Field trials of a portable prototype digital hearing aid

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1:40–1:50 Break

1:50

3pPP5. Intensity discrimination of amplitude modulated stimuli in electric hearing. Fan-Gang Zeng and Robert V. Shannon (House Ear Inst., 2100 W. 3rd St., Los Angeles, CA 90057)

In cochlear implants loudness is a power function of electrical amplitude at low frequencies (<300 Hz) and an exponential function for higher frequencies [Zeng and Shannon, Science **264**, 564–566 (1994)]. In addition, the just-noticeable-difference (jnd) in intensity is inversely proportional to the slope of the loudness function. Implant speech processors generally use low-frequency modulation of a high-frequency carrier. Because the loudness functions are different for the modulator and carrier frequencies, this raises the question: Do the loudness and jnd of a modulated stimulus follow the modulator or the carrier? Intensity discrimination was measured for a 100-Hz sinusoidally modulated 1000-Hz sinusoid or pulse train in implant listeners. The jnd was measured either as an increment in the carrier level for a fixed modulation depth or as an increment in the modulation depth for a fixed carrier level. The results showed that the jnd function of the modulated stimuli is similar to the jnd function of the high-frequency carrier. At high sensation levels, implant listeners can discriminate extremely small changes in modulation depth (1%–2%). This implies that modulated stimuli can produce more jnd steps across the dynamic range than either the modulator or the carrier alone.

2:05

3pPP6. Preliminary evaluations of cochlear implantees using a wearable CIS processor. W. M. Rabinowitz, D. K. Eddington, J. Tierney, and L. A. Delhorne (Res. Lab. of Electron., MIT, 50 Vassar St., Rm. 36-789, Cambridge, MA 02139)

Each channel of a continuous-interleaved-stimulation (CIS) sound processor uses the compressed envelope of its bandpass-filtered output to modulate biphasic current pulses that are delivered to an intracochlear electrode. Pulses are interleaved across channels to avoid simultaneous field interactions, and pulse rates are high (~2000 pps/channel) to preserve temporal waveform cues. Using up to six monopolar electrodes directly accessible with the Ineraid implant, this strategy has shown considerable promise in acute evaluations conducted in the laboratory [Wilson *et al.*, Nature **352**, 236–238 (1991)]. In collaboration with a group in Innsbruck, a prototype portable real-time system has been developed (based on a DSP56001) that can realize some CIS implementations. Two subjects with 9 years of experience using the Ineraid analog sound processor are now wearing the CIS system on a full-time basis. After several weeks, one subject prefers the CIS strategy; however, objective measures of speech reception show no gains (*re*: the Ineraid processor). The second subject shows large gains with CIS and some evidence of continuing improvements. Without lipreading, he scores near perfect on relatively difficult (IEEE/Harvard) sentences in quiet; for speech reception in noise, he shows a deficit of 7 dB *re*: normal-hearing listeners. [Work supported by NIH.]

2:20

3pPP7. Field trials of a portable prototype digital hearing aid. Donna J. Gelnett, Jean A. Sullivan, Michael J. Nilsson, and Sigfrid D. Soli (House Ear Inst., 2100 W. 3rd St., Los Angeles, CA 90057)

A battery-operated digital processor connected to microphones and receivers located in left and right ear modules was built and used in a hearing aid field trial. Eight hearing impaired individuals with moderate to moderately severe hearing losses served as subjects. All subjects had symmetric hearing losses and were experienced binaural hearing aid users. Four binaural hearing aid algorithms were programmed into the processor for evaluation in the field trial. The algorithms all equalized the magnitude and phase insertion effects of the ear modules, but differed in their gain prescription. Two prescriptions based on the Articulation Index (AI), one on NAL-R, and a control prescription were evaluated in the two week field trial. Subjects rated each algorithm in seven categories. Objective measures of speech intelligibility in noise, including measures of binaural directional hearing, were taken before and after the field trial. Intelligibility and directional hearing was best with the AI prescriptions, although these prescriptions did not receive the highest subjective ratings. Details of the binaural algorithms and fittings, as well as objective and subjective measures of their benefit will be reported.

2:35

3pPP8. Combining ratings and paired comparisons in hearing aid evaluation. Harry Levitt, Arlene C. Neuman, and Christopher Oden (Ctr. for Res. in Speech and Hear. Sci., Graduate School and Univ. Ctr., City Univ. of New York, 33 W. 42nd St., New York, NY 10036)

The method of paired comparisons is a rapid and efficient technique which has proven to be useful in hearing aid evaluation. In the conventional application of the technique, the subject is limited to a binary decision. Greater efficiency can be obtained if, in addition, a confidence rating is obtained. A method for combining confidence ratings with paired-comparison data is provided. Data are presented in which a set of hearing aids differing in compression characteristics (compression ratio, release time) was evaluated by the traditional paired-comparison technique and the paired-comparison plus rating technique. Data will also be presented on the relative precision and efficiency of the two techniques.

2:50

3pPP9. Effects of hearing aids on binaural directional hearing in hearing-impaired individuals. Donna J. Gelnett, Michael J. Nilsson, and Sigfrid D. Soli (House Ear Inst., 2100 W. 3rd St., Los Angeles, CA 90057)

Binaural directional hearing, the ability of a listener to "tune out" noise from one direction and listen to a signal from another direction, improves speech intelligibility in noise. This ability is present in the hearing-impaired individual, but may be reduced as a result of hearing impairment. The present research examined the relationship between aided and unaided directional hearing, and directional hearing capacity—as measured under headphones with simulated head-related transfer functions and idealized amplification. Reception thresholds for sentences (RTSs) were measured with and without spatial separation of the speech and a spectrally matched noise for 25 hearing-impaired binaural hearing aid users. Directional hearing capacity for these individuals often fell within the normal range. Unaided RTSs were elevated 3–6 dB on average over the capacity measures. Aided RTSs were also elevated 2–3 dB over average scores for directional hearing capacity, suggesting that the interaural cues for binaural directional hearing are either inaudible or absent from the hearing aid output. Detailed analyses will be reported with respect to the type of hearing aid, hearing aid transfer function, and degree of hearing loss.

3:05

3pPP10. Sound localization in the median sagittal plane by hearing impaired listeners. Brad Rakerd, Timothy J. Vander Velde (Dept. of Audiol. and Speech Sci., Michigan State Univ., East Lansing, MI 48824), and William Morris Hartmann (Michigan State Univ., East Lansing, MI 48824)

Previously, it was reported that listeners with substantial high-frequency hearing loss have difficulty localizing sounds in the median sagittal plane [Vander Velde *et al.*, J. Acoust. Soc. Am. **94**, 1812(A) (1993)]. When asked to localize broadband noise, they performed near chance level on an elevation task and somewhat better, but far below normal, on a task that required that they distinguish between sources to the front, overhead, and rear. In the present study, these experiments were repeated with new subjects ($n=16$), and with the following variations, each introduced to encourage improved performance. (1) Low-frequency