, and learning. Recent interest in neural networks has developed in many fields including neuroscience, psychology, signal processing, computer science, and artificial intelligence. Neural networks may provide a powerful tool for the study of hearing, speech, and language.

**PROPERTIES OF NEURAL NETWORKS**

A typical neural network consists of three layers of "units": (1) input; (2) hidden; and (3) output. All input units connect to all hidden units, and all hidden units connect to all output units. The strength of each connection is determined by a "synaptic" weight. There can be inhibitory connections between units at the same layer so that only one hidden or one output unit can be active at a time. The objective of the network is to perform some type of computational function, that is, for some input pattern, generate the appropriate output. The power of neural networks is that they can learn through experience to perform the desired function. Neural networks learn by adjusting the weights of the connections in response to stimulation and experience. Neural networks demonstrate many properties like biologic neural systems; they process information in parallel, they can learn, they efficiently handle error and variability, and they can generalize.

**Example.** To illustrate the concepts, a simple neural network will be simulated on a microcomputer. This network will learn to appropriately classify several simple stimuli through competitive learning (no teacher).

**Applications.** Two major applications will be discussed.

1. **Expert Systems.** Neural networks offer an important advantage over traditional expert systems which must be provided the necessary rules and algorithms. Neural nets can learn the rules from experience. Possible applications include hearing aid fitting and the interpretation of diagnostic tests.

2. **Models of Central Auditory Processing.** Neural networks provide a powerful technique to model and study cortical function. Applied to the auditory system, they may help explain cortical organization and the processing of auditory stimuli. They may also be useful in the study of the effects of pathology on auditory capability.
Arnold-Chiari Malformation—Some Audiological Features

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Arnold-Chiari malformation was first described by John Cleland in 1883 as an unusual congenital anomaly of the brainstem in which portions of the hindbrain and cerebellum are found in the neck instead of the posterior cranial fossa. This malformation was later classified into four anatomic categories based on the severity of displacement. Previous research has addressed types and degree of hearing loss associated with this disorder, and rather intense research was concentrated on the results of electronystagmography (ENG) testing. However, it does not appear that any research or discussion has included the results of auditory evoked potential testing on a patient with the disorder.

METHODOLOGY

This patient was initially seen for an audioligic evaluation at which time a bilateral hearing loss was indicated. Symptomatology consists of rather ill-defined episodic dizziness, headaches, and tinnitus. She returned for repeat audioligic evaluation approximately 6 years later. At that time, electronystagmography (ENG) and auditory evoked potential testing was completed. CT-scan and magnetic resonance imaging were recommended and completed, which confirmed the diagnosis of Arnold-Chiari malformation. Successive pure-tone air and bone conduction thresholds, speech audiometry, impedance and acoustic reflex testing, site of lesion testing, electronystagmography, and auditory evoked potential testing are presented on the patient.

RESULTS

Results suggests progressive, asymmetric, sensorineural hearing loss can occur with this disorder. ENG results are not inconsistent with previous data. Auditory Evoked Potential testing is abnormal as well, indicating a significant interaural wave V latency difference and an overall prolongation of waveforms on the affected side. The ABR includes a latency-intensity function and rate study.

DISCUSSION

Results suggest that dizziness, tinnitus, and hearing loss can be presenting symptoms of Arnold-Chiari malformation. As auditory evoked potential testing increases in application for the assessment of a variety of patients, it becomes important for audiologists to be aware of the several sources of abnormal response patterns. Further, it is interesting to note in what ways different disorders can affect auditory evoked potentials test results.

Attitudes and Characteristics Differentiating Elderly Hearing Aid Users and Nonusers

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A retrospective study was conducted to determine what percentage of elderly hearing impaired candidates obtain amplification and identify the factors and characteristics that differentiate elderly hearing aid users from nonusers.

Subjects consisted of 68 males and 110 females ranging in age from 62 to 92 years (mean age 73 years). All subjects were evaluated approximately 2 to 3 years prior to this study at the Bill Wilkerson Hearing and Speech Center, Nashville, Tennessee. The participants were seen in conjunction with the CHARGE project (Changing Hearing Aid Rehabilitation for the Growing Elderly Population). All subjects were referred by their general practice physician following an audioscope screening in their office. Regardless of results, all patients screened were referred for further evaluation at the Bill Wilkerson Center.

Records were obtained for the 178 subjects described above. Results indicate 83 (47 percent) of the subjects were considered hearing aid candidates. From this group, 14 (17 percent) already owned personal amplification, 54 (65 percent) were referred for hearing aid evaluations but declined, and 11 (13 percent) had a hearing aid selection and purchased amplification.

Presently, 25 hearing impaired elderly who were evaluated in this study are using amplification. The intent of this study was to determine why 54 elderly chose not to seek rehabilitation and identify the factors that distinguish them from the 25 elderly hearing aid users.

Analysis revealed that the following factors or measures did not differentiate elderly hearing aid users and nonusers: sex, race, age, education, Short Portable Mental Status Questionnaire score and visual acuity. However, differences were evident when audioscope results, better ear pure-tone averages, and Hearing Handicap Inventory for
the Elderly-Screening Version (HHIE-S) were compared between the two groups.

Subjects who failed the audioscope screening at 40 dB HL were more likely to be considered hearing aid candidates and purchase amplification. A closer look at the 60 elderly who failed revealed 13 (22 percent) already owned hearing aids, 14 (23 percent) had a hearing aid selection and of these, 11 (18 percent) eventually purchased a hearing aid. Generally, elderly who preferred not to seek rehabilitation did not have better ear pure-tone averages indicating more than a mild degree of hearing impairment through the speech range. The most distinguishing factor that differentiated elderly hearing aid users from nonusers was HHIE-S score. Hearing impaired elderly who obtained amplification generally had high HHIE-S scores while elderly nonusers had low scores.

Automated Algorithm In Newborn ABR Screening

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The primary objective of auditory screening programs is to identify hearing impaired newborns correctly. Test validity is determined by the proportion of results that are diagnostically confirmed and predicted on the measures used to identify the disease process. Although auditory brainstem response (ABR) testing has gained clinical acceptance as a precise and objective measure of newborn auditory status, it is not without fault. The recent advent of automated ABR (ALGO-1), which provides only a pass-refer outcome, introduces a series of new variables. The question arises as to the validity and reliability of an instrument yet clinically unproven. This presentation reports the results of a series of high-risk infants who were comparatively screened by automated and conventional ABR protocol.

METHODOLOGY

A repeated measures design was used whereby 224 stable infants (447 ears) of an NICU were tested with automated and conventional ABR procedures during the same session. A commercially available clinical averager was used as the standard against which the automated (ALGO-1) test results were measured. Stimulus and recording procedures were similar, given the two instruments. Failure criteria was defined as the absence or prolongation (Re: adjusted age, normative data base) of a replicable wave V response (conventional) or “refer” by the automated system.

RESULTS/DISCUSSION

Initial test results produced an 11.2 percent failure rate for the automated (ALGO-1) system compared to an 8.3 percent failure rate for conventional screening at 35 dB nHL. At 60 dB, (conventional ABR only) failure rate was 5.1 percent. Whereas initial comparative test results found a sensitivity rate of 89 percent, retest diagnostic confirmation by means of conventional ABR and behavioral assessment resulted in rates of 100 percent sensitivity and 94 percent specificity for the automated procedure. The overall efficiency of the ALGO-1 was 94 percent. Advantages of a two-test combination are illustrated. Automated advantages include a dual artifact rejection system, attenuating ear couplers, and a battery operated design. Disadvantages are the lack of a visual interpretation in older models and impedance override capability. These findings suggest that the automated ABR screener is a viable alternative to conventional ABR instrumentation for the limited purpose of neonatal auditory screening.

Behavioral Method For Determining Infant Hearing Sensitivity: The Interweaving Staircase Procedure

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A computer-assisted adaptive threshold acquisition procedure has been developed to determine hearing sensitivity in infants 5 to 24 months of age. Infants are trained to make a head-turn when a tone is presented. This behavior is maintained by presentation of a visual reinforcer. Thresholds at three frequencies are obtained with independent and concurrent staircases. On each staircase trial, the test frequency is randomly selected and then presented at a level determined by the response history at that frequency. High-level probe trials are randomly interspersed to assess the infant's motivation. In addition, catch trials (no signal present) are also randomly presented to permit the false-alarm rate to be determined. All test signals are routed through a clinical audiometer, allowing the stimuli to be presented either in a soundfield, via earphones, or a bone oscillator. In one run (40 to 50 trials), an estimate of an infant's hearing at three frequencies is obtained.

The Interweaving Staircase Procedure (ISP) offers several advantages for clinical hearing assessment. Motivation and attention to the task is the same for the three test frequencies. In the event of marked changes in motivation/attention,
trial-by-trial history allows threshold estimates to be adjusted. Further testing is time-efficient, objective, and reliable. The poster will describe the procedure and present threshold data acquired from infants using standard audiometric techniques and the ISP. Results from both normal and hearing-impaired babies and toddlers demonstrate the clinical utility of the procedure.

Binaural Interaction of the Human ABR: Observations of Normal Hearing Chronic Schizophrenic Subjects and Normal Controls

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Abnormal sensory coding has long been a suspicion in the evaluation of schizophrenic patients. Numerous differences in early evoked potentials have been documented for the visual and somatosensory sensory modalities and middle to late auditory evoked potentials among schizophrenic and normal control populations. There is debate as to whether or not the early auditory evoked potentials and the auditory brainstem response (ABR) are significantly different between these populations. There is additional debate as to these differences being a medication variable and whether or not ABR may act as an objective index of poorly medicated versus therapeutically medicated schizophrenia.

Binaural interaction is calculated by summing monaural ABRs and then subtracting this summed trace from a binaural ABR to produce a difference trace for otologically normal subjects. The far-field ABR is collected in a routine clinical fashion with a nuchal reference to Cz active electrode montage, ground at FPz. One thousand six hundred click stimuli presented at 23.7 clicks per second were analogue filtered from 100 to 5,000 Hz, computer averaged into a composite waveform and digitally filtered afterwards to produce an optimal trace.

Preliminary results show striking binaural interaction morphologic differences between properly medicated schizophrenic subjects and normopsychiatric controls. The ABR differences in absolute wave form latency and wave form amplitude are most noticeable for the latter waves of P3 and P5. Data collection is ongoing and continues.

The implications include (1) that binaural interaction calculations may serve as a more objective index of medication-induced normalization for some psychiatric impaired patients.

Brain Topography and Equivalent Dipole Localization of the Auditory P300 Response

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Topographic mapping of the auditory P300 using the International 10–20 system allows one to view scalp distribution of the auditory P300 response. Although the scalp distribution of the auditory P300 in normals typically has the greatest amplitude over midline centroparietal areas, other patterns occur in the normal population. The purpose of this study was to review normative data in order to categorize and quantify the distribution of topographic patterns of the P300 response. Further, the different patterns identified were submitted to a dipole modeling program.

METHODOLOGY

All data were collected on Bio-logic Brain Atlas topographic mapping systems using a standard auditory odd-ball paradigm. All subjects were between the ages of 18 to 40 years, and all reportedly had no significant medical history. In addition, samples of EEG from each subject were reviewed by a neurologist/electroencephalographer and were found normal. A total of 92 subjects were included in this study.

RESULTS

It was possible to assign 89 of the P300 responses into either a midline Frontal (Fz maxima), midline Central (Cz maxima), or midline Parietal (Pz maxima) pattern. Three percent of the subjects had asymmetric P300 patterns that did not have midline maxima and their data were not included in subsequent analyses. The Frontal, Central, and Parietal patterns occurred in 11 percent, 53 percent, and 33 percent of the data respectively.

A mean file for each of the midline patterns was then created using 10 subjects from each category. These representative mean files were submitted to a dipole estimation program using a one equivalent dipole model. The location of estimated dipoles for the Central and Parietal patterns were very similar and the primary differences
between the two patterns were in the orientation parameters of the dipoles. The Frontal pattern evidenced a dipole solution that was quite different from the other two patterns and seemingly cannot be explained by a single equivalent dipole.

**DISCUSSION**

Although the Central pattern is the most common topographic pattern, it is important to recognize the occurrence of other patterns in the normal population.

The dipole modeling program is a research tool to aid in the understanding of the possible intracranial sources of measured scalp activity. The equivalent dipole solutions for both the Central and Parietal patterns are consistent with depth electrode and magnetic imaging studies, which suggest the hippocampus as a source for the P300 response.

**Comparison of Speech-Recognition Performance Obtained With Three Prescriptive Methods**

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There are presently at least 10 hearing-aid prescription procedures that have been described in the literature over the past decade. There are, however, very few comparisons of performance obtained with responses prescribed by different methods. Those comparisons that do exist have typically involved laboratory studies of frequency responses that were realized with laboratory equipment, such as 1/3-octave multilters or computer-controlled digital filters. It is not clear how representative these few laboratory studies are of actual clinical settings. It is unlikely, for example, that real hearing aids and earmolds will be as easy to fine tune to produce a perfect match between the prescribed response and that observed on the patient. No comparisons of speech-recognition performance achieved with real hearing aids and real earmolds are available.

In the present study, the speech-recognition performance of 12 hearing-impaired listeners was measured in quiet and in noise using the CUNY Nonsense Syllable Test. Subjects were tested in the sound field with and without a hearing aid. The hearing aid/earmold combination was one of three selected for the patient. Each aid/earmold combination was selected to produce the closest match to the gain prescriptions made by one of the following three methods: (1) POGO; (2) NAL-revised; or (3) the Memphis State University (COX) method. Speech-recognition testing took place after the aid/earmold combination was fine tuned to produce as close as possible a match between the prescribed and observed insertion gain.

In general, subjects did better with amplification than without for the quiet test condition. This was true less frequently for the condition with background noise. The group data and the individual data show no change in speech-recognition performance with prescriptive method. The speech-transmission index is also evaluated as a predictor of the speech-recognition performance for these patients in aided and unaided listening conditions.

**Comparison of Two Gradient Methods In Normal Ears Versus Otitis Media**

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Recent publications indicate renewed interest in tympanogram gradient for assessment of middle ear status. Previous papers suggest that gradient contributes information not available from conventional static admittance measures. Although the technique is clinically attractive, it awaits documentation in patient populations. The purpose of the present investigation was to compare two gradient methods in normal ears and in ears with otitis media.

**METHOD**

Subjects. There were 160 subjects. All subjects were otoscopically examined and diagnosed by an otolaryngologist or pediatrician. One ear for each subject was categorized into one of the following two groups:

1. Normal hearing and normal middle ear function by otoscopic examination (n = 80 ears, average age 30 years, and average PTA 6 dB HL).
2. Otoscopically diagnosed otitis media (n = 80 ears, average age 6 years, and average PTA 23 dB HL).

Procedure. A tympanogram was obtained for each subject using a Grason Stadler 33 Middle Ear Analyzer. A complete audiogram was obtained for all normal hearing subjects and for approximately one-half of the otitis media subjects. Two methods for calculating tympanogram gradient were compared. One gradient value was computed by the GS33, by taking the average of two admittance points on the tympanogram, one at +50 daPa from the peak and the other at −50 daPa from the peak, and then subtracting this
value from the peak admittance value. A second gradient was determined according to the ASHA Guidelines For Screening For Middle-Ear Disease and Hearing Loss, by calculating the pressure interval corresponding to a 50 percent reduction in peak static admittance.

**RESULTS AND DISCUSSION**

Mean gradient values calculated by the GS33 were 0.53 for the normal ears and 0.20 for the otitis media ears. The ASHA gradient method yielded mean gradients of 88 daPa and 253 daPa for normal ears and otitis media ears, respectively. Gradient did not vary as a function of hearing threshold levels in the otitis media group. There are limitations to both gradient techniques. Gradient was not calculated by the GS33 for lack of a tympanogram peak in approximately one-third of the subjects with otitis media. For an additional 20 tympanograms the ASHA technique did not yield exact gradient values.

These data present normative values for two gradient techniques. Closer analysis of possible relationships among otologic findings and gradient methods is underway.

**Decision Matrix Analysis of Selected Children's Central Auditory Processing Tests**

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A basic tenet of any test is its sensitivity, specificity, and efficiency. Virtually all the literature dealing with central auditory processing (CAP) disorders in children have reported data on subjects with known educational and/or speech-language problems. Thus, data on the true-positive and false-negative ratios of children's CAP tests is unavailable. The purpose of the present investigation was to determine the sensitivity, specificity, and efficiency values for a selected set of children's CAP tests. In addition to the decision matrix analysis, test-retest reliability measures were obtained for each of the CAP tests under evaluation.

**METHOD**

To date 1,104 children between the ages of 8 and 13 years have been administered the following CAP tests: (1) Dichotic Digits Tests; (2) Staggered Spondaic Word Test; (3) Low Pass Filtered Speech Test; (4) Binaural Fusion Test; (5) Time Compressed Speech Test; (6) Speech Recognition MLD Test; and (7) Pitch Pattern Sequence Test. Eighty-one percent of the children assessed were not suspected of having a CAP disorder while the remaining 19 percent were suspected of having a CAP disorder prior to assessment. The three testers had no knowledge of which category any individual child belonged. All the children in the investigation had normal hearing and middle ear function.

**RESULTS**

Sensitivity, specificity, and efficiency values were computed for each of the seven CAP tests. The outside criteria used to determine CAP validity was a positive educational history for learning problems, a positive psycho-educational assessment and/or neurologic evaluation. These data analyses indicated that the dichotic tests had the best efficiency value while the Pitch Pattern Sequence Test had the poorest efficiency value. The test-retest correlations ranged from .86 for the Dichotic Digits Test to .33 for the Pitch Pattern Sequence Test.

**DISCUSSION**

Based on the sensitivity, specificity, and efficiency values for the above data, a CAP test battery that consisted of the Dichotic Digits Test, the Staggered Spondaic Word Test, the Time Compressed Speech Test, and the Speech Recognition MLD Test would have the highest hit rate. If, however, the test battery selection was based on both the efficiency values and the test-retest correlation values, the test battery would be the Dichotic Digits Test, the Staggered Spondaic Word Test, and the Speech Recognition MLD Test.

**Development of the VA Compact Disc for Speech Identification and Recognition Tasks**

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The audio compact disc (CD) is an ideal medium on which speech audiometry materials can be and are recorded. In comparison to analog disc and tape technology, the compact disc technology offers the following advantages: (1) high-fidelity recordings with enhanced signal-to-noise ratio, virtually infinite channel separation, and no "print through"; (2) identical recordings from one disc to another; (3) a recording medium that does not deteriorate as a function of use and time and, therefore, does not need replacing; (4) almost
instantaneous access to any one of 100 tracks, i.e., no winding or rewinding to access a particular test list or even specific test item; and (5) up to 144 minutes of recorded materials per disc (single channel). The compact disc players offer an extremely favorable "quality-value ratio," i.e., the players are relatively inexpensive. Because the laser read mechanism does not physically contact the disc, there is virtually no wear on either the disc or the recorder.

We are in the process of a "technology-transfer" activity involving the production of an audio compact disc that contains speech recognition and speech identification materials for use in the auditory evaluation and rehabilitation of VA patients. We anticipate that the compact disc produced by the VA will be available to non-VA audiology clinics for a modest charge. A survey was conducted of all VA audiology clinics to determine what speech audiometry materials would be most useful. The results of the survey, which obtained a 99 percent response, will be presented. The following materials, all of which were derived from the original analog master recordings, are included on the compact disc:

1. Maryland CNC lists (6 lists),
2. Northwestern University Auditory Test No. 6 with competing message (4 lists),
3. CID W-22 (4 lists) Technisonic Studios version,
4. Rush Hughes lists of PB-50s (4 lists),
5. W-1 spondaic words (Causey recordings, 6 lists),
6. Picture Identification Task Lists (2 lists), and
7. Synthetic Sentence Identification (Jerger, 9 randomizations).

Because the original analog recordings included some undesirable noise and had somewhat variable interstimulus intervals, production of the compact disc required development of digitization and signal processing techniques, including a cursor-controlled waveform editor. A portion of the poster will detail the digitizing and signal processing techniques used to produce the digital signals recorded on the compact disc.

Ear Pathology Among Indians of Costa Rica

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The high incidence of middle ear pathology among the Indians and Eskimos of North America has been well documented. The purpose of this study was to obtain data that might indicate whether a similar propensity for ear pathology exists among Central American Indians.

One hundred twenty-seven Telamanca Indians located at Amubri, Costa Rica were examined for middle-ear and hearing disorders. The focus of the study was to be on children; however, a significant number of adult subjects also appeared for testing and were examined. Ages ranged from 6 months to 70 years. The procedure consisted of simple otoscopic examination, audiometric screening (where possible), and tympanometry.

Results indicated a high incidence of middle ear abnormality (41 percent of the ears) in the age groups 6 months to 4 years and 5 to 6 years (43 percent of the ears). Beyond these ages signs of middle ear disorders decreased with increasing age. However, in the age span 21 to 30 years, an increase in hearing abnormality was noted. Although some middle ear pathology was evident, most failed the pure-tone screening only, which suggests an increase in sensorineural hearing impairment in this age group. Interestingly, evidence of hearing disorders decreased in the age group 31 to 43 years.

These data suggest that the incidence of ear pathology among the Telamanca Indian children likely is as high as that found among North American Indians. Although numerous studies dealing with otitis media among North American Indians and Eskimos are available, comparison is difficult because of focus on different manifestations of the pathology and use of different methodology. Reports of frequency of occurrence range from 9 percent for Navajo Indians, identified by Jaffe as having central perforations or atelectasis, to 50 percent abnormality among Ojibwa children, K to 3, reported by McShane and Nordin using otoscopy and impedance measures. A 20 percent rate was found among white children in the same Minneapolis public school system. This is in sharp contrast to the findings for Ojibwa children and the Indian children of Costa Rica.

Effects of Aging on Four Event-Related Potentials

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Four event-related potentials (ERPs) were measured in a group of 80 elderly subjects ranging in age from 50 to 85 years. Three of the four ERPs were auditory, while the fourth was visual. The auditory stimuli included pure tones and two
series of words; the first list of words varied in phonemic characteristics, and the second in semantic characteristics. The visual stimulus was an octagon shape that flashed on a computer screen.

First, a baseline response was obtained to a frequent event—either 1000 Hz tone pips, unrelated monosyllabic words, or a complete octagon shape. Then the subject was asked to count rare events occurring 20 percent of the time—either 500 Hz tone pips, words with a specific phonemic or semantic characteristic, or octagons with one side missing. The baseline condition was subtracted from the rare condition to obtain a difference representing the effects of the rare stimulus alone.

Typical latencies occurred around 350 ms for the “acoustic” ERP (pure tones), 470 ms for the “visual” ERP, 640 ms for the “phonemic” ERP, and 660 ms for the “semantic” ERP. Results showed an increase in latency of the acoustic ERP with increasing age. These changes were not related to increasing hearing loss.

There was no systematic change in the latency of the visual ERP with age. Similarly, the phonemic and semantic ERPs showed no latency change with increasing age.

Since age impacts on a variety of auditory tasks (i.e., hearing sensitivity decreases with age; speech understanding gets poorer), it was not unexpected that increasing age would result in longer acoustic ERP latencies. Likewise, we expected the visual ERP to be less resistant to aging. Unexpected, however, was the finding that latency of neither the phonemic nor the semantic ERP was affected by age. These measures may provide a useful baseline for evaluating other dimensions of change with age, since they are apparently resistant to the effects of normal aging.

Effects of Maternal Cocaine Abuse on Neonatal ABR: Premature and Small-for-Dates Infants
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Infants exposed to cocaine in utero are at risk for congenital malformations, perinatal mortality, and neurobehavioral impairment. Recently, ABR abnormalities were found in full-term infants whose mothers abused cocaine. These abnormalities included prolonged absolute and interpeak ABR latencies similar to those seen in neurologically compromised infants or adults.

To extend and confirm the results of this first study, a second investigation was undertaken to evaluate auditory system function in cocaine exposed neonates of subnormal birth weight and/or gestational age.

METHODS

Eighteen test neonates born to cocaine abusing mothers were matched on the basis of birth weight and conceptional age to a control group of neonates. The 18 control neonates were free of exposure to maternal substance abuse. The infants in the test and control groups had a mean birth weight of 2615 g and a mean conceptional age of 37 weeks.

ABRs were recorded from all 36 infants using standard electrophysiologic procedures. Stimuli for eliciting ABRs were square wave clicks at 80, 60, 40, and 20 dB nHTL presented at 33/s rate, 80 dB nHTL at 11/s rate, and 80 dB nHTL at 89/s rate. The absolute and interpeak values for Waves I, III, and V were measured in each stimulus condition.

RESULTS

ABR absolute and interpeak latencies for the cocaine-exposed infants were prolonged relative to their age and weight matched controls. Specifically, absolute latencies for peaks I, III, and V were prolonged at 80 dB nHTL—11/s rate, for III and V at 80 and 60 dB nHTL—33/s rate, and for V at 80 dB nHTL—89/s rate. The I to V interpeak latency was significantly prolonged in cocaine infants compared to controls at 80 dB nHTL, for all stimulus rates. The difference in I to V interpeak latency between test and control infants increased with stimulus rate.

DISCUSSION

Prolonged absolute and interpeak ABR latencies were found in cocaine-exposed infants of subnormal birth weight or conceptional age. It should be noted that maternal cocaine use has been associated with fetal low-birth weight and intra-uterine growth retardation (IUGR). It has also been shown that intra-uterine growth retarded term or pre-term infants have delayed maturation of ABR peak latencies. However, this investigation shows that ABR latencies of cocaine-exposed neonates are prolonged relative to control neonates matched for IUGR and prematurity.

The effect of maternal cocaine use upon the neonatal auditory system is prolonged brainstem neural conduction time, an exacerbation of the effect seen in other developmentally compromised infants. Cocaine may be toxic to the developing auditory nervous system. Alternatively, vasoconstriction in the placenta subsequent to maternal cocaine use may cause anoxia to the fetus and thereby impair the central nervous system.
Expectations of Older Adults Regarding the Use of Hearing Aids
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Sharon A. Lesner
Sharon A. Sandridge
University of Florida, Gainesville, Florida

The authors of this proposal have been engaged for the past several years in research to determine the influence of central auditory deficits on perceived benefits of amplification by older adults. It has struck us that the older adults' satisfaction with, use of, and perceived benefits from amplification, regardless of the status of the central auditory mechanism, may be very much influenced by the original attitudes and expectations of the older adults toward hearing aids prior to the actual hearing aid fitting. We felt it might be useful to determine what the average senior citizen knows about the use of hearing aids and what the general attitudes and expectations toward hearing aid use are by elderly individuals.

The purpose of this study, therefore, was to determine, through the use of a questionnaire, the attitudes and expectations of older adults (60 years +) regarding the use of hearing aids. Subjects were queried as to expected benefits from hearing aid use, problems, cost, etc. A 53-item questionnaire was administered to 100 older adults to determine their expectations regarding hearing aid use. The questionnaire was designed to examine the older adults' expectations for the following factors: cosmetics, acoustics, communication benefits, comfort, ease of use, cost and upkeep, and attitudes toward hearing aid use. Subjects consisted of volunteers from organizations such as the American Association of Retired People, the Retired Faculty Club of the University of Florida, and the Older Women's League.

It is estimated by the Hearing Aid Industries Association that there are approximately 14 million Americans, many of whom are older adults, who might be helped by a hearing aid, but who do not use one. The investigators' clinical experience suggests that how satisfied an older hearing-impaired adult is with his or her hearing aid depends to a large extent on what their original expectations for hearing aid use were. Overly high expectations may result in the older adult being disappointed with the actual use of a hearing aid. On the other hand, negative expectations may prevent many older adults from seeking amplification as a remedy for their hearing difficulties. The information provided in this study on the expectations of older adults in general regarding hearing aid use may be useful in improving the prefitting counseling of older hearing-impaired adults by audiologists.

Faculty Private Practice: Implications for the Future of Audiology
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Some have suggested that the audiology educational training model contributes to the perceived low status of the profession. Does the typical graduate training program curriculum provide sufficient opportunity for the student to develop a sense of professionalism and professional autonomy?

In many cases the doctoral level faculty in audiology programs either have no opportunity to or no interest in participating in independent, university-sanctioned private practice. Some even have a basic disdain for clinical service. Under these conditions, the graduate student desirous of entering the clinical and/or private practice arena is denied the kind of "model" so typically seen in other clinical professions such as medicine or dentistry. In many cases, the young audiologists come into the field having experienced only the "sheltered workshop" of the academic institution. As a result, she/he has limited experience in fast-paced diagnostic environments, lacks substantial interprofessional skills, and has little or no knowledge of practice management strategies. Audiology curricula should include an experience that demonstrates that the practice milieu is much larger than the sound treated booth. The practice arena includes a much broader social, political, and economic environment that can be highly competitive. Students must be shown, by example, how to negotiate and survive the health care system.

For more than 10 years, the faculty of the Graduate Program in Communicative Disorders at the University of Louisville School of Medicine has encouraged graduate students to participate in their University-sanctioned, private audiology practice. In that the private office practice differs in many respects from the university teaching clinics, the student clinicians gain valuable experience in such areas as office finance, personnel relations, marketing, and practice development. Furthermore, student participation in the faculty-owned private practice provides an experience in an intense clinical diagnostic setting that allows significant development of both testing and diagnostic thought processes under the direct aegis of the same faculty members who teach theory in the classroom. The young audiologists comes away from the experience with an understanding of what it takes to establish and maintain an autonomous audiology practice.

This poster session will (1) present an overview of our faculty private practice plan; (2) out-
line the advantages accruing to the graduate student; (3) discuss the implications of this training model for the profession; and (4) present issues relative to use of this model in the establishment of a clinical doctoral degree.

Hearing Aid Success Over a One-Year Period

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With the increased interest in quality assurance comes a need to document the efficacy of the hearing aid fitting. The purpose of the present study was to determine and monitor the benefit received from the use of a hearing aid by 25 new hearing aid users. The longitudinal study was completed over three time intervals during the first year of hearing aid use. The measurement tool employed was the Hearing Handicap Inventory for the Elderly (HHIE); any change in score on the test pre- and post-fitting should reflect a true change in degree of handicap as a result of the use of the hearing aid.

The HHIE was administered pre-hearing aid fitting, after 3 weeks, 3 months, and 1 year of hearing aid use. The objective of the longitudinal testing was to measure changes in behavior and self-perceived handicap as a result of the hearing aid. The initial 3-week time period was selected because this is the trial period and the time frame for most hearing aid returns. The follow-up periods were to determine and try to ensure continued hearing aid acceptance.

Results of the study indicate a significant decrease in degree of handicap after 3 weeks of hearing aid use ($p<0.001$). After 3 months of hearing aid use, patients were less satisfied with the hearing aid. Preliminary analysis of the data after 1 year indicates that hearing handicap again decreases. This study indicates the necessity of following hearing aid patients for an extended period of time to ensure continued use of the aid and to familiarize patients with hearing strategies and aids such as assistive listening devices.

Hearing Impairment as a Major Determinant of Function in the Elderly

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Approximately 30 percent of individuals aged 65 years or older are hearing impaired, making hearing loss one of the three most common chronic conditions in the elderly. Commonly called presbycusis, it is characterized by a mild-to-moderate bilateral high frequency sensorineural hearing impairment with subsequent difficulty understanding conversational speech.

Although hearing loss affects a substantial number of elderly, there is limited and conflicting information on the impact of this condition on functional status and psychosocial well-being. Measures of functional health status provide us with insight into the prognosis of a condition, impact of intervention on general health, and the ramifications of a disease on an individual's quality of life. This study was designed to assess the association of hearing level with scores on the Sickness Impact Profile (SIP). The SIP is a 136-item standardized questionnaire for determining sickness related behavioral dysfunction.

Internists in six practices referred a consecutive sample of 50 patients over 65 years of age to the Bill Wilkerson Hearing and Speech Center. Of the patients referred by the practices 153 kept their appointments at the hearing center for testing. Of the total, 86 percent completed an assessment of hearing and the SIP.

The results showed that poor hearing was associated with higher SIP scores and increased dysfunction. Multiple linear regression was used to adjust for age, race, sex, education, mental status, near visual acuity, number of illnesses, presence of diabetes, presence of ischemic heart disease, and number of medications. After adjustment, a 10 dB increase in hearing loss was found to result in the following increases in SIP scale changes:

<table>
<thead>
<tr>
<th>SIP Scale</th>
<th>Change/10 dB</th>
<th>Per Cent Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical</td>
<td>2.8 (1.8–3.8)</td>
<td>24</td>
</tr>
<tr>
<td>Psychosocial</td>
<td>2.0 (0.8–2.3)</td>
<td>7</td>
</tr>
<tr>
<td>Overall</td>
<td>1.3 (0.1–2.5)</td>
<td>6</td>
</tr>
</tbody>
</table>
Efforts to improve hearing health care services might result in significant improvement on the life quality of the aged. Further research is needed to determine whether prevention, early identification, and amplification of hearing impairment will lead to better health outcomes.

**Interaural Time Delay and Sensorineural Hearing Loss: A Preliminary Study**

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Two preliminary studies were made to test the hypothesis that interaural time delay (ITD) in hearing-impaired subjects shows a dispersion across the frequency spectrum. In both studies, an alternating loudness balance method was first employed to equalize the loudness in each ear in order to ensure that the measured lateralization was based on time delay alone. This was followed by two different lateralization measurement methods and stimuli. In the first study, lateralization of pure-tone pulse trains (50 percent duty cycle), 250 to 1500 Hz with a delayed stimulus reaching one ear relative to the other, was used. Using the Method of Adjustment, stimuli with interaural delays from –500 to +500 μs were presented via earphones to two hearing-impaired and two normal-hearing subjects. In the second preliminary study, 250 ms bursts of 250 to 4000 Hz signals, 100 percent 60 Hz sinusoidally amplitude-modulated in the manner of Henning 1974, were presented with the same interaural delays to two different hearing-impaired subjects using the Method of Constant Stimuli (MCS). Regardless of the method and stimuli used, normal-hearing subjects exhibited only small variations in ITD (less than 80 μs) at different frequencies while hearing-impaired subjects exhibited large variations (up to 470 μs) of ITD at different frequencies. Subsequent work will focus on differentiating lateralization ability between older and younger hearing-impaired and normal-hearing subjects.

**Real Ear Measurements of FM via Direct Audio Input**

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FM amplification delivered via direct audio input (DAI) to the personal hearing aid alters the sound pressure level measurements at the tympanic membrane (TM). Therefore recommended settings of the FM receiver should reflect acoustic gain at the TM, as well as the client’s subjective evaluation among directional and omnidirectional microphone options.

**METHODOLOGY**

Real ear measurements were obtained with a variety of personal Phonic Ear hearing aids on school-age children. Instrumentation used for these measurements was the Aurora with a wide band signal stimuli. The microphone of the hearing aid was disengaged after the first real ear measurement was made. The FM signal then sent via Direct Audio Input (DAI) to the hearing aid with the FM auxiliary microphone held at the hearing aid microphone port and facing the soundfield speaker. The subject’s angle to the soundfield microphone was maintained by measurements during the test at a 30 degree angle. The chin of the subject was 15 inches from the bottom of the speaker while the distance to the hearing aid or FM microphones was maintained at 18 inches. Measurements were made with directional and omnidirectional Phonic Ear auxiliary microphones at 60 dB and 70 dB HL. Hearing aid microphone measurements were made at 60 dB HL.

**RESULTS**

Hearing aid acoustics are altered at the ear-drum with directional and omnidirectional microphones compared to hearing aid performance. The
difference between the directional and omnidirectional measurements were surprisingly similar. The difference between 60 dB HL and 70 dB HL output measurement from the soundfield speaker were also similar. There appears to be a peak of gain via DAI at about 750 Hz with roll off, or reduced gain beginning about 1000 Hz. Subject preference for FM volume setting varied with each microphone. Subject preference for volume setting did not always reflect the hearing aid gain for 1000 Hz. Some students set the FM volume wheel at a level to enjoy additional gain at 750 Hz which they perceived as "better" reception of the teacher's voice. Subject preference for omni or directional microphones was inconsistent in quiet. Subject preference for microphone directionality was more consistently in favor of the directional microphone in the actual classroom setting.

Discussion

Use of FM via DAI to the hearing aid for rehabilitation should include real ear measurements. It may be appropriate to sacrifice high frequency information to achieve distance communication with FM. This should, however, be closely scrutinized when delivering habilitation training to high frequency residual hearing. Real ear measurements should also be completed with the telecoil. Limitations of the system can be better explained to the client when objective measurements are obtained.

Sensitivity and Specificity of the "Head-Shake Test" for Detecting Vestibular System Abnormalities

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The head-shaking test (HST) has been reported to be a sensitive screening evaluation for peripheral vestibular system disease. A nystagmus with a predominate horizontal component and a fast phase directed toward the intact end organ may be observed following rapid horizontal head-shaking in patients with vestibular system disease (HSN). Previously, Kamei and Kornhuber reported the absence of HSN in normal subjects and the presence of HSN in 25 percent of their patients with central nervous system disease. Hain et al reported the presence of HSN in 100 percent of their patients with peripheral vestibular system disease (six subjects). The purpose of the present investigation was to determine the sensitivity and specificity of this simple and convenient screening test.

Methods

The subjects consisted of 116 consecutive dizzy patients seen for balance function testing. The test battery consisted of the HSN test, the conventional ENG test, and rotary chair testing (test fre-
frequencies from 0.01 to 0.16 Hz. The head-shake test was conducted prior to the ENG examination. Surface electrodes were placed bitemporally and above and below the eye with better corrected vision. Following calibration of the EOG the patients were instructed to close their eyes and shake their heads rapidly left-right in a sinusoidal manner (approximately 2 Hz) for 30 s after which Frenzel lenses were placed over their eyes. Subsequently, each subject was asked to open their eyes and stare straight ahead. EOG recordings were conducted during the head shaking and for 30 s after the eyes were opened.

RESULTS

There were a total of 116 examinations conducted. On 51 of these examinations (44 percent) abnormalities were found on caloric (e.g., directional preponderance, unilateral weakness, or caloric reversals) and/or rotary chair testing (e.g., abnormal phase or asymmetry). There were 23 instances of HSN (20 percent prevalence). The sensitivity and specificity of the HSN test was calculated. The results showed that the HSN test has a 25 percent sensitivity and 85 percent specificity when compared with the criterion measures of abnormal caloric and/or rotary chair testing. There was a 15 percent false-positive rate and a 75 percent false-negative rate.

DISCUSSION

The results of this investigation have suggested that the HSN test is a poor predictor of vestibular system disease as indicated by caloric and/or rotary chair test findings. It is possible that the poor intertest agreement occurred because the HSN test evaluates the upper end of the frequency range that is not measured with conventional caloric (e.g., low frequency) or rotary chair (e.g., low and mid-frequency) stimulation.

Simplified Promontory Electrode Recording Technique for Electrocochleography

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In recent years, clinical application of electrocochleography (ECochG) has increased. Although a factor in this renewed interest is the availability of ear canal electrodes which permit noninvasive measurement, few would question that ECochG is optimally recorded with promontory electrode placement. Amplitude with the promontory site is often 10 to 20 times larger than for the ear canal electrode site. Thus, the promontory ECochG can be recorded very quickly and detected in patients with serious hearing loss. Difficulties in placing the traditional promontory electrode and maintaining consistent placement during testing are most often cited as limitations of this technique. In this paper we describe a new approach for promontory ECochG measurement that overcomes these difficulties.

METHODOLOGY

There were 20 subjects with audiovestibular dysfunction of varied etiologies. All subjects underwent audiologic assessment, plus ECochG measurement with a new promontory electrode technique. ECochG was carried out intraoperatively (under general anesthesia) for 10 patients and in a clinic examining room (with local anesthesia of the tympanic membrane) for another 10 patients. ECochG was recorded with a commercially available evoked response system. The promontory electrode was a standard subdermal needle electrode, which was inserted under microscope view through the posterior-inferior portion of the tympanic membrane and placed on the promontory. The electrode was stabilized by a foam ear plug in the ear canal, which also served for stimulus delivery.

RESULTS AND DISCUSSION

Promontory electrode placement, including local anesthesia for clinic patients, required less than 2 minutes. Promontory electrode impedance never exceeded 12 k ohms (mean value of less than 7 k ohms) and placement was stable throughout testing for all patients. There were no instances of patient complications or refusal to be tested. Simultaneous three-channel ECochG recording with earlobe, ear canal, and promontory electrode placements showed a minimal 10-fold amplitude enhancement for the promontory site and marked differences in the summating potential/action potential (SP/AP) ratio among electrode sites. The promontory ECochG was detected with as few as 25 sweeps (in about 5 seconds) and in patients with even severe high-frequency hearing loss, whereas ear canal electrodes required over 1000 sweeps (or over 4 minutes of test time) and were not detectable in serious hearing loss. Based on these clinical experiences and ECochG data, we offer guidelines for application of the promontory electrode in diagnosis of Meniere's disease and in monitoring auditory function intraoperatively.