

Headphone Essentials 2:

Basics of Headphone Sound

© Dale Cotton, 2020. All rights reserved. **Beta version 1.**

You may re-circulate this document. You may not claim authorship or copyright to it.

Note: this unit assumes understanding of the concepts and vocabulary explained in the preceding unit: *Basics of Musical Sound*. See <http://daystarvisions.com/music/index.html>.

Audio reproduction involves several sound variables. Here are the four most commonly discussed as they apply to headphones:

1. Frequency response (FR)



Fig. 1: millisecond view of a complex orchestral passage
(photo credit: Johannes Jansson, Wikimedia Commons)

This refers to the bass-tenor-alto-soprano sort of thing. Tuba, tenor sax, piccolo for another set of examples. The common vocabulary for this in audio reproduction is bass-mids-treble for low frequencies, middle frequencies and high frequencies respectively. *Upper-mids* is a narrow but important range of high frequencies between the mids and treble. Technically, the frequency ranges are defined as follows:

Frequency ranges:

Bass: 16-256 Hz* (approximate notes: C0 to middle C4)

Sub-bass: 20-60 Hz, mid-bass: 60-125, high: 125-256

Mids: 256-2048 Hz (C4-C7)

Low-mids: 256-512, Mid-mids: 512-1024, high/upper-mids: 1024-2048

Treble: 2.048 kHz-16.384 kHz (C7-C10)

Low treble: 2048-5120, mid-treble: 5120-10240, high-treble: 10240-20480

You can hear what the various frequency ranges sound like at:

<https://www.szynalski.com/tone-generator/>

*Frequency is measured in Hz = Hertz = air pressure changes per second

Basics of Headphone Sound

Few headphones exist which match any known standard of FR accuracy; few even come close. Some reproduce all or part of the bass too loudly or not enough, some reproduce all or part of the middle frequencies too loudly or not enough, etc. A primitive EQ (equalization)

Commonly used **frequency response vocabulary**:

- **Neutral/flat/accurate** = all frequencies from sub-bass to treble are subjectively even in loudness.
- **Bright** or **cool/cold** = the high frequencies are louder than the low or middle frequencies.
- **Warm** or **dark** = the lower frequencies are louder than the middle or high frequencies.
- **Mid-focused** or **mid-forward** = the middle frequencies are louder than the low or high frequencies.
- **V-shaped** or **U-shaped** or **fun tuning** = bass and treble both emphasized with reduced mids.
- A **relaxed** tuning (frequency balance) = something like warm/dark in that the high frequencies are toned down (but often the bass and mids are fairly neutral).

applet is available in Window's Media Player and in MacOS/iTunes. If you have EQ available to you, experiment with raising and lowering the various adjustment points while listening to music to get a feel what this means. But be aware that your existing headphone has its own imbalance that is contributing to what you are hearing.

As you might expect, for music and video production work the closer to FR accuracy/neutrality the better.

Audio professionals have developed a colourful vocabulary over the years to describe too much loudness in specific frequency response areas (courtesy MON):

Boom: 80 - 160 kHz

Mud: 100 - 400 kHz

Honk: 500 - 1 kHz

Grit: 1 - 2.5 kHz

Fatigue: 2.5 - 5 kHz

Sibilance: 5 - 8 kHz

Hiss: 10 - 20 kHz

2. Dynamics

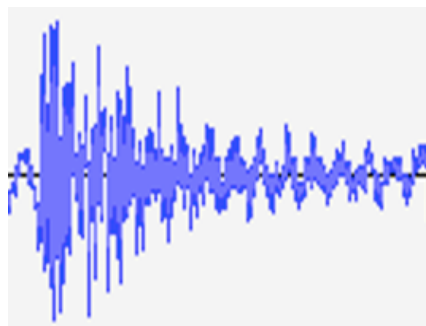


Fig. 2: milliseconds view of a drum strike

Another audio reproduction variable is dynamics. This is how responsive the headphone is to changes in the loudness of a given frequency. Most headphones do a very good job with dynamics. A headphone that cannot achieve the full range from quietest to loudest has dynamic compression. A headphone that cannot respond quickly enough to sudden changes in loudness is slow in speed and so lack a certain sense of precision.

3. Detail

Another variable is detail reproduction. Expensive headphones often excel at allowing the listener to hear the faintest details in a recording. Many listeners mistake extra loudness of the treble frequencies for detail.

Surprisingly, simple accuracy of frequency response plays an especially important role in detail reproduction. Perhaps you're used to listening to a particular track on a pair of headphones that have a weak frequency response over a certain range of sounds. When listening to the same track on a different pair of headphones you may hear a quiet instrument or voice that you hadn't been aware of as being in the track. Yet all that's happening is likely that the second pair of headphones plays that frequency range at a louder (and more accurate) level.

4. Sound Stage and Imaging

Sound stage is an illusion created by the proper recording and playback, especially of at least 2-channel (stereo) sound. Sound stage gives you the sense of sounds coming from all three dimensions of space — left-right, back-front, up-down. *Imaging* is how precise or pinpoint the location of each sound source is within the sound stage.

Commercial recordings are engineered to provide this spatial illusion via playback on loudspeakers. Headphones are handicapped at reproducing sound stage by their inability to do *crosstalk* (the fact that the left ear can hear sound from the right speaker and vice versa). There is a special recording technique called *binaural* that targets headphone listening.

Other considerations

The phrase *sound signature* is used for the combination of frequency response, dynamics, detail, sound stage, etc. for a given headphone. In other words — how it handles sound reproduction as opposed to its build quality, comfort, etc. The *tuning* of a headphone is its frequency response.

Finally, here's an important but potentially confusing point. Many headphone enthusiasts are not looking for accuracy, especially in the area of frequency response. Enthusiasts tend to treat frequency response like a menu of flavours at a restaurant. Buy one headphone that does bass-emphasis really well, buy another headphone that does V-shape really well, etc. With the other sound variables the attitude is generally the more the better — the more dynamics, detail retrieval, sound stage size, and imaging accuracy the better.



And that's a wrap. Be sure to proceed to the next wild and crazy instalment in the epic Headphone Essentials series: *HE-3 The Basics of Headphone Types and Tech* (<http://daystarvisions.com/Music/index.html>).