

By Dr. Derek Conte

In a March, 2016 article (BRIGHTSIDE, "The Workings of the Ear") I described the anatomy and physiology of the human ear apparatus and its ability not only to hear the world around us but to give us our primary sense of balance which allows us to move about on two legs without constantly falling down. But there are other features of the ear such as our range of hearing different frequencies, which frequencies we are most sensitive to and our perception of them. This is known as the field of psycho-acoustics.

Sound and acoustics have always fascinated me. I have been designing and building stereo loudspeakers since 1990 and my designs have appeared in over a dozen publications and showrooms. It has been a wonderful exploration for me.

The potential range of human hearing is 20 Hz - 20,000 Hz (also known as cycles per second) but this range narrows with age especially in the higher frequencies and the losses are more pronounced in men than in women. The normal frequency range of the male speaking voice is 85 - 180 Hz, whereas the female speaking voice ranges from 165 - 255 Hz. A pipe-organ can reach down to 16Hz while cymbals, violin and piccolo can get all the way up above 15,000Hz.

By the chart above you can see the frequencies where human hearing is most sensitive. On the left is the scale of loudness in decibels (dB), with each increment 10X louder than the one below. 60 dB is 10X louder than 50dB and 70dB is 100X louder than 50dB. At the bottom is the scale of frequencies. Bottom left are very low frequency sounds (20 Hz) with frequency increasing, in octaves, going to the right (16,000 Hz). An example on the low end: a truck growling uphill in low gear can be heard far down the street and might vibrate your windows. Jingling keys are an example on the high end.

Our greatest hearing sensitivity is in the 2,000 - 5,000 Hz range with peak sensitivity at 3,500 Hz, so it is necessary for very low and very high-frequency sounds to be much louder in order for us to hear them equally well with our most sensitive ranges.

Sibilant consonant sounds like "S, T and F" occupy the 2,000 - 5,000 Hz frequency range and offer valuable detail to the sound of words. Without these higher-frequency cues, distinguishing between similar-sounding words becomes much more difficult. Irritating sounds are also found in this range and are believed to strike the primitive, deep-brain centers of the limbic system and evoke strong emotional responses.

The crying of a child is in the 1,000 - 5,000 Hz range and is ALSO centered at 3,500 Hz! It is very interesting, and likely not accidental, that our highest sensitivity is tuned to the frequency of a crying child... or a woman in distress? Yet at the same time a baby laughing is perceived as one of the most pleasant human sounds along with the sounds of thunder, rain, flowing water and applause. I might also add to the list a string quartet by Franz Schubert or Gregorian chant!

References: http://www.simonheather.co.uk/pages/articles/science_hearing.pdf (fascinating!)

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