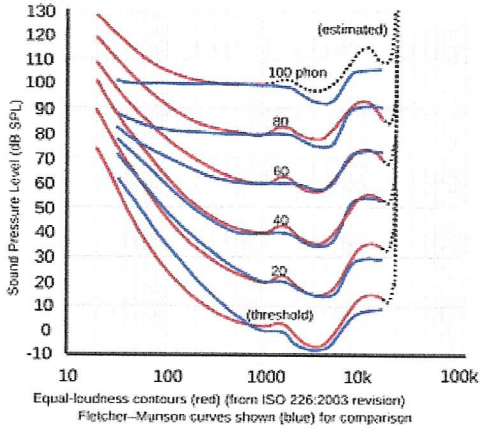
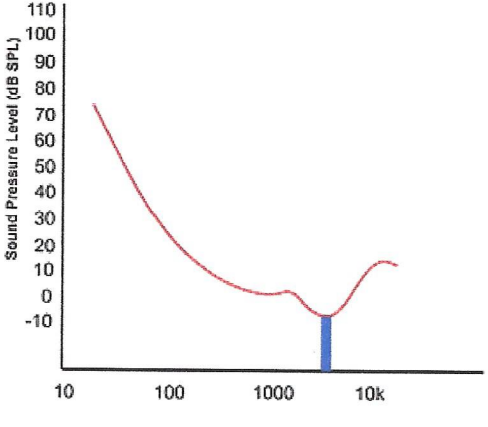
researchers Fletcher and Munson who investigated our hearing sensitivity as a function of level and frequency. The results presented on the right, is a set of graphs that show ears sensitivity to level and frequency. As you see, our hearing system is a complex beast, changing its sensitivity based simultaneously on how loud a signal is and is pitch (frequency).



For the purposes of this article, we only care about the bottom curve labeled "threshold." This is the lowest audible level (for the average population) of a tone plotted on a per frequency basis. It becomes very clear from this research that our hearing system is far more sensitive in the mid-range frequencies of roughly 2 to 4 KHz. If there is going to be an audible distortion, that is where it is going to manifest itself first.

The next figure shows what our distortion needs to do to reach the level of audibility. Naturally I have picked the mid frequencies which correspond to the highest sensitivity for our ears. For jitter to therefore not be audible, it needs to be at a level below this.



Computing the above level in the context of jitter distortion can be rather complicated mathematically. Fortunately for us, Dunn and Hawksford in their Audio Engineering Society paper performed this analysis for us. *Their conclusion was that the blue bar is as small as 20 picoseconds of jitter.* Let me repeat: it takes just 20 trillionth of a second for the distortion created by jitter to rise up to the level of audibility! Inverted, unless you can demonstrate that jitter is below 20 picoseconds, you can't claim it is inaudible.

As I explained in one of my articles on jitter, mass market AVRs routinely have jitter over their HDMI input of 4,000 to 7,000 picoseconds based on measurements performed by Paul Miller in HiFi News (UK magazine). S/PDIF distortion was far lower but still measured in hundreds of picoseconds, not 20. So clearly our blue bar exceeds our red threshold of hearing in such gear.