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Title:

Considerations in modeling the nonlinearity of human hearing for loudness perception

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Abstract:

The relationship between human loudness perception and sound pressure level is non-linear. In the past, several experiments have been conducted to investigate this behavior. A simplified model for this relationship is the assumption of a factor of two in loudness perception for a level difference of 10 dB for pure tones with a loudness level above 40 phon. This assumption is used, for example, in the Zwicker Loudness Model, which is standardized in ISO 532-1, and in the Moore-Glasberg-Schlittenlacher Loudness Model, standardized in ISO 532-3. However, the Sottek Hearing Model Loudness, standardized in ECMA-418-2, uses a more elaborate approximation of the nonlinear perception of humans, which results in a more accurate estimate of loudness compared to the results of listening tests. Consequently, the estimated loudness from this method must differ from the other models that use simplified approximations.

In this article, we review the existing data on the nonlinearity of human hearing in terms of loudness perception and analyze the effects of different approximations in the various loudness standards ISO 532-1, ISO 532-3, and ECMA-418-2. The results show that the consequence of a more precise approach to human nonlinear perception leads to significant differences in the estimated loudness in sone.

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