Modal analysis of a Caribbean steel drum

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Session GG. Musical Acoustics I: Extended Vocal Techniques, and Production and Perception of Music

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Chairman's Introduction—8:30

Invited Paper

8:35

GG1. Harmonic singing and the Harmonic Choir. David Hykes (The Harmonic Arts Society, 1047 Amsterdam Avenue, New York, NY 10027)

In harmonic singing, the singer emphasizes a selected upper harmonic of the vocal pulse. In this way, he can sing two notes at once, the fundamental and the selected harmonic. Members of the Harmonic Choir have developed techniques for the following effects: (1) The fundamental is constant while the selected harmonic varies; (2) the fundamental varies in a melody while the selected harmonic remains constant, leading to parallel harmony; (3) both the fundamental and the selected harmonic vary, either in converging or in diverging directions. The Choir together performs unaccompanied works which are composed but not scored. Different performances follow a common path but differ in many details.

Contributed Papers

9:20

GG2. Regional cerebral blood flow for singers and nonsingers while speaking, singing, and humming a rote passage. C. Formby (Departments of Communicative Disorders and Neurology, University of Florida, Gainesville, FL 32610) and R. G. Thomas (Department of Biometry, Emory University, Atlanta, GA 30322)

Two groups of singers ($n = 12,13$) and a group of nonsingers ($n = 12$) each produced the national anthem by (1) speaking and (2) singing the words, and by (3) humming the melody. Regional cerebral blood flow (rCBF) was measured at rest and during each phonation task from seven areas in each hemisphere by the 133-Xe-inhalation method. Global, intrahemisphere, and interhemisphere rCBF were generally similar across phonation tasks and did not yield appreciable differences among the nonsingers and the singers. From these rCBF data, it was concluded that: (1) the normal production of a familiar passage by speaking, singing, or humming requires the interaction of both cerebral hemispheres more or less equally and (2) these tasks are relatively independent of musical training. [Research supported by NIH.]

9:35

GG3. Note coupling in Caribbean steel drums. D. Scott Hampton, Clifford Alexis, and Thomas D. Rossing (Department of Physics, Northern Illinois University, DeKalb, IL 60115)

The acoustical behavior of Caribbean steel drums is characterized by strong coupling between the different note areas [T. D. Rossing, D. S. Hampton, and J. Boverman, J. Acoust. Soc. Am. Suppl. 1 **80**, S102 (1986)]. This makes it difficult to maintain tuning stability, especially in the harmonics of the various notes. An improved new design makes use of double grooves to separate the various note areas. By means of holographic interferometry, the note coupling was compared in two comparable double second (alto) drums, one with single grooves and one with double grooves. The drum with double grooves exhibits less internote coupling at high amplitudes, and better tuning stability.

9:50

GG4. Modal analysis of a Caribbean steel drum. Uwe J. Hansen (Department of Physics, Indiana State University, Terre Haute, IN 47809) and Thomas D. Rossing (Department of Physics, Northern Illinois University, DeKalb, IL 60115)

Modes of vibration and coupling between adjacent note areas in a double-second steel drum are compared by several complementary techniques, including impact modal analysis, holographic interferometry, and recording sound spectra under varying conditions of damping. Each note has at least one overtone mode tuned to a harmonic of the fundamental frequency. Striking the A_4^b note area, for example, excites not only a second harmonic A_5^b in that same note area but also the strategically located A_5^b and A_6^b note areas adjacent to it. The coupling depends upon amplitude in a nonlinear way.

10:05

GG5. Physical correlates of perceptual similarity among synthesized approximations to selected targets. G. L. Gibian, D. R. Clements, E. N. Harnden, H. E. F. Williams, and R. K. Massaro (Physics Department, American University, Washington, DC 20016)

Experiments are described to evaluate the relative merits of several measures for predicting the perceived closeness of synthesized approximations to selected steady-state portions of musical tones ("targets"). Approximations were synthesized by means of audio-rate frequency modulation [Chowning, J. Audio Eng. Soc. **21**, 526–534 (1973)] using a computer program developed in a previous paper [Gibian *et al.*, J. Acoust. Soc. Am. Suppl. 1 **81**, S46 (1987), and Audio Engineering Society Preprint #2380]. The importance of including level- and frequency-dependent error weightings according to the Fletcher–Munson curves will be assessed. This information can be useful to composers who are blending electronic and traditional instruments in mixed ensembles.