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## Speech Processing for Cochlear Implants and Bimodal Stimulation

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BACKGROUND:
An increasing number of cochlear implant (CI) recipients have usable acoustic hearing in one or both ears post-operatively. Several recent studies have shown that such people usually benefit from bimodal stimulation in comparison with separate use of either the CI or an acoustic hearing aid (HA). In general, the different devices function autonomously and are fitted to each user independently. However, future improvements in performance are likely if the acoustic and electric modes of stimulation are designed to provide compatible and complementary information.

AIMS:
Previous research has related the pitch perceived with electric stimulation to that perceived acoustically. Although providing compatible pitch sensations may be beneficial with bimodal stimulation, it is also important to ensure that loudness is perceived appropriately via each mode of stimulation. The present study aimed to investigate loudness perception in CI subjects who had usable acoustic hearing.

METHOD:
Eight subjects provided loudness estimates for a band of noise presented at 10 levels spanning the dynamic range (DR) of their acoustic hearing. Subsequently, the levels of the same noise that corresponded to loudness categories of ‘soft,’ ‘comfortable,’ and ‘loud but OK’ were determined when the subjects listened via their CIs.

RESULTS:
There was a wide range of DRs across subjects for the acoustically presented signal. On average, the level ratio between the ‘loud but OK’ and ‘soft’ categories was about 15 dB. In contrast, CI sound processors are typically programmed for users such that the DR for acoustic input signals is approximately constant (e.g., 35 dB).

CONCLUSIONS:
To optimise loudness perception with bimodal stimulation, amplitude compression functions in HAs should be programmed individually so that the acoustic signals are perceived appropriately relative to the electric stimuli delivered by the CI.