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Equal loudness level contours below 1 kHz

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3pPP12. Temporal integration mechanisms for complex tones consisting of unresolved harmonics. Louise J. White (Dept. of Experimental Psych., Univ. of Sussex, Brighton BN1 9QG, UK)

There is a large effect of duration on fundamental frequency ($F0$) discrimination for complex tones consisting of harmonics unresolved by the peripheral auditory system [C. J. Plack and R. P. Carlyon, J. Acoust. Soc. Am. **98**, 1355–1364 (1995)]. The present experiment investigated the mechanisms underlying this effect by measuring $F0$ discrimination for complexes of unresolved harmonics with continuous durations between 20 and 160 ms and for pairs of 20-ms unresolved complexes separated by a silent interval of between 5 and 80 ms. For the continuous signals, d' increased by a factor of 2.4 between the 20-ms signal and the 40-ms signal. For the paired signals d' increased relative to the 20-ms signal by a factor between 1.2 and 1.6, independent of the silent interval duration. This increase is similar to that predicted by signal detection theory. These data support the hypothesis that the pitch mechanism for unresolved harmonics can use a long integration window for continuous signals but reverts to a "multiple looks" mechanism, involving the efficient combination of discrete short-duration samples, when there is some discontinuity in the signal. [Work supported by MRC (UK).]

4:15

3pPP9. Equal-loudness level contours below 1 kHz. Morten Lydolf and Henrik Møller (Acoust. Lab., Fredrik Bajers vej 7B, Aalborg Univ., DK9920 Aalborg, Denmark)

Binaural equal-loudness level contours and the threshold of hearing have been measured on 25 otological normal-hearing subjects. In the frequency range from 50 Hz to 1 kHz the measurements were made in the free field for frontal sound incidence. From 20 to 100 Hz the experiments were made in a pressure field chamber with an inner volume for the test subjects of approximately 1 m³. The experiment is made with pure tones at each of the third octave frequencies in the frequency range. Loudness levels between 20 and 100 phon are measured. The data are going to be used for the standardization work in the Working Group ISO/TC43/WG1 for a revision of the international standard ISO 226.

4:30

3pPP10. Air versus bone conduction: An equal loudness investigation. Stefan P. Y. Stenfelt and Bo E. V. Hakansson (Appl. Electron., Chalmers Univ. of Technol., S-412 96 Göteborg, Sweden)

Air versus bone conduction loudness balance testing was performed at the frequencies 0.25, 0.5, 0.75, 1, 2, and 4 kHz in three groups of subjects: normal-hearing subjects, subjects with pure sensorineural hearing loss, and subjects with mixed hearing loss. The subjects were fitted with earphones (Koss portaPro) and a percutaneous bone transducer (HC-380) or an audiometric transducer (B71). Narrow-band noise was presented interchangeably between the earphones and the bone transducer. Balance testing was performed at each frequency and at different levels (30–80 dB HL in 10-dB steps) in the following manner: The sound pressure from the earphones was fixed and the subject under test adjusted the output level from the bone transducer for equal loudness similar to the procedure used in the conventional ABLB test. Preliminary results and their interpretation will be presented.

3pPP13. On the pitch identification of complex tones by the autocorrelation function (ACF) model. T. Sumioka and Y. Ando (Graduate School of Sci. and Technol., Kobe Univ., Rokkodai, Nada, Kobe, 657 Japan)

The pitch of the complex tone consisting of harmonics without the fundamental frequency is investigated. The pitch is called "residue pitch." If the pitch of the complex tone is insensitive to the relative phases of the spectral components, then the pattern transformation model [F. L. Wightman, J. Acoust. Soc. Am. **54**, 407–416 (1973)], which corresponds to the autocorrelation function (ACF) of a signal, may be identified. In this study, subjects were asked to control the frequency of a sinusoidal wave to match the pitch of a test stimulus with a different waveform which is generated by setting the different phases of each component. The components consist of frequencies 600, 800, 1000, 1200, and 1400 Hz with the same amplitude. The measured pitch of the stimulus was almost the same as that of the fundamental frequency (average: 201–202 Hz). The result, therefore, indicates that the ACF model is acceptable.

4:45

3pPP11. Estimation of the new equal-loudness level contours. Hisashi Takeshima (Sendai Natl. College of Technol., 1, Kitahara, Kami-ayashi, Aoba-ku, Sendau, 989-31 Japan), Yôiti Suzuki (Tohoku Univ., Sendai, 980-77 Japan), Masazumi Kumagai (Sendai Natl. College of Technol., Sendai, 989-31 Japan), and Toshio Sone (Tohoku Univ., Sendai, 980-77 Japan)

The current international standard of the equal-loudness level contours specified in ISO 226 is found to involve large errors, epecially for frequencies below 1 kHz. In the past 10 years, a series of experiments has been conducted for full revision of ISO 226 in ISO/TC 43. At the final stage of this project, the new equal-loudness level contours should be drawn from available data points. To do this, the use of an appropriate model for loudness perception is actually useful. A loudness function is proposed by combining that proposed by Lochner and Burger to express the steepness near threshold with the two-stage model proposed by Atteave to consider the loudness-comparison process. Equal-loudness levels are then estimated according to the following procedure. (1) Parameters of the loudness function are estimated from the experimental data by the nonlinear least-squares method. (2) The estimated parameters are smoothed along the frequency axis with B-spline functions. (3) The equal-loudness level contours are calculated by using estimated parameters and the threshold of the hearing curve. Through this procedure, the new equal-loudness level contours are determined from the experimental data obtained hitherto.

3pPP14. Pitch and pitch strength of iterated rippled noise: Is it the envelope or fine structure? William A. Yost (Parmly Hearing Inst., Loyola Univ., 6525 N. Sheridan Rd., Chicago, IL 60626)

Iterated rippled noise (IRN) stimuli are generated by a cascade of delay and add networks; where delay, gain after delay, and number of iterations of delay and add are the variables controlling IRN stimuli. IRN stimuli produce a sound with a tonal and a noisy percept. The tonal component is related to regularity in the stimulus and the noisy component is related to a lack of regularity. Autocorrelation is a useful measure for describing the degree of regularity in IRN stimuli. However, the envelope of IRN stimuli also has a regular and an irregular structure that can be revealed by autocorrelation. Thus, the perception of IRN stimuli could be based on fine structure and/or envelope. Autocorrelation based on fine structure is different when the delayed noise is subtracted (gain<0) than when it is added (gain>0) to the undelayed noise. However, the autocorrelation function for the envelope is the same for both addition and subtraction. Discrimination between IRN stimuli generated with addition and subtraction as a function of highpass filtering suggests that processing of IRN stimuli is based on fine structure. [Work supported by NIDCD.]