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metrically varied. In addition, estimates of the amount of partial masking for each condition were obtained from loudness matches. Preliminary results suggest that, for levels above 60 dB SPL, the pitch shifts associated with partial masking usually reduce or eliminate pitch changes with level. [Work supported by NIDCD and the Virginia Merrill Bloedel Hearing Research Center.]

2aPP12. Frequency discrimination in noise by untrained listeners. Lynne A. Werner (Dept. Speech & Hear. Sci., JG-15, Univ. of Washington, Seattle, WA 98195)

The frequency discrimination performance of adults, with no prior experience as listeners in psychoacoustic experiments, was examined for tones of 1000 and 4000 Hz presented in a background of broadband noise. The tones were presented at a signal-to-noise ratio expected to produce 80% correct detection. The level of the stimuli was either 45 or 60 dB SPL. The subjects were tested in a procedure similar to one used in infant psychoacoustics [Olsho *et al.*, Devel. Psychol. **23**, 627–640 (1987)]. Threshold values of Δf were found to be more similar to those of well-trained listeners at 4000 Hz than at 1000 Hz. The effects of stimulus level were similar to those reported by Dye and Hafter [J. Acoust. Soc. Am. **67**, 1748–53 (1980)] for well-trained listeners: Threshold Δf increased with increasing level at 4000 Hz, but not at 1000 Hz. This result suggests that the effects of level on frequency discrimination in noise are robust enough to be replicated in subjects with little listening experience. Further, the effects of level on human infants' frequency discrimination in noise may provide important information about why their frequency discrimination in quiet is more adultlike at high frequencies. [Work supported by NIDCD DC00396.]

2aPP13. On the perceptual asymmetry in frequency modulation discrimination. Tao Zhang, Lawrence L. Feth, and Ashok K. Krishnamurthy (Dept. of Speech and Hear. Sci. & Elec. Eng., Ohio State Univ., Columbus, OH 43210)

Several researchers have observed perceptual asymmetry in frequency modulation discrimination experiments. Porter *et al.* (1991) found that when listening to a formant transition followed by a frequency plateau, listeners detected the onset frequency much better for the falling transition than for the rising transition. Demany and McAnally (1994) discovered that the frequency difference limen measured at frequency maxima of a 5-Hz cosine frequency modulation is significantly smaller than at frequency minima. Heil *et al.* (1992) also observed asymmetry in the FM response in chick auditory cortex. They proposed that this effect was due to the asymmetrical lateral inhibition in the unit. Preliminary results in this lab indicated that this perceptual asymmetry also exists when listeners were asked to discriminate between a sinusoidal plus linear ramp frequency modulation (SLRFM) and a linear ramp frequency modulation (LRFM) (Zhang *et al.*, 1994). In this presentation, perceptual asymmetry is systematically studied for both rising and falling LRFMs. The effect of starting phase of a SLRFM signal is also examined. The experimental results are discussed in terms of existing modulation models and physiological explanations. [Work supported by AFOSR.]

2aPP14. Stimulus-driven, time-varying weights for comodulation masking release. Søren Buus (Commun. and Digital Signal Processing Center, Dept. of Elec. and Comput. Eng., 409 DA, Northeastern Univ., 360 Huntington Ave., Boston, MA 02115-5096), Lei Ji Zhang, and Mary Florentine (Northeastern Univ., Boston, MA 02115)

This study tests the hypothesis that CMR is mediated by "listening in the valleys" [S. Buus, J. Acoust. Soc. Am. **78**, 1958–1965 (1985)]. Detectability was measured for signals consisting of 6 consecutive 25-ms, 1-kHz tone bursts presented in a 50-Hz wide masker or in maskers consisting of seven 50-Hz wide noises, one critical band apart, with either correlated or uncorrelated envelopes. Each burst varied randomly around masked threshold according to Gaussian distributions with 3- or 6-dB standard deviations. For each listener and condition, the responses from 5000 trials were sorted to construct conditional psychometric functions for d' as a function of burst energy for 10 ranges of short-term level of the on-frequency masker band during the burst. The slopes of these functions for three normal listeners decrease markedly with increasing short-term masker level for the correlated multiband masker, but are largely constant for the other maskers. This indicates that the weight applied to the signal channel is high when the masker level is low and *vice versa* for the correlated masker, but is approximately constant for single-band and uncorrelated mutliband maskers. This finding provides direct evidence that CMR is mediated by "listening in the valleys." [Work supported by NIH-NIDCD R01DC00187.]

2aPP15. Temporal resolution and CMR can depend upon frequency. Sid P. Bacon and Jungmee Lee (Psychoacoust. Lab., Dept. of Speech and Hear. Sci., Arizona State Univ., Tempe, AZ 85287-1908)

An estimate of temporal resolution can be obtained by subtracting the signal threshold obtained in the presence of a modulated masker from that obtained in the presence of an unmodulated masker (yielding the modulated-unmodulated difference, or MUD). An estimate of comodulation masking release (CMR) can be obtained by measuring the MUD with both a broadband and critical-band masker. The present study obtained MUD and CMR for signal frequencies from 250 to 4000 Hz. The masker was unmodulated or sinusoidally amplitude modulated at rates from 2 to 16 Hz. For all rates and both masker bandwidths, the MUD increased monotonically with signal frequency; it was larger for the broadband masker, indicating an across-channel CMR. The CMR increased from a few dB at 250 Hz to 14 dB at 4000 Hz. The frequency effect (for MUD and CMR) was considerably reduced when the modulation depth (m) of the masker was decreased from 1.0 to 0.9, and was essentially eliminated at a depth of 0.5. The results of a forward-masking experiment using the unmodulated masker at both masker bandwidths suggest that the frequency effect is due to differences in the recovery of forward masking, and that suppression can influence CMR (and MUD) at very large modulation depths. [Work supported by NIDCD.]

2aPP16. Modeling modulation perception: Modulation low-pass filter or modulation filter bank? T. Dau, B. Kollmeier (Graduate College 'Psychoacoustics', FB 8, Postbox 2503, University of Oldenburg, 26111 Oldenburg, Germany), and A. Kohlrausch (IPO, Eindhoven, The Netherlands)

In current models of modulation perception, the stimuli are first filtered and nonlinearly transformed (mostly half-wave rectified). In order to model the low-pass characteristic of measured modulation transfer functions, the next stage in the models is a first-order low-pass filter with a typical cutoff frequency of 50 to 60 Hz. From physiological studies in mammals it is known that many neurons in, e.g., the inferior colliculus, show a *bandpass* characteristic in their sensitivity to amplitude modulation. Results from psychophysical studies of modulation masking also suggest some kind of bandpass analysis of modulation frequencies. Results of two experiments on modulation detection that allow discrimination between models incorporating a low-pass filter and those using a modulation filterbank are presented. In the first experiment, modulation detection thresholds were measured for noise carriers of bandwidths between 3 and 6000 Hz. In the second experiment, modulation detection for a sinusoidal carrier was measured in the presence of interfering modulation components with a bandpass characteristic in the modulation spectrum. The results from these experiments could not be simulated by a model including a modulation low-pass filter, but were successfully simulated by a model using a modulation filterbank.

2aPP17. Gating effects in CMR. J. W. Hall, III, J. H. Grose, and D. R. Hatch (Div. Otolaryngol./Head & Neck Surgery, Univ. North Carolina at Chapel Hill, Chapel Hill, NC 27599-7070)

CMR is sometimes smaller for gated than continuous maskers. Our current work on CMR for multiple, comodulated narrow noise bands indicates that the gating effect is minimized when the number of comodulated bands is large. The present study extends this work to the CMR paradigm where pure tone signal thresholds are obtained as function of modulated and unmodulated noise bandwidth. Results indicate that in unmodulated noise, gated and continuous thresholds do not differ, regardless of noise bandwidth. In modulated noise, thresholds are often higher for gated noise than continuous noise when noise bandwidth is narrow, but not when the noise bandwidth is considerably wider than the auditory filter bandwidth. These results may suggest that gating effects on CMR are