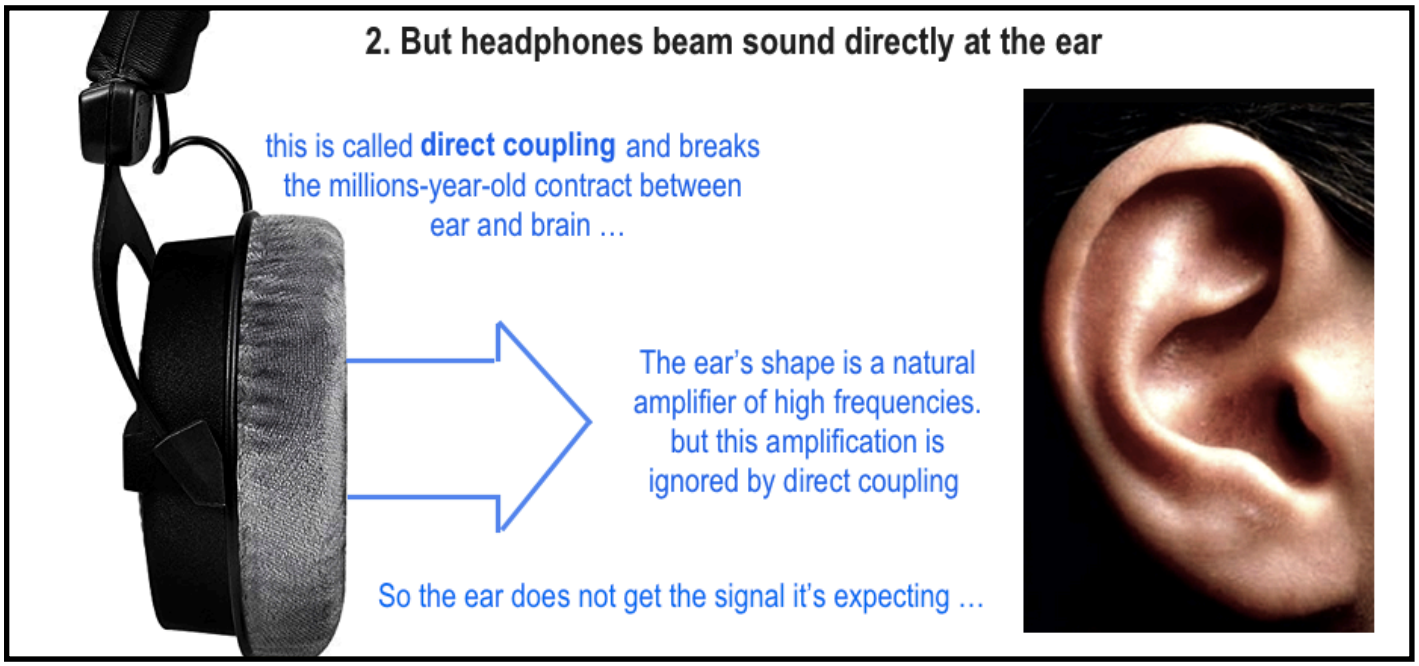
Headphone Essentials 5 (tl;dr version):

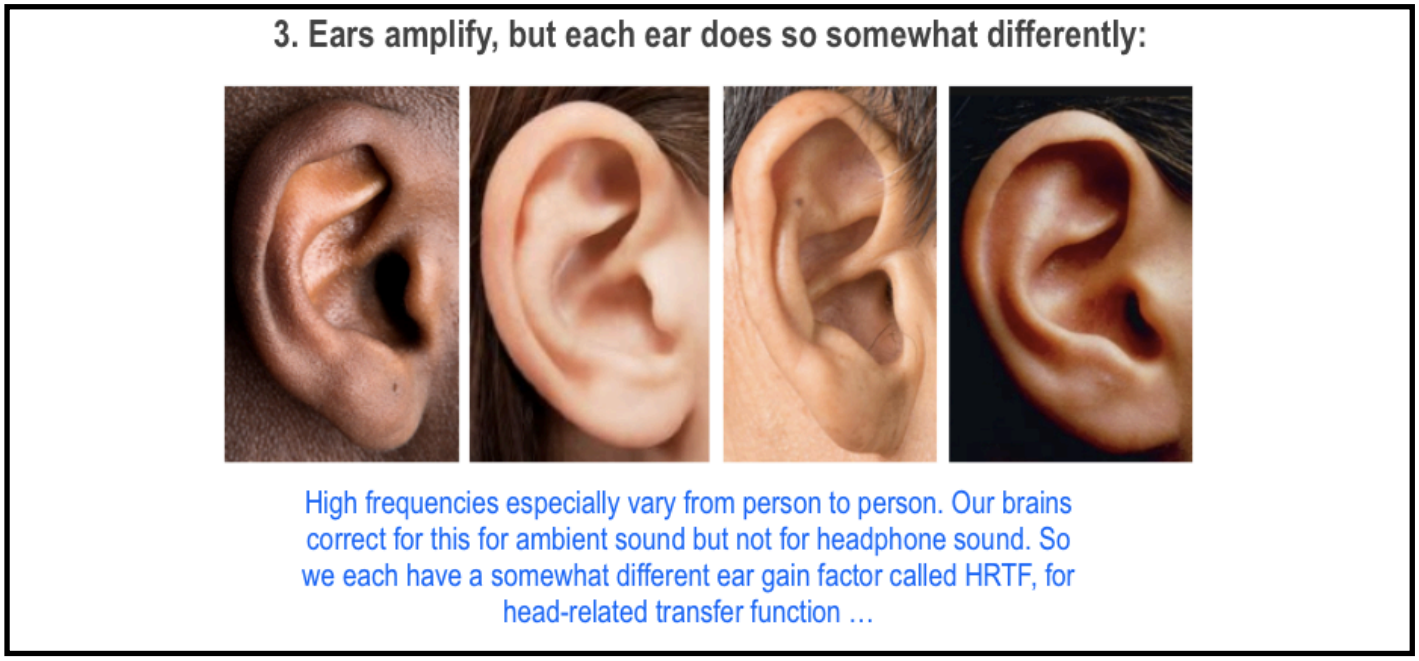
The search for headphone flat

Note: this document is part of a instructional series. If you would like to start with more foundational information, see Headphone Essentials.

When shopping for a headphone we quickly notice that some headphones have more bass or more treble than others. It's natural to ask what the accurate/correct levels for bass, mids and treble are. This is a question that is not so easily answered…

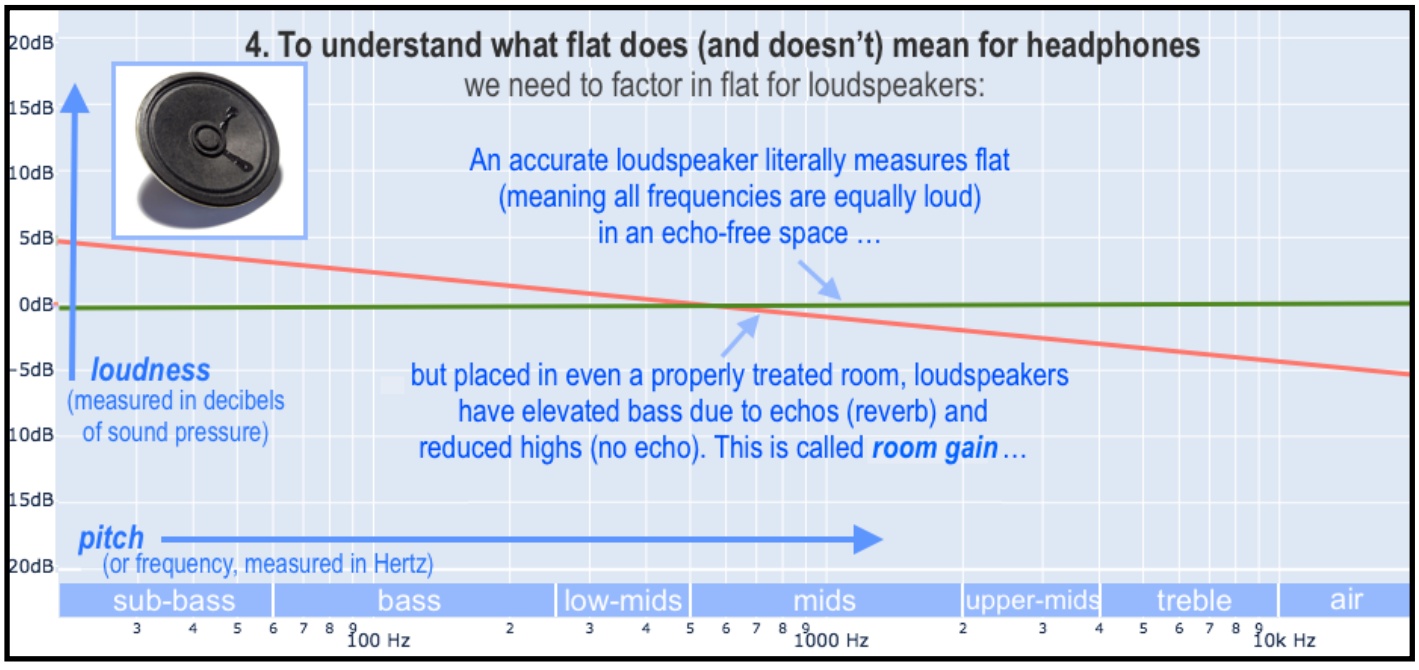


And there's another factor…

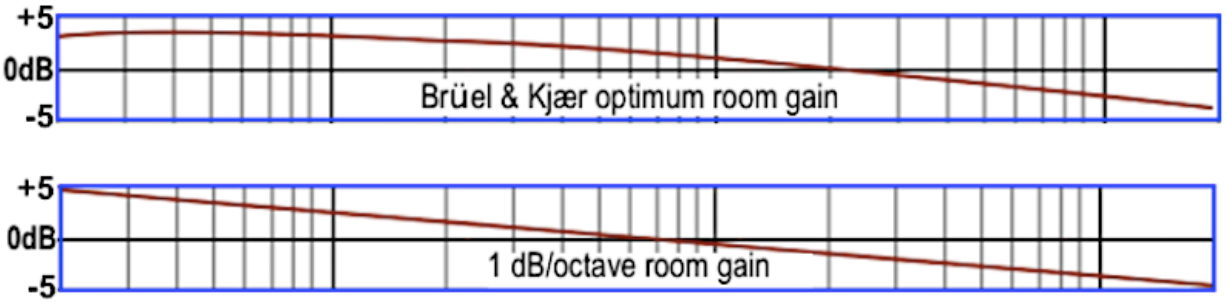


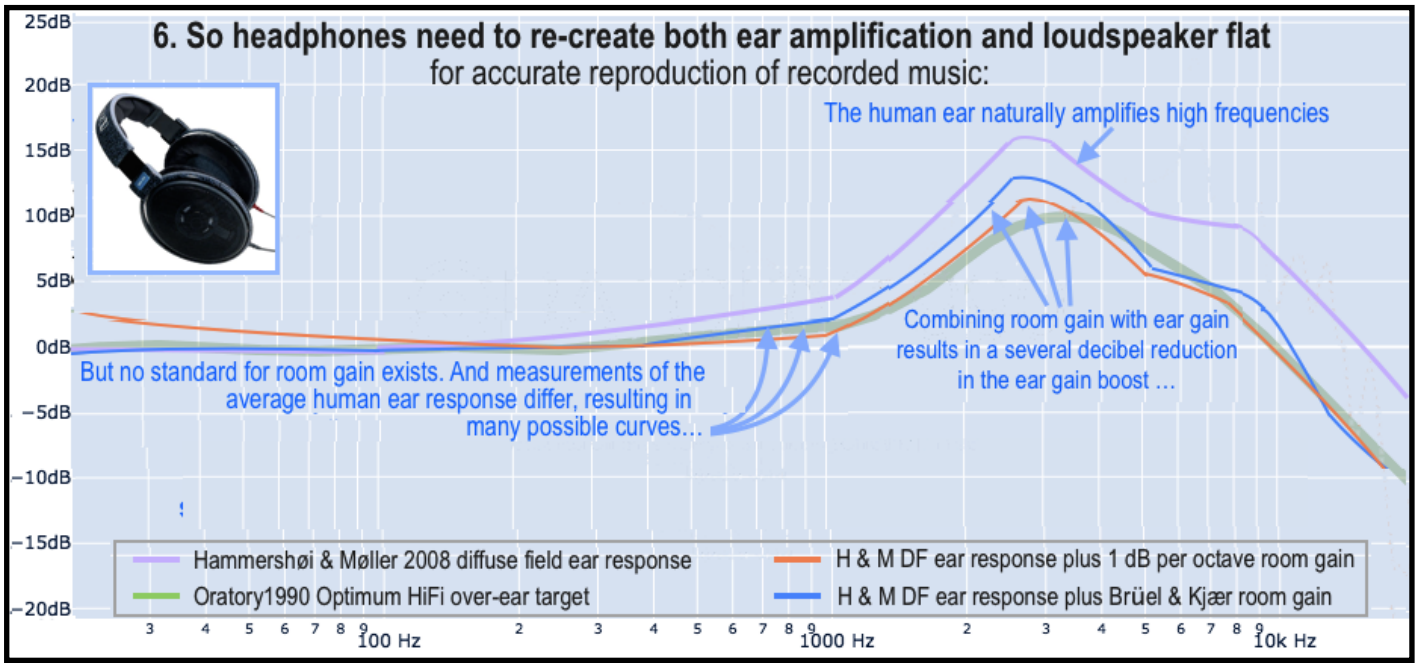
With the invention of the first headphones in the late 1800s audio engineers had to learn to add the missing loudness boost to the high frequencies so speech would sound clear and unmuffled.

And still another factor — in our day headphones are commonly used for listening to recorded music as well as speech. Recorded music has traditionally been produced to sound correctly on loudspeakers in a room of a home…



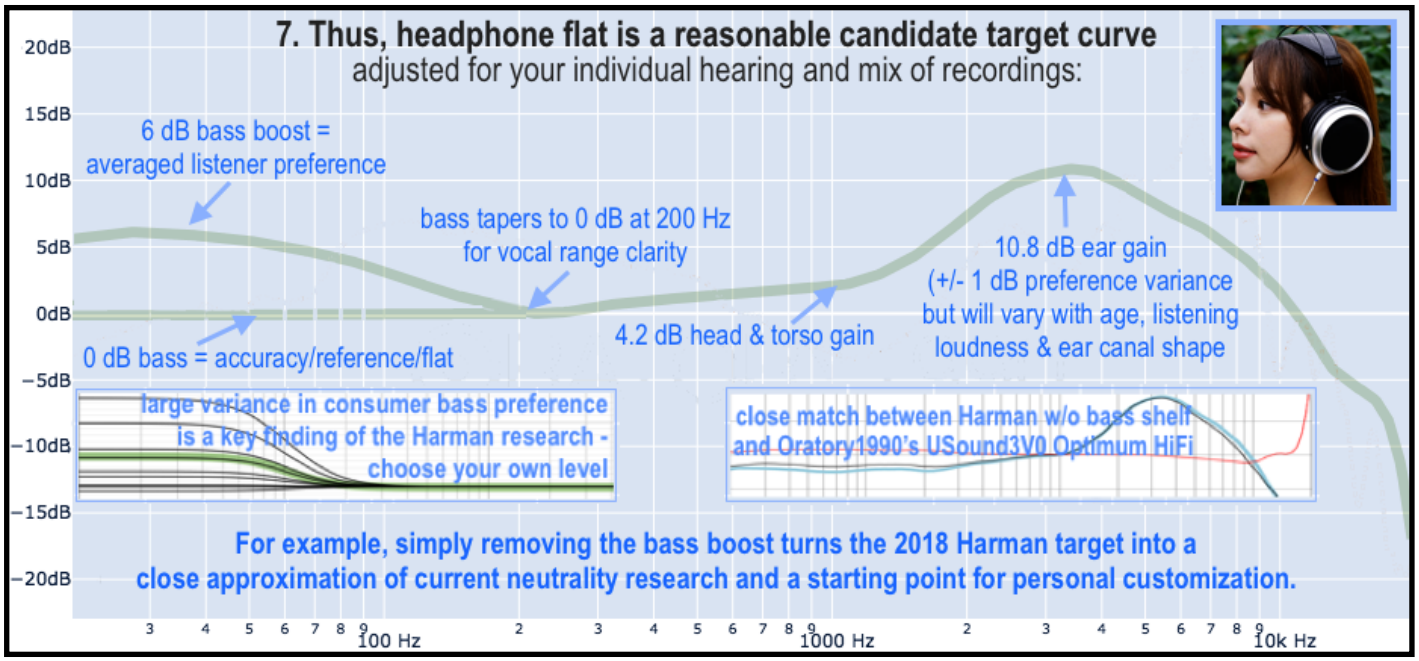
No standard for room gain exists, even for studio use. But several room gain targets are in use. Here are two of the more common:





The elevated pale purple line in slide 6 shows an average ear amplification for sound arriving with equal loudness from all directions. This is called the *diffuse field* response. Slide 6 also shows three different curves that result when ear amplification (or ear *gain*) and room gain are combined, depending on which particular ear gain research and which particular room gain slope is chosen. Crucially, the ear gain hump on the right is *significantly reduced* from the diffuse field's height by the two room gain candidates.

Going back to the original question, none of these is — or even can be — said to be the correct headphone "flat" curve. This is not only because recording studios make recordings while listening in very different room gain environments (as shown by the graph in slide 5). In addition, recording engineers now have to find a compromise that works when playing back the same recording in such diverse ways as car audio, boom boxes and the tiny speakers built into smart phones and laptops. Each recording studio is on its own for that.

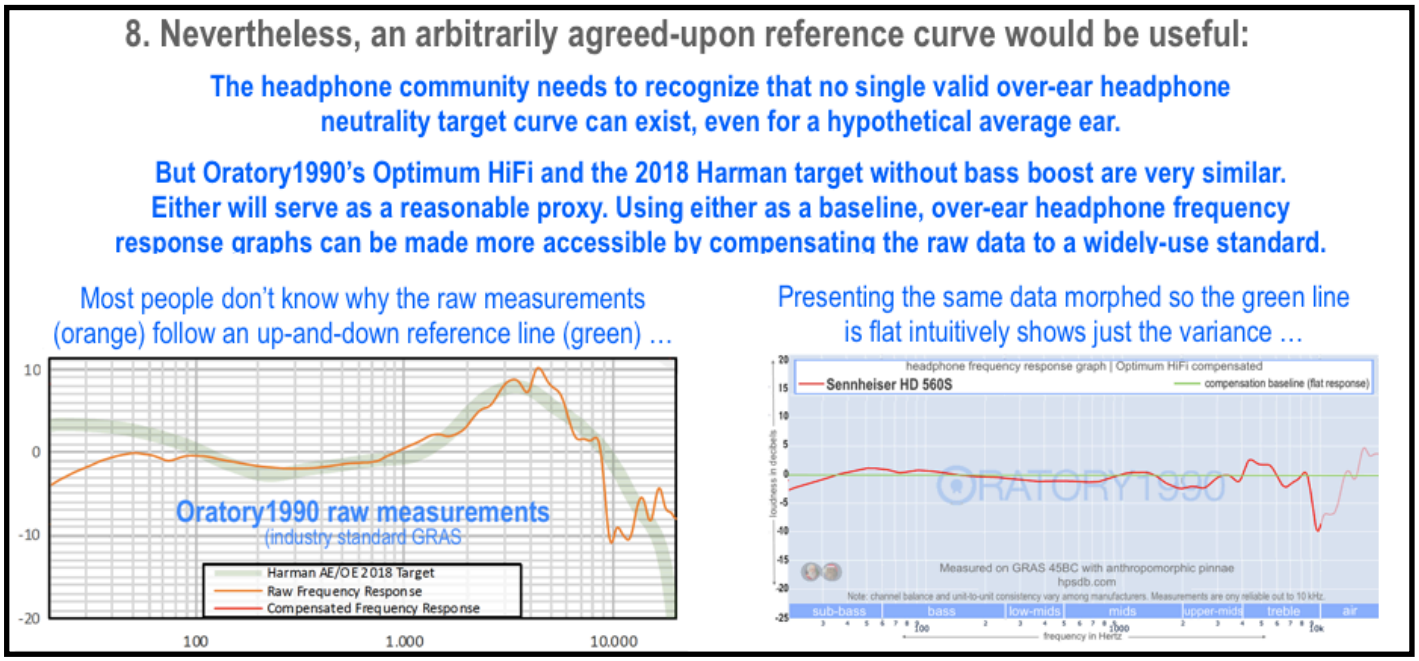


We can get fairly close to defining what flat/neutral/accurate means for over-ear headphones. But we can't, even in theory, nail it. In-ears are no different, and a reasonable proxy for in-ear flat is still up for grabs. But even if such standards existed, they wouldn't be recipes for the production of good-sounding headphones. Most consumers want a "fun" sound — meaning boosted bass and often less elevated highs. This is what sells. Headphone hobbyists tend to enjoy the endlessly different flavours of headphone frequency response tunings as an end in itself.

A (reasonably) flat, or reference headphone, such as the Sennheiser HD 560S, is a useful tool in the recording studio. Many also find it desirable for listening to purely acoustic music such as folk, world, jazz and classical. But some agreed-upon standard for headphone flatness would be highly useful as a baseline from which to specify where any given headphone departs from mere frequency response accuracy.

The unmodified (2018) Harman over-ear/on-ear headphone target has been gaining traction as a compensation target for presenting headphone frequency response in graph form. But the Harman curve's bass boost is nothing like a flat/accurate response, however enjoyable many people may find it to be. And it certainly doesn't make sense to show a well-engineered planar

magnetic headphone as being bass-deficient, when in fact its bass is likely very close to flat. All that's needed is to remove the Harman bass boost and let each potential purchaser decide for her/himself whether a headphone that shows as being bass-boosted is in fact what she/he wants.



Credits:

- The graphs with pale blue backgrounds were generated from the amazing resources at the Headphone Database.
- The ear photographs are from an open access paper on morphological variations.
- The recording studio variability graph is from this AES paper.
- The bass preference graph in slide 7 is from material by Sean Olive.
- The comparison graph between Optimum HiFi and Harman 2018 was on Jaakko Pasanen's GitHub page but seems to be no longer available.
- The photograph in the first slide is my own. All other photographs are to the best of my knowledge in the public domain and are excluded from this document's copyright.