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Modelling categorical loudness perception for arbitrary listeners and sounds

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While "classical" loudness models predict loudness in sone using the concepts of Stevens' compressive power law, (subdivided) categorical loudness perception after Heller follows the compressive logarithmic Weber-Fechner law. To bridge the gap between both approaches, this contribution reviews various steps towards a loudness model that predicts categorical loudness (in categorical units, CU) for normal and hearing-impaired listeners for arbitrary sounds. It uses a (modified) classical loudness model for stationary signals to derive the loudness in sone and a nonlinear transformation from sone to CU. This transformation is approximated by a cubic polynomial equation wich is derived from categorical loudness data of 84 normal-hearing subjects. The model parameters are further set to predict the standard isophones that are in good agreement with the equal loudness level contours derived from categorical loudness data. Also, the model predicts the loudness functions near threshold both for normal and hearing-impaired listeners and can be extended to predict duration-dependent loudness perception. Since categorical loudness can be measured more easily and directly than loudness in sone, the current modelling approach can be experimentally tested and can be used in various applications, such as, e.g. hearing aid processing and fitting procedures.