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Sources of variability in reflectance measurements on normal human ears

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Purpose: The development of acoustic reflectance measurements to augment middle-ear diagnostic testing may lead to noninvasive tests that provide information about the middle ear that is currently unavailable from standard audiometric testing. One factor limiting the development of diagnostic tests that rely on ear-canal reflectance measurements is that normal-hearing human ears show inter-subject variations of up to 10 dB between 100 and 4000 Hz and up to 25 dB between 4000 and 10000 Hz [e.g., Voss, S.E., and Allen, J.B. , 1994, "Measurement of acoustic impedance and reflectance in the human ear canal," J. Acoust. Soc. Am., 95, 372-384]. The work presented here aims to quantify inter-subject variability relative to intra-subject due to temporal changes in either an individual ear or the measurement system, methodological issues including estimates of ear-canal area, and measurement location within the ear canal.

Methods: Reflectance measurements were made on both live-human and human-cadaver ears.

Results: In live-human ears, reflectance was measured in five separate measurement sessions over a time period of four weeks in each of five human subjects (10 ears) to compare intra-subject versus inter-subject variability. The variability among ears from different subjects was significantly greater than the variability within repeated measurements on a single ear. Reflectance measurements in human-cadaver ears demonstrate that reflectance depends on both the ear-canal location and variations in the ear-canal area. However, these variations are also small relative to inter-subject variations.

Conclusions: Both sets of experiments suggest that intra-subject variability in reflectance measurements is not a significant factor in the observed inter-subject variability.