

Individual Differences in Cognitive, Musical, and Perceptual Abilities

Lisa M. Mauney and Bruce N. Walker
School of Psychology
Georgia Institute of Technology
654 Cherry Street
Atlanta, Georgia 30332-0170

Summary

The increasing use of auditory graphs and sonifications in technology is leading to a wider variety of system users, which, in turn, suggests a need for research in how differences between individual listeners affect sound interpretation. Frequency discrimination, tempo discrimination, working memory, and spatial reasoning are fundamental skills for interpreting auditory displays. As a first step in this arena, the current study investigates the question of whether or not cognitive abilities and musical experience predict frequency and tempo discrimination in individuals. Participants in the study were 30 undergraduate students from Georgia Institute of Technology and 20 adults from the Atlanta, Georgia community. These participants took part in two sessions of experiments, one that comprised the auditory discrimination task and the other that comprised the cognitive ability tasks. In the cognitive ability session, participants completed the Operation Span (Ospan) task as a measure of working memory capacity and the Raven's Progressive Matrices task as a measure of spatial reasoning. In the auditory discrimination session, participants performed a tempo and a frequency discrimination task that utilized the method of constant stimuli and required 2-alternative forced choice responses. The tempo discrimination task used standard tempo speeds of 150 ms inter-click interval (ICI), 250 ms ICI, and 350 ms ICI and required a decision to determine which interval contained the slower tempo or the faster tempo. The frequency discrimination task used standard tones of 250 Hz, 840 Hz, and 1600 Hz and required a decision to determine which interval contained the lower frequency or the higher frequency. The Quick function, a psychometric function, was used to find the difference thresholds for the three standard tempos and the three standard frequencies. Demographics on age, gender, handedness, years of playing a musical instrument, and years of formal musical training were also collected.

A correlational analysis of all variables (250 Hz, 840 Hz, 1600 Hz, 150 ms, 250 ms, 350 ms, Ospan, Raven's, age, gender, handedness, years of playing a musical instrument, years of formal musical experience) was performed. Paired-samples t-tests on the Weber fractions of the six threshold means were also performed to determine if there were any significant differences between the frequency thresholds and the tempo thresholds. Lastly, multiple hierarchical regressions were performed on each of the six dependent variables to identify significant predictors of frequency and tempo discrimination. The paired samples t-tests show a significant difference between 250 Hz and 840 Hz and between 250 Hz and 1600 Hz, a violation of Weber's Law. However, this violation of Weber's Law may be explained by the small sample size used in the study. The t-tests also show a significant difference between the means of 150 ms and 250 ms and between the means of 250 ms and 350 ms. The results of the regression analyses show that good performance on Raven's seems to predict lower thresholds at 1600 Hz. The results also show that good scores on Ospan appear to predict lower thresholds at 350 ms ICI. In addition to these significant predictors from the regression analyses, there are many significant correlations that provide further support that cognitive abilities are related to frequency and tempo discrimination.