

Related Phenomenon:

The perceived harmonic content of a complex tone changes with loudness level!!

e.g. triangle and square waves sound **brighter** at 100 *dB* than *e.g.* @ 60 *dB*

This is simply due to fact that the human ear has an ~ **logarithmic** response to sound intensity, which indeed is a **non-linear** response to sound intensity.

$$\text{Loudness, } L = 10 \log_{10} (I/I_o)$$

Compare the **ratio** of loudnesses *e.g.* for the 3rd ↔ 1st harmonics of a square wave @ 100 *dB* to that for 3rd ↔ 1st harmonic loudness **ratio** for a square wave @ 60 *dB*:

$$\left(\frac{L_3}{L_1} \right) \Big|_{\text{square wave @ 100 dB}} = 90.5\% \quad \leftarrow$$

Not the same fractional amount!!!

$$\left(\frac{L_3}{L_1} \right) \Big|_{\text{square wave @ 60 dB}} = 84.1\% \quad \leftarrow$$

Loud complex sounds are thus perceived to be brighter-sounding than the same complex sounds at reduced loudness! See UIUC Physics 406 Lecture Notes on Fourier Analysis for more details...