and frequency discrimination were obtained as a function of reference frequency, reference displacement, and duration. Results obtained for low-frequency motional stimulation will be discussed and related to results reported in the literature for vibrational frequencies. In a second study, computer-generated sequences of International Morse code were delivered to the fingertip using high-amplitude square-wave stimulation. The ability to identify Morse code sequences was studied as a function of rate of presentation and length of the stimulus stream for subjects who were either naive or highly experienced in the traditional sending and receiving of Morse code. Results will be discussed in terms of the differences in learning and information transmission rates between naive and experienced subjects. [Work supported by NIDCD.]

11:15

5aBV9. Tactile and auditory measures of modulation resolution. W. M. Rabinowitz, C. M. Reed, L. A. Delhorne (Res. Lab. of Electron., MIT, Rm. 36-789, Cambridge, MA 02139), and J. M. Besing (Louisiana State Univ., Baton Rouge, LA 70803)

Limited signals derived from speech can provide effective supplements to speechreading. For a single-band speech envelope that is used to modulate a 200-Hz tone, the benefit to speechreading is, however, greater with auditory than tactile presentation. Is this due to differences between hearing and touch in the psychophysical ability to perceive amplitude modulation changes? Experiments are being conducted to assess amplitude modulation discrimination as a function of reference modulation depth (m=0 to 1) and modulation frequency (f_m=5 or 50 Hz). Carrier frequency is fixed at 200 Hz and stimulus presentation is via headphone for audition and a minishaker for taction. Preliminary results indicate that, on average, auditory thresholds for Δm are roughly 6 dB more sensitive than tactile thresholds. These results extend those previously available in the literature by considering cases of nonzero reference values for m, which may be particularly relevant to the information that is conveyed in the single-band speech envelope. [Work supported by NIDCD.]

11:30

5aBV10. Examining the effects of long-term experience using tactile supplements to speechreading. Edward T. Auer, Lynne E. Bernstein (Ctr. for Auditory and Speech Sci., Gallaudet Univ., 800 Florida Ave., N.E., Washington, DC 20002), and David C. Coulter (Coulter Assoc., Fairfax, VA 22031)

Typically, studies evaluating tactile supplements to speechreading are relatively short in duration and limited to the laboratory. Results from an ongoing 10-month study of the effectiveness of four tactile devices will be presented. Two devices encode voice fundamental frequency ($F0$): One encodes $F0$ as rate of vibration of a single solenoid, and the other as both rate and location of vibration on a linear array of eight solenoids. Two devices are 16-channel vibrotactile vocoders: One encodes wideband speech spectral information, and the other encodes the $F2$ range of frequencies. Subjects are adults with pre- and postlingual profound hearing impairments and are each assigned to use a single device for the duration of the study. Some of the subjects assigned to the single channel $F0$ device are also using a wearable version outside the laboratory. Comparisons of the effectiveness of all four devices over long-term exposure are being conducted using both traditional performance measures and novel measures of on-line cognitive processing. To data, 10–20 percentage point improvements in identification of words in sentences have been observed with the single channel device.

11:45

5aBV11. Effects of haptic movement on tactile pattern identification. Janet M. Weisenberger (Speech and Hear. Sci., Ohio State Univ., Columbus, OH 43210) and Christopher J. Hasser (Human Systems Ctr., Air Force Materiel Command, Wright-Patterson AFB, OH 45433)

Craig [Percept. Psychophys. **30**, 151–166 (1981)] found that tactile perception of complex vibratory patterns presented to the fingertip was better for "static" patterns that did not move across the display than for "scan" patterns that moved horizontally across the display. It is possible that Craig's finding resulted from the fact that observers did not have active control of the movement of the scan patterns. In the present work, tactile patterns were presented to the fingertip under three modes: a static mode in which stimuli did not move; a passive scan mode in which stimuli moved horizontally across the display under a stationary fingertip; and a haptic scan mode in which observers moved the fingertip and the display across a virtual surface containing the stimulus. Results with a set of simple patterns showed no differences across modes, with all modes yielding performance greater than 90% correct. To eliminate the possibility of ceiling effects, a second experiment was conducted with a more complex stimulus set. Preliminary results showed lower levels of performance for all presentation modes, with the haptic scan mode showing the best performance. Results are discussed in terms of development of tactile displays for sensory communication and telerobotics applications.

FRIDAY MORNING, 10 JUNE 1994 STUDENT CENTER, ROOM 407, 8:00 A.M. TO 12:15 P.M.

Session 5aNS

Noise and Structural Acoustics and Vibration: Active Noise and Vibration Control

Paul J. Remington, Chair
BBN Systems and Technologies Corporation, 10 Moulton Street, Cambridge, Massachusetts 02138

Contributed Papers

8:00

5aNS1. Passive-active isolator control of sound radiation from a raft-cylinder system. C. R. Fuller and E. Toffin (Vibration and Acoust. Labs., Dept. of Mech. Eng., VPI & SU, Blacksburg, VA 24061-0238)

This paper analytically investigates the active-passive control of sound radiation from an elastic finite cylinder containing a rigid raft mounted on active-passive isolators. The disturbance is narrow band and acts at various locations on the internal raft. The control cost function is constructed from radiated far-field pressure or supersonic shell structural wave-number estimates in contrast to the usual practice of minimizing vibration directly under the mount attachment point. A control effort term is included in the cost function to overcome the problem of an undetermined system when many isolators are used. The results demonstrate that, using an acoustic-based cost function in conjunction with a fully coupled control approach of the active-passive isolators leads to significant radiated sound reduction with a very low control effort. The mechanism is similar to "modal restructuring" observed in previous plate studies. The results are contrasted to direct

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