

(Research Laboratory of Electronics, MIT, Room 36-730, Cambridge, MA 02139)

Filtering simultaneous messages into different frequency bands prior to summation and presentation to a single ear was examined as an aid to message reception. Two or four concurrent sentences spoken by different talkers were presented through a single earphone to normal-hearing subjects. Listeners were instructed to write down the message spoken by the target talker, whose voice was indicated by an isolated lead-in message. In the reference condition, the wideband (0–4.5 kHz) sentences were simply summed; in various test conditions, the sentences were passed separately through different filters and then summed. Average intelligibility of the filtered sentences in the two-message task did not exceed that of the reference condition for any scheme tested. In the four-message task, however, performance improved significantly for three of five filtering configurations evaluated, the best of which resulted in 39% correct overall intelligibility compared to approximately 22% correct in the reference condition. Such a filtering scheme may be beneficial in future hearing aids that present multiple directional channels to a single ear. [Work supported by NIH.]

9:18

**MM5. The perception of temporally modified conversational and clear speech by hearing-impaired listeners.** R. M. Uchanski, L. D. Braida, N. I. Durlach, and C. M. Reed (Research Laboratory of Electronics, MIT, Room 36-749, Cambridge, MA 02139)

Hearing-impaired listeners find clearly articulated speech more intelligible than conversational speech [M. A. Picheny *et al.*, *J. Speech Hear. Res.* **28**, (1985)]. Acoustical measurements indicate that the temporal characteristics of clear and conversational speech differ [M. A. Picheny *et al.*, *J. Speech Hear. Res.* (in press)]. In particular, clearly articulated segments are nonuniformly longer than the corresponding segments in conversational speech [R. M. Uchanski *et al.*, *J. Acoust. Soc. Am. Suppl.* **1 77**, S54 (1985)]. For example, the percent increase in duration for fricatives and diphthongs is much larger than that for short vowels and voiced plosives. To evaluate the importance of these temporal differences we have measured the intelligibility of two types of processed speech materials: conversational speech with nonuniformly increased segment durations and clear speech with nonuniformly compressed segment durations. Results from several hearing-impaired listeners will be discussed. [Work supported by NIH.]

9:30

**MM6. Spectral compression, a processing scheme for single-channel sensory aids.** Richard R. Hurtig (Department of Speech Pathology and Audiology, University of Iowa, Iowa City, IA 52242)

Single-channel vibro-tactile discrimination and identification of vowels was assessed using a scheme which maintains the spectral shape of the complex speech waveform. A series of vowels and diphthongs were synthesized using the Klatt algorithm. Unlike conventional synthesis, the formant frequencies were set such that the first four formants fell under 660 Hz and the formant bandwidths were narrowed. This synthesis effectively generated 5:1 frequency compression. The synthesized segments sound speech like. Naive subjects were presented both discrimination and identification tasks. The stimuli were felt with a Audiological Engineering V1220 transducer. With no prior exposure discrimination exceeded 7%, and within a few hours of testing discrimination levels of 95% were achieved. Subjects were able to accurately identify many of the vowel segments. Furthermore examination of the confusions reveals patterns similar to those reported for auditory confusions of natural vowels. These findings appear to contradict the premise underlying the development of multichannel tactile aids and cochlear implants that the tactile senses and the impaired ear are incapable of extracting the appropriate information from a single complex speech waveform.

9:42

**MM7. Judgments of intonation and contrastive stress during lipreading.** Lynne E. Bernstein, Silvio P. Eberhardt (Sensory Aids Laboratory,

Department of Electrical Engineering, Johns Hopkins University, Baltimore, MD 21218), and Marilyn E. Demorest (Department of Psychology, University of Maryland Baltimore County, Catonsville, MD 21228)

As part of work to develop vibrotactile devices to convey voice fundamental frequency to hearing-impaired lipreaders, an experiment was conducted to investigate the visibility of contrastive stress and question-versus-statement intonation contours. Four sentences (“We will weigh you,” “We owe you a yoyo,” “Chuck caught two cats,” and “Pat cooked Pete’s breakfast”) with contrastive stress on one of the first three words and spoken as either statements or questions by a male and a female were presented from videodisk. Sentences were chosen to minimize indexical or affective information that might be used to judge stress or intonation. Subjects were tested in a six alternative forced-choice procedure with response alternatives labeled “question” or “statement” and stress position “1,” “2,” or “3.” Results suggest that contrastive stress and intonation can be judged visually at levels significantly above chance. Judgments of stress were significantly more accurate than judgments of intonation. Results will be discussed in terms of loglinear models to assess the relative independence of stress versus intonation in visual judgments. [Work supported by NIH.]

9:54

**MM8. Transformations of voice fundamental frequency for a vibrotactile device to aid lipreading.** Silvio P. Eberhardt and Lynne E. Bernstein (Sensory Aids Laboratory, Department of Electrical Engineering, Johns Hopkins University, Baltimore, MD 21218)

As part of the development of a wearable vibrotactile device to convey voice fundamental frequency  $F_0$  to hearing-impaired lipreaders, a study was conducted to compare transforms of  $F_0$ . Rothenberg and Moliter [*J. Acoust. Soc. Am.* **66**, 1029–1038 (1979)] reported that most errors in a tactile-alone task of judging stress and intonation in sentences were mislocations of the stressed word. We found that contrastive stress can be detected visually. The present experiment compared  $F_0$  transforms in a tactual-visual task. Transforms included: (1) direct glottal to tactile pulse; (2) linear transform with lowering of center frequency and shift in range; (3) similar to (2) with log of the normalized glottal period; (4) similar to (2) with the difference of logs of the current period and a weighted sum of previous periods; and (5) a constant pulse train during voicing. Subjects received tactile stimulation to the index finger by an AV-6 vibrator, and responses were labeled “question” or “statement” and one of three stress positions. Effects of the transforms and conditions of vision-only versus tactual-visual presentation will be reported. [Work supported by NIH.]

10:06

**MM9. Effects of filter configuration on categorical perception of tactually presented speech.** Rebecca E. Eilers, D. Kimbrough Oller, Edward Miskiel, Debra Moroff (Department of Pediatrics, University of Miami, P. O. Box 016820, Miami, FL 33101), and Ozcan Ozdamar (Department of Biomedical Engineering, University of Miami, P. O. Box 016820, Miami, FL 33101)

The effect of filter configuration on the relationship between auditory and tactual perception of speech was investigated via a 32-channel computer controlled electrocutaneous display and normal audition. Two 11-step synthetic speech continua, /a/ to /ə/ and /sta/ to /sa/, served as stimuli for study of three filter configurations: logarithmic, linear, and average (arithmetic mean of log and linear). Four well-practiced subjects performed two tasks with each stimulus continuum and each filter configuration: (1) a standard identification procedure where all 11 steps are categorized as either endpoint 1 or 11, and (2) a pairwise discrimination task (where equal interval stimuli were discriminated across the continuum). The same tasks were presented in the auditory modality for comparison purposes. Results indicate (1) a close correspondence between tactual and auditory perception, (2) categorical perception of the consonantal continuum and more continuous perception of the vowel continuum in both modalities, and (3) an interaction between filter configuration and speech syllable type that affects the degree of similarity between auditory and tactual functions. Implications in terms of theories of speech perception will be discussed. [Work supported by NIH.]